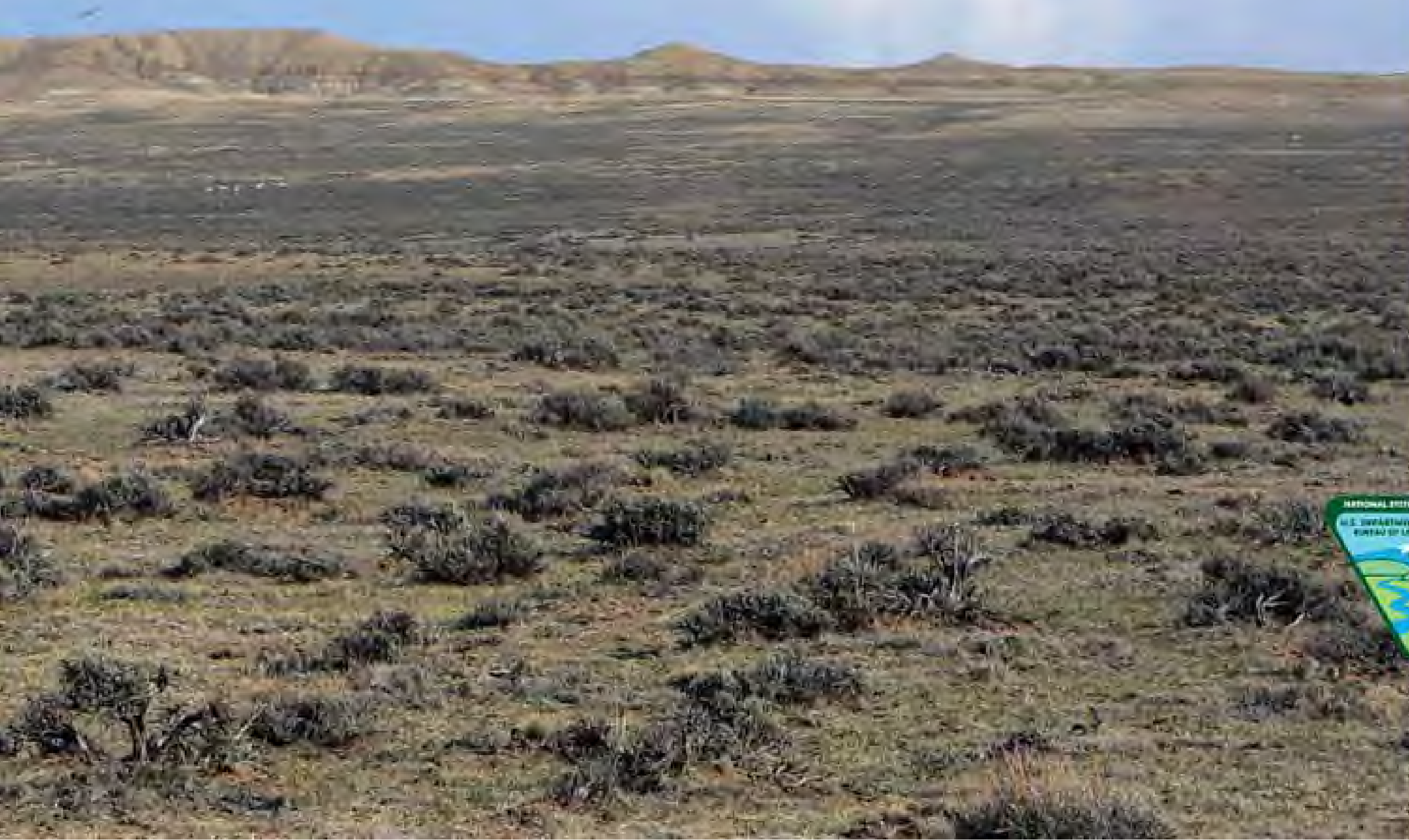
DRAFT

Environmental Impact Statement
Continental Divide-Creston
Natural Gas Development Project

Volume I

November 2012



BLM

Wyoming High Desert District – Rawlins Field Office

The BLM's multiple-use mission is to sustain the health and productivity of the public lands for the use and enjoyment of present and future generations. The Bureau accomplishes this by managing such activities as outdoor recreation, livestock grazing, mineral development, and energy production, and by conserving natural, historical, cultural, and other resources on public lands.

BLM/WY/PL-13/002+1310

Draft Environmental Impact Statement (EIS)
BP-America Production Company and 20 Other Operators
Continental Divide-Creston Natural Gas Development Project

Lead agency:	U.S. Department of the Interior, Bureau of Land Management (BLM)
Project location:	Carbon and Sweetwater Counties, Wyoming
Comments & further information on the Draft EIS:	David Simons, Team Lead Bureau of Land Management, Rawlins Field Office 1300 North Third Street Rawlins, WY 82301-2407 Phone: (307) 328-4200
BLM Authorized Officer responsible for preparing the Draft EIS:	Dennis Carpenter, Field Office Manager

Abstract

The Operators propose to develop oil and gas resources within the 1.1 million-acre Continental Divide-Creston (CD-C) project area located in Carbon and Sweetwater Counties west of Rawlins, Wyoming. The CD-C project is an in-fill project with over 4,400 existing oil and gas wells and associated infrastructure. The Proposed Action would include the development of an additional 8,950 gas wells at down to 40-acre downhole spacing. Construction would begin after the issuance of the Final EIS and Record of Decision and approval of individual Applications for Permit to Drill and/or approved right-of-way grants. Construction would require approximately 15 years. The productive life of the project would extend an estimated 30 to 40 years beyond that.

The Proposed Action and five alternatives were analyzed in detail in this Draft EIS. The alternatives are:

- The Proposed Action;
- Alternative A, 100-Percent Vertical Drilling;
- Alternative B, Enhanced Resource Protection;
- Alternative C, Surface Disturbance Cap—High and Low Density Development Areas;
- Alternative D, Directional Drilling; and
- Alternative E, No Action.

Under all the action alternatives, the analysis includes impacts produced by development activities on federal, state, and private mineral estate. In addition to the applicable BLM environmental protection measures listed in Appendix C of the EIS document, mitigation is recommended that would lessen the environmental effects of the proposed project.

Written comments on the Draft EIS will be accepted by the Rawlins Field Office of the BLM throughout a 45-day public comment period beginning on the date the United States Environmental Protection Agency publishes a Notice of Availability for this EIS. A summary of the comments and responses to the comments will be provided in the Final EIS.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
High Desert District
Rawlins Field Office
P.O. Box 2407 (1300 North Third Street)
Rawlins, WY 82301-2407

TAKE PRIDE IN AMERICA

In reply refer to: 3160 (WYD03)

Dear Reader:

The Draft Environmental Impact Statement (EIS) for the Continental Divide-Creston Natural Gas Development Project is available for your review and comment. It was prepared to analyze the potential impacts of a proposal from BP America Production Company and others for natural gas field development. The Continental Divide-Creston (CD-C) project area encompasses approximately 1.1 million acres (1,672 square miles) in an existing gas-producing area located west of Rawlins, Wyoming in Carbon and Sweetwater Counties.

The CD-C project is an in-fill project with over 4,400 existing oil and gas wells. The Proposed Action includes the development of an additional 8,950 gas wells, including construction of supporting infrastructure—access roads, pipelines, electrical power lines, a central gas-processing plant, and water management and disposal facilities. Construction would begin after the issuance of the Final EIS and Record of Decision and approval of individual Applications for Permit to Drill and/or approved right-of-way grants. Construction would require approximately 15 years. The productive life of the project would extend an estimated 30 to 40 years beyond that, for a combined total project life of 45 to 55 years.

This Draft EIS analyzes the Proposed Action and the following five alternatives in detail:

- Alternative A, 100-Percent Vertical Drilling;
- Alternative B, Enhanced Resource Protection;
- Alternative C, Surface Disturbance Cap—High and Low Density Development Areas;
- Alternative D, Directional Drilling; and
- Alternative E, No Action.

Total new surface disturbance under the Proposed Action would be approximately 47,200 acres, or 4.4 percent of the CD-C project area.

The Draft EIS was prepared pursuant to the National Environmental Policy Act (NEPA), as well as other regulations and statutes, to address possible environmental and socioeconomic impacts that could result from implementation of the project. The Draft EIS is not a decision document. Its purpose is to inform the public and the decision maker of the impacts associated with implementing the proponent's proposal, to evaluate alternatives to the proposal, and to solicit comments from other agencies and the public. Comments are being sought to ensure that the EIS includes an appropriate range of alternatives to the Proposed Action and that the analysis of environmental effect is appropriate and complete.

The CD-C Draft EIS is available for download on the following website:

http://www.blm.gov/wy/st/en/info/NEPA/documents/rfo/.html

The Draft EIS is also available for review during normal business hours at the following locations:

- BLM Wyoming State Office, 5353 Yellowstone Road, Cheyenne, Wyoming
- BLM High Desert District Office, 280 Highway 191 North, Rock Springs, Wyoming
- BLM Rawlins Field Office, 1300 North Third Street, Rawlins, Wyoming
- Carbon County Library, 215 West Buffalo Street, Rawlins, Wyoming

If you wish to submit comments, we request that you make them as specific as possible, with references to page numbers and chapters of the document. The most useful comments will contain new technical or scientific information, identify data gaps in the impact analysis, and/or provide technical or scientific rationale for opinions or preferences. Please refer to "Continental Divide-Creston EIS" in your correspondence. Written comments will be accepted by fax, email, or letter for 45 days following the publication of the Notice of Availability in the Federal Register by the U.S. Environmental Protection Agency. Please provide your comments to:

Bureau of Land Management
Attn: David Simons
Rawlins Field Office
P.O. Box 2407 (1300 North Third Street)
Rawlins, WY 82301-2407
Fax: 307-328-4224
Email: BLM_WY_Continental_Divide_Creston@blm.gov

Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you may ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. The BLM will not consider anonymous comments. Comments may be published as part of the NEPA document and other related documents. All submissions from organizations or businesses will be made available for public inspection in their entirety. For further information concerning the document, please contact David Simons at (307) 328-4328.

Sincerely,

Dennis J. Carpenter
Rawlins Field Office Manager

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ACRONYMS AND ABBREVIATIONS

ºF	degrees Fahrenheit
µeq/l	microequivalents per liter
µg/L	micrograms per liter
µg/m3	micrograms per cubic meter
µmhos/cm	micromhos per centimeter
AADT	annual average daily traffic
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ac-ft	acre-feet
AML	appropriate management level
ANC	acid neutralizing capacity
AO	Authorized Officer
APD	Application for Permit to Drill
AQTSD	Air Quality Technical Support Document
APE	area of potential effect
AQRV	Air Quality Related Values
AR4	IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report
ATT	*Artemisia tridentata ssp. tridentata* (basin big sagebrush*)*
ATVP	*Artemisia tridentata ssp. vaseyana and Artemisia tridentata ssp. pauciflora* (mountain big sagebrush)
ATW	*Artemisia tridentata ssp. Wyomingensis* (Wyoming big sagebrush)
AUE	animal unit equivalent
AUM	animal unit month
BA	Biological Assessment
BACT	Best Available Control Technology
bbl	barrel
Bcf	billion cubic feet
BCLLC	Blankenship Consulting LLC
BLM	Bureau of Land Management
BMP	Best management practice
BP	BP America Corporation
B.P.	before present
BSC	biological soil crust
CAAQS	Colorado Ambient Air Quality Standards
$CaCO_3$	calcium carbonate
CAMx	Comprehensive Air quality Model with Extensions
CASTNET	Clean Air Status and Trends Network
CBG	Creston Blue Gap
CBM	Coalbed methane
CBNG	coalbed natural gas
CCLUP	Carbon County Land Use Plan
CCR	Carbon County Road
CCRBD	Carbon County Road and Bridge Department
CCSD	Carbon County School District
CCVC	Carbon County Visitors Council

ACRONYMS AND ABBREVIATIONS

CDA	Concentrated Development Area
CD-C	Continental Divide-Creston
CDW2	Continental Divide/Wamsutter II
CEM	continuous emissions monitoring
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CIAA	cumulative impact analysis area
CO	carbon monoxide
COA	condition of approval
CRBSCF	Colorado River Basin Salinity Control Forum
CRM	Coordinated Resource Management
CSU	controlled surface use
CTL	coal to liquid
CWA	Clean Water Act
CWRRI	Colorado Water Resources Research Institute
CWR	crucial winter range
CW/Y	crucial winter/yearlong
dBA	decibel
DEIS	Draft Environmental Impact Statement
DAT	deposition analysis threshold
DIR	dividends, interest, and rent
DM	Department Manual
DOI	Department of the Interior
dv	deciview
Δdv	delta deciview
EA	Environmental Assessment
EGU	electrical generating unit
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency (United States Environmental Protection Agency)
ERP	Enhanced Resource Protection Alternative
ERMA	Extensive Recreation Management Area
ESA	Endangered Species Act of 1973
FDOP	first date of production
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FEIS	Final Environmental Impact Statement
FLM	Federal Land Managers
FLPMA	Federal Land Policy and Management Act of 1976
FMR	federal mineral royalties
ft	feet
FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
gpm	gallons per minute
GPS	Global Positioning System

ACRONYMS AND ABBREVIATIONS

GDRMP	Great Divide Resource Management Plan
GWP	Global Warming Potential
HAP	Hazardous Air Pollutants
HMRRP	Hazard Management and Resource Restoration Program
HMA	herd management area
HNO_3	nitric acid
HUC	hydrologic unit code
HWA	Hayden-Wing Associates, LLC
I-80	Interstate 80
IDLH	Immediately Dangerous to Life or Health
IDT	interdisciplinary team
IM	Instruction Memorandum
IMPROVE	Interagency Monitoring of PROtected Visual Environments
IN	Initial (as in *initial disturbance)*
IPCC	Intergovernmental Panel on Climate Change
IRO	Interim rollover objective
ISR	in situ uranium recovery
ISWM	Integrated Solid Waste Management
JPAD	Jonah-Pinedale Anticline Development
kg/ha-yr	kilograms per hectare per year
KMDA	known mineral deposit area
lb	pound(s)
kHz	kilohertz
KOP	Key Observation Point
LOS	level of service
LSRCD	Little Snake River Conservation District
LSRV	Little Snake River Valley
LT	Long-term (as in *long-term disturbance*)
LWC	Lands with Wilderness Characteristics
LWDII	lost work day [due to] injuries and illness
m^3	cubic meters
MATS	Modeled Attainment Test Software
Mcf	thousand cubic feet
MEI	maximally-exposed-individual
mg/L	milligrams per liter
MGD	million gallons per day
mi^2	Square mile
MLE	most-likely-exposure
MMBtu	gigajoules
MMcf	million cubic feet
MHSC	Memorial Hospital of Sweetwater County
MHCC	Memorial Hospital of Carbon County
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mph	miles per hour
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NADP	National Acid Deposition Program

ACRONYMS AND ABBREVIATIONS

NASS	National Agricultural Statistics Service
NEPA	National Environmental Policy Act
NH_4	ammonium
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NO_2	nitrogen dioxide
NO_3	nitrate
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSO	No surface occupancy
NSPS	New Source Performance Standards
NSR	New Source Review
NTL	Notice to Lessee
NTN	National Trends Network
NTU	nephelometric turbidity unit
NWI	National Wetland Inventory
OHV	off-highway vehicle
OPS	Office of Pipeline Safety
OSHA	Occupational Safety and Health Administration
OSM	Office of Surface Mining Reclamation and Enforcement
OWUS	Other Waters of the U.S.
ppb	parts per billion
PCT	personal current transfers
PFC	Proper Functioning Condition
PFYC	Probable Fossil Yield Classification
PGM	photochemical grid model
PM_{10}	particulate matter less than 10 microns
$PM_{2.5}$	particulate matter less than 2.5 microns
PRPA	Paleontological Resources Preservation Act
PSD	prevention of significant deterioration
psi	pound per square inch
PUP	Pesticide Use Proposal
PWMTF	Permanent Wyoming Mineral Trust Fund
RCRA	Resource Conservation and Recovery Act
REL	Reference Exposure Levels
RfC	Reference Concentrations for Chronic Inhalation
RFFA	Reasonably Foreseeable Future Action
RFO	Rawlins Field Office
RIP	Recovery and Implementation Plan
RMG	Reservoir Management Group
RMP	Resource Management Plan
RMPPA	Resource Management Plan Project Area
ROD	Record of Decision
RV	recreational vehicle
SCCP	Sweetwater County Land Use Plan

ACRONYMS AND ABBREVIATIONS

SCR	Sweetwater County Road
SCRBD	Sweetwater County Road and Bridge Department
SCSD	Sweetwater County School District
scf	standard cubic feet
SCSWDD	Sweetwater County Solid Waste Disposal District
SDLLC	Sammons/Dutton Consulting LLC
SDWA	Safe DrinkingWater Act
SEO	State Engineer's Office
SGEO	Greater Sage-grouse Core Area Protection Program
SHPO	State Historic Preservation Office
SHWD	Solid and Hazardous Waste Disposal
SO_2	sulfur dioxide
SO_4	sulfate
SPCC	Spill Prevention Control and Countermeasures
SRMA	Special Recreation Management Area
SRP	Special Recreation Permit
SSA	sole source aquifer
STR	Continental Divide-Creston Natural Gas Development Project Socioeconomic Technical Report
SVR	standard visual range
SWEDA	Sweetwater Economic Development Authority
SWPPP	Stormwater Pollution Prevention Plan
SWR	severe winter relief areas
Tcf	trillion cubic feet
TDS	total dissolved solids
tg	teragrams
T&E	Threatened, Endangered, or Candidate
TNW	Traditionally Navigable Water
TP	Transportation Plan
TPC	Transportation Planning Committee
TPQ	threshold planning quantity
tpy	tons per year
TRC	Texas Resource Consultants
UGMA	Upland Game Management Area
UIC	Underground Injection Control
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USDOT	United States Department of Transportation
USDW	Underground Sources of Drinking Water
USFS	USDA—Forest Service
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service
UW	University of Wyoming
VIEWS	Visibility Information Exchange Web System
VRI	Visual Resource Inventory
VRM	Visual Resource Management
WAAQS	Wyoming Ambient Air Quality Standards

WAQSR	Wyoming Air Quality Standards and Regulations
WAS	Western Archaeological Services
WDA	Wyoming Department of Agriculture
WDEQ	Wyoming Department of Environmental Quality
WDEQ-AQD	Wyoming Department of Environmental Quality—Air Quality Division
WDEQ-LQD	Wyoming Department of Environmental Quality—Land Quality Division
WDEQ-WQD	Wyoming Department of Environmental Quality—Water Quality Division
WEAD	Wyoming Department of Administration and Information, Economic Analysis Division
WET	Whole Effluent Toxicity
WGFD	Wyoming Game and Fish Department
WHDP	Wyoming Housing Database Partnership
WHMA	Wildlife Habitat Management Area
WOGCC	Wyoming Oil and Gas Conservation Commission
WOS	Wildlife Observation System
WOSHA	Wyoming Occupational Safety & Health Administration
WoUS	Waters of the U.S.
WRAP	Western Regional Air Partnership
WRCC	Western Regional Climate Center
WRDS	Water Resource Data Center
WRS	Wyoming Revised Statutes
WSA	Wilderness Study Area
WY	Wyoming State Highway
WYDOT	Wyoming Department of Transportation
WYNDD	Wyoming Natural Diversity Database
WYPDES	Wyoming Pollutant Discharge Elimination System

EXECUTIVE SUMMARY

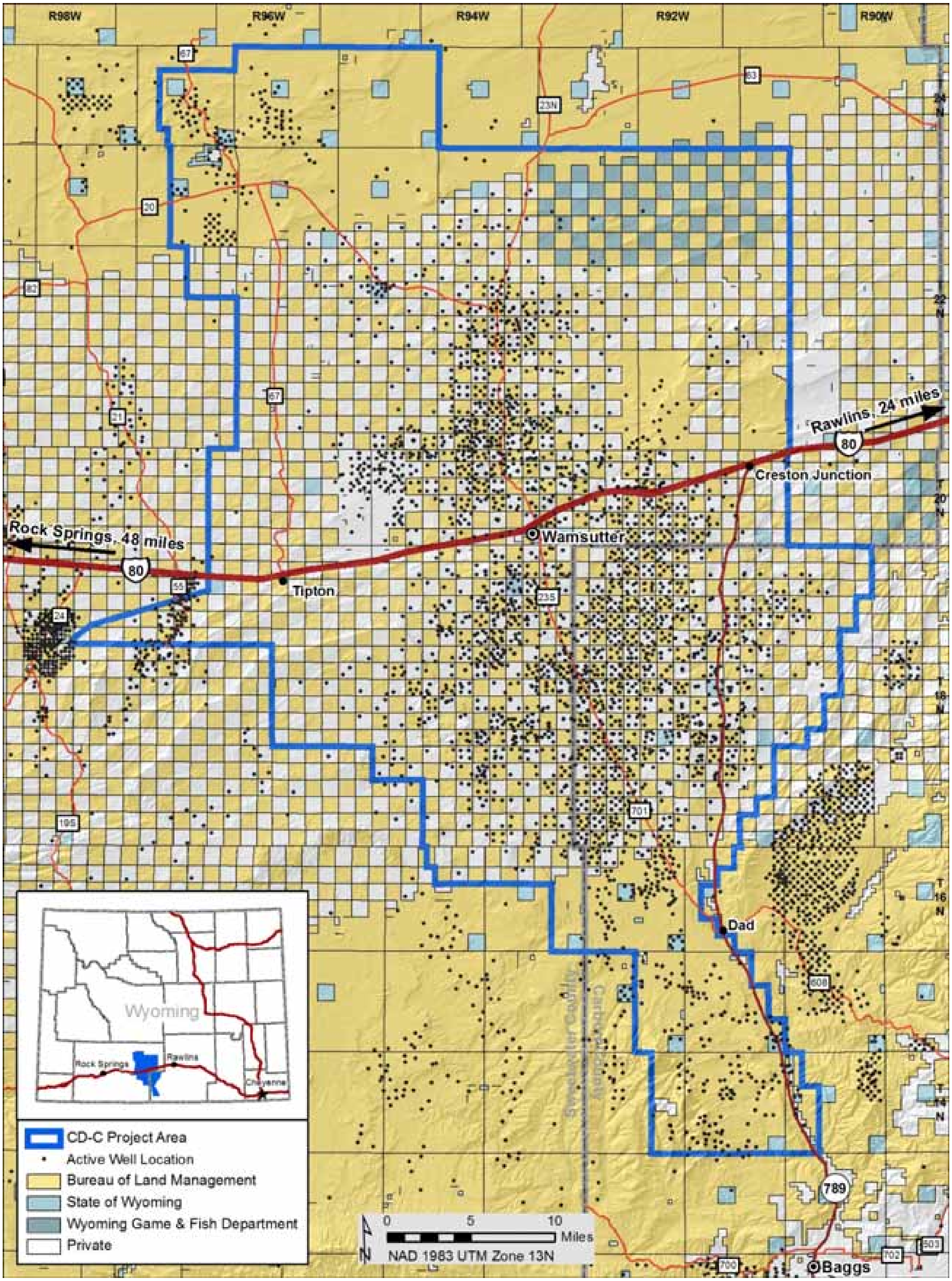
BP America Production Company (BP), representing itself and more than 20 other natural gas development companies (collectively referred to as the "Operators"), has submitted a proposal to the U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) Rawlins Field Office (RFO) to expand development of natural gas and condensate resources within two previously developed project areas described as the Continental Divide/Wamsutter II and Creston/Blue Gap project areas. The BLM has designated the new consolidated proposal the Continental Divide-Creston (CD-C) Natural Gas Development Project.

The RFO has determined that the proposed project constitutes a major federal action requiring preparation of an Environmental Impact Statement (EIS). This EIS serves the purpose of disclosing and analyzing impacts resulting from the development proposed within the CD-C project area with consideration of identified and applied Best Management Practices (BMPs) and Conditions of Approval (COAs). A summary of these BMPs and COAs is included in **Appendix C**.

The CD-C project area consists of approximately 1.1 million acres (1,672 square miles) in an existing gas-producing region between Rock Springs and Rawlins, Wyoming and bisected by Interstate 80 (**Map ES-1**). The project area is located on lands administered by the federal government (626,932 acres, 58.6 percent) and the State of Wyoming (48,684 acres, 4.5 percent), as well as private lands (394,470 acres, 36.9 percent), in Carbon and Sweetwater Counties. The central portion of the CD-C project area has a *checkerboard* pattern of mixed land ownership produced by grants made by the federal government in the 19^{th} century to the Union Pacific Railroad (UPRR) Company to spur construction of the transcontinental railroad.

The Operators propose drilling up to 8,950 infill natural gas wells with a potential surface disturbance of 47,200 acres (4.4 percent of the project area). The precise locations of the wells have not been identified at this time but the Operators anticipate drilling at well densities of up to one well per 40 acres. Wells may be drilled conventionally with a vertical well bore on a single pad or with multiple directional bores from a single pad. The proposed project includes construction and operation of ancillary facilities such as: roads; gas, water, and condensate-gathering pipelines; overhead and buried power lines; and separation, dehydration, metering, and fluid-storage facilities.

More than 4,400 wells have already been drilled within the CD-C project area under previously authorized drilling programs; over 500 of those have been plugged and abandoned. Supporting infrastructure associated with the existing development includes access roads, compressor stations, a central gas-processing plant, water management facilities (fresh-water wells and evaporation pits, recycling facilities, and injection wells for produced water disposal), gas and water pipelines, and electric power lines. Total existing surface disturbance in the project area, including that associated with natural gas and other development, is estimated at 60,176 acres (5.6 percent of the project area).



Map ES-1. Project boundary and existing natural gas development (EIS Map 1-1)

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

PURPOSE AND NEED FOR THE ACTION

The BLM's purpose and need is to determine the conditions under which the applicant's exercise of valid existing rights from federal oil and gas leases within the CD-C project area may be developed in accordance with its multiple-use mandate, the Mineral Leasing Act (MLA) of 1920 as amended by the Federal Land Policy and Management Act of 1976 (FLPMA), and the Federal Onshore Oil and Gas Leasing Reform Act of 1987. The MLA, as amended, provides that exploration and development of domestic oil and gas is in the best interest of the United States. The intent of the MLA and its implementing regulations is to allow, and essentially encourage, lessees or potential lessees to explore for oil and gas or other mineral reserves on federally-administered lands. The BLM will consider approval of the proposed drilling in a manner that reduces impacts on water, wildlife, and other resources throughout the CD-C project area, consistent with the lease rights granted to the applicant.

SCOPING AND PUBLIC INVOLVEMENT

The BLM conducted two public and internal scoping processes to solicit input and identify environmental issues and concerns associated with the proposed project. The first responded to a proposal by operators of the Creston/Blue Gap project to expand drilling in that project area, under what was titled the Creston/Blue Gap II project. A Notice of Intent (NOI) for the Creston/Blue Gap II proposal was published in the *Federal Register* on September 8, 2005. A public meeting was held at the Jeffrey Center in Rawlins on October 13, 2005, and the official scoping period ended November 15, 2005.

Shortly after the Creston/Blue Gap II scoping process was completed, BP submitted a proposal for additional drilling in the Continental Divide/Wamsutter II project area. The BLM decided to combine the two projects and prepare a single EIS. The NOI for the combined Continental Divide-Creston Natural Gas Development Project was published in the *Federal Register* on March 3, 2006. The BLM prepared a scoping notice and provided copies to the public, other government agencies, and Tribes. The notice included information on scoping and announcement of an open house, which was held at the Jeffrey Center in Rawlins on April 6, 2006. The official scoping period ended May 5, 2006.

The BLM also invited other federal, state, and local government agencies to participate in the EIS process as cooperating agencies. The State of Wyoming, Sweetwater County, the Little Snake River Conservation District, and the Sweetwater County Conservation District requested and received Cooperating Agency status.

Written comments received during both public scoping periods consisted of 50 comment letters from federal and state agencies, non-government organizations, and one Tribe, as well as individuals and private corporations.

Key issues and concerns identified through scoping are discussed and addressed in Chapters 3, 4, and 5 of this document, and include the following:

- Air Quality: What are the potential project and cumulative impacts on air quality, including Air Quality Related Values (AQRV)?
- Cultural resources: Estimate the effects on the historic trails and transportation corridors in the project area.
- Water resources: What is the potential for degradation of water quality by project construction and drilling activities? What are the issues related to disposal of produced water associated with coalbed methane production?
- Land ownership as it affects mitigation: Opportunities to reduce impacts through mitigation may be complicated by land ownership patterns in the *checkerboard*.

- Non-native, Invasive Plant Species: Evaluate the current and projected presence of non-native, invasive species.
- Range Resources: Evaluate the potential loss of livestock forage and project-associated hazardous conditions for area livestock/livestock operations.
- Special Status Species: What are the Threatened, Endangered, or Candidate species and Sensitive wildlife species that could be impacted by the project and what would be the extent of the effects?
- Socioeconomics: Define the impact of the project on traditional socioeconomic indicators such as employment, housing, tax revenues, and human services.
- Surface Disturbance/Reclamation: Define the extent of existing and proposed surface disturbance and its effects on resources in the project area.
- Wildlife Habitat: Evaluate the project's effects on wildlife habitat, including fragmentation and subsequent effects on the value of that habitat.

The BLM has determined that the proposed project is in conformance with BLM management plans and policies and is consistent with other federal and local land management plans and policies. The BLM will use the public comment process under the National Environmental Policy Act (NEPA) to comply with the public consultation requirements of Section 106 of the National Historic Preservation Act.

PROPOSED ACTION AND ALTERNATIVES

Chapter 2 of the EIS describes the Operators' Proposed Action, four development alternatives, and the No Action alternative that are analyzed in the document. In addition to the four development alternatives carried forward for analysis in this EIS, two other development alternatives were considered but dismissed from detailed analysis.

Proposed Action. Under the Proposed Action, up to 8,950 additional natural gas wells would be drilled from an estimated 6,126 well pads. Spacing of well pads would vary according to location within the project area. An estimated 42 percent of the future wells would be located on multiple-well pads and drilled to formation directionally. To fully develop the targeted resources, the Operators would collectively drill the new wells at the rate of approximately 600 wells per year over a period of 15 years. The productive life of each well is estimated to be 30 to 40 years. Combining well life with a 15-year production period produces a potential project life of 45 to 55 years. In support of the new wells, the Operators would construct additional access roads, pipelines, overhead and buried electric power lines, a gas processing facility, water management and disposal facilities, and equipment storage facilities. The total new surface disturbance for the Proposed Action would be an estimated 47,200 acres, or about 4.4 percent of the project area.

Alternative A: 100-Percent Vertical Drilling. Alternative A examines the possibility that all 8,950 wells would be drilled vertically from single-well pads. All ancillary elements of the new development would be the same as the Proposed Action. The estimated surface disturbance for Alternative A is 61,696 acres (5.8 percent of the project area), a 31-percent increase over the Proposed Action.

Alternative B: Enhanced Resource Protection. The premise of this alternative is that some resources may be more at risk from intensive natural gas development and thus may require protections and mitigations beyond the basic measures ordinarily applied. The alternative identifies the following resources that may be more at risk from natural gas development:

- Mule deer crucial winter range,
- Pronghorn crucial winter range,
- Greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas,
- Ferruginous hawk nesting habitat,

- The Muddy Creek and Bitter Creek corridors and watersheds,
- Chain Lakes alkaline wetland communities and other playas, and
- Livestock forage.

Each resource has basic protections provided by RFO Resource Management Plan (RMP) requirements, BMPs, COAs, and on right-of-way grants. This alternative would add enhanced protections to each Application for Permit to Drill (APD) or right-of-way grant on BLM-administered lands and federal mineral estate in the appropriate habitat or area of the identified resource. One of the enhanced protections would require that APDs in most of the identified habitats above be submitted as part of a development plan whose aim is to limit overall impacts. For some resources, further protections and mitigations would be applied only if a threshold were reached. These thresholds are defined for a specific percentage of habitat loss—usually 5 or 10 percent of a lease—and for a reduction of a species population to an unacceptable level.

The estimated surface disturbance for the Enhanced Resource Protection Alternative is 45,516 acres (about 4.3 percent of the project area), slightly less than the Proposed Action.

Alternative C: Surface Disturbance Cap – High and Low Density Development Areas. Under this alternative the portions of the CD-C project area that have seen the most intensive natural gas development to date would be designated as high-density development areas (**Map 2-1** in the EIS). The amount of unreclaimed surface disturbance allowed per section of public land in these areas would be capped at 60 acres at any one time. The remainder of the project area would be designated as low-density development areas, with an unreclaimed surface disturbance cap of 30 acres per section at any one time. The 60-acre cap represents the disturbance associated with a 9-well per section drilling program (80-acre spacing) achieved with vertical wells only, a typical development in the high-density area; a 30-acre cap represents the disturbance associated with a 16-well per section drilling program (40-acre spacing) achieved with directional drilling. All prior natural gas surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Successfully reclaimed acreage would not count against the cap.

About 44 percent of the CD-C project area would be within the high-density development area. The average historic surface disturbance within the high-density area is 33 acres per section, with an average of 5 wells per section. In the low-density areas, the average disturbance is 4.5 acres per section with an average of less than 1 well per section. About 24 percent of the CD-C project area has had no development to date.

Only BLM-administered lands and mineral estate in the CD-C project area would be subject to the cap. The estimated surface disturbance of this alternative is 42,955 acres (about 4 percent of the project area), a 9-percent decrease from the Proposed Action.

Alternative D: Directional Drilling. This alternative would require all future natural gas wells on BLM-administered lands and federal mineral estate to be drilled from multi-well pads. In areas with no existing oil and gas development, one multi-well pad would be permitted per section (or per lease if the lease area is less than a section). A single access corridor would be permitted for required roads, pipelines, and electrical power distribution for each new multi-well pad. In sections with existing oil and gas development, enlargement of one existing well pad would be permitted and that pad would serve as the multi-well pad for all future drilling in that section.

Proposals for access across federal lands for oil and gas development on adjacent private and state lands would continue to be considered by the BLM. Operators may request that an APD be exempted from the general rule when an extraordinary situation exists that could limit full development of the natural gas resource.

The estimated surface disturbance for this alternative is 36,449 acres (about 3.4 percent of the project area), a 23-percent decrease from the Proposed Action.

Alternative E: No Action. Under the No Action Alternative, it is assumed that none of the development activities proposed by the CD-C Operators would be approved or authorized. The analysis of the No Action alternative assumes that previously authorized activities would continue but that no new development would occur.

Alternatives Considered but Eliminated from Detailed Analysis. The BLM considered two alternatives to the Proposed Action that were not carried forward for detailed analysis in this EIS—a Surface Disturbance Cap with Reclamation Credits and Debits alternative and a Focused Development alternative.

The Surface Disturbance Cap with Reclamation Credits and Debits would have placed a 30-acre cap on the amount of future surface disturbance at any one time in a section of public land, with credits and debits for successful or failed reclamation of previous disturbance. Operators would have received a credit for each acre of land successfully reclaimed and a debit for each acre not yet reclaimed, thereby providing a reward for successful reclamation and a penalty for slow or failed reclamation. The BLM determined the operation of this alternative would be unpredictable and that neither the BLM nor the operators could rely on its results. In certain instances, the formulation could yield a cap in one section of perhaps 90 acres and in an adjacent section of minus 30 acres. The complexity of the alternative and the uncertainty of its results would promote contention between the BLM and the Operators over the meaning of and the operation of the cap. Because of the complexity and the uncertainty about its effects, and because Alternative C already satisfied all the criteria for a surface disturbance cap, the BLM decided that the Surface Disturbance Cap with Reclamation Credits and Debits would not be carried forward for analysis in the EIS.

Several variations of a Focused Development alternative were considered during discussions between the Operators and the CD-C cooperating agencies between 2007 and 2009. The BLM was not a participant in those discussions. The concept of focused development is that drilling would be phased over time, focusing on completion of development within a defined area before moving to another defined area. This alternative would have provided opportunities to leave large tracts of wildlife habitat undeveloped for extended periods of time in exchange for relaxing some seasonal wildlife stipulations in the areas of focused development. Upon completion of development in a focus area, it would become an area with no activity and development would shift to the previously undeveloped area. This alternative would have required that the leaseholders in both the focus and undeveloped areas have a shared interest in developing or delaying development of their leases. With the large number of leaseholders and the fractured nature of land ownership in the project area, it proved impossible to reach agreement among a sufficient number of parties as to which properties should be developed first. The BLM concluded that unitization of the leases over such a large area would not be viable and thus could not provide a framework for focusing development. The BLM also concluded that relaxation of seasonal wildlife stipulations in focus areas—an essential element of such an alternative—was not appropriate.

AFFECTED ENVIRONMENT

Chapter 3 of the EIS describes the affected physical, biological, human, and management environment of the CD-C project area. The identified resources present within the project area provide the basis to address substantive issues of concern brought forward during internal and public scoping. Chapter 3 provides quantitative data and spatial information where appropriate to the resource, which serves as a baseline for comparison of the direct, indirect, and cumulative impacts of each of the alternatives. Following **Table ES-2** is a summary description of the Affected Environment and the Environmental Impacts by discipline.

ENVIRONMENTAL IMPACTS: OVERVIEW

Chapter 4 of the EIS describes the environmental effects of implementing the Proposed Action and alternatives on the affected environment described in Chapter 3. The chapter is divided into subsections that address the impacts for the resources identified during scoping. Much of the analysis of impacts for each resource is related to the surface disturbance associated with the Proposed Action and Alternatives A through D, which is over and above the existing disturbance in the project area. For Alternative E, there are no new impacts. The resource-specific effects of the alternatives are evaluated quantitatively and qualitatively, as appropriate, based on available data and the nature of the resource analyzed.

Figure ES-1 displays initial disturbance by alternative with historical disturbance.

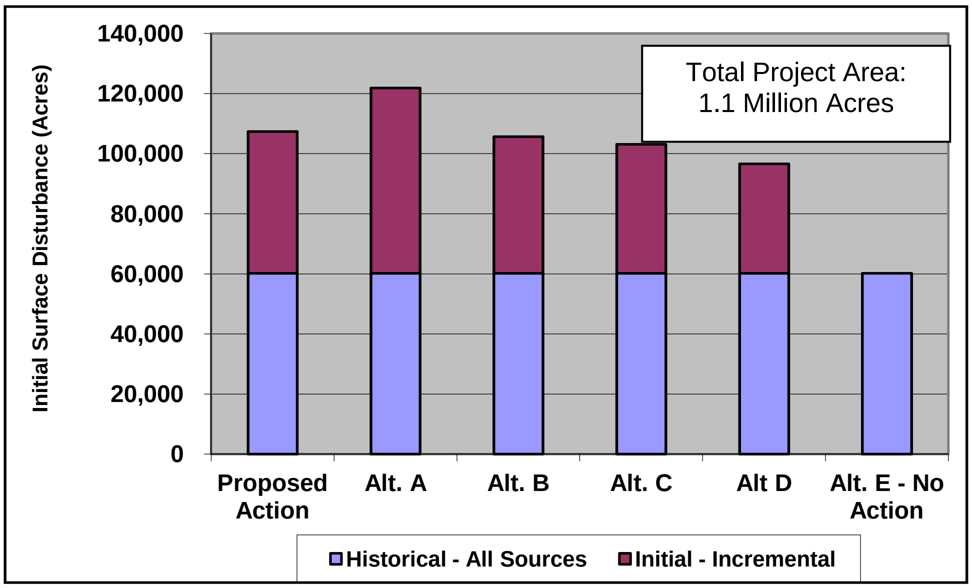


Figure ES-1. Historical and projected initial disturbance, Proposed Action and alternatives

A comparison of the disturbance within the project area associated with the Proposed Action and the five alternatives is provided in **Table ES-1**. A brief summary of the Chapter 4 impact analysis by discipline is provided in **Table ES-2**. Following Table ES-2 is a more detailed summary description of the Affected Environment and the Environmental Impacts by discipline.

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Table ES-1. CD-C surface disturbance – Historical, Proposed Action and Alternatives (acres)

Category	Surface Disturbance						
	Oil and Gas			Grand Total	*Percent of Project Area*	Change from Proposed Action	
	Well Pads (incl. roads)	Related Facilities[1]	Total			Acres	%
Historical							
Initial	20,524	28,694	49,218	60,176	*5.6%*	—	—
Long-term	6,403	2,069	8,472	17,663	*1.7%*	—	—
Proposed Action							
Initial	41,889	5,311	47,200	47,200	*4.4%*	—	—
Long-term	17,998	863	18,861	18,861	*1.8%*	—	—
Combined IN[2]	62,413	34,005	96,418	107,376	*10.0%*	—	—
Combined LT[2]	24,401	2,932	27,333	36,524	*3.4%*	—	—
Alternative A: 100-Percent Vertical Drilling							
Initial	56,385	5,311	61,696	61,696	*5.8%*	14,496	*30.7%*
Long-term	23,270	863	24,133	24,133	*2.3%*	5,272	*28.0%*
Combined IN[2]	76,909	34,005	110,914	121,872	*11.4%*	14,496	*13.5%*
Combined LT[2]	29,673	2,932	32,605	41,796	*3.9%*	5,272	*14.4%*
Alternative B: Enhanced Resource Protection Alternative							
Initial	40,205	5,311	45,516	45,516	*4.3%*	-1,684	*-3.6%*
Long-term	17,386	863	18,249	18,249	*1.7%*	-611	*-3.2%*
Combined IN[2]	60,729	34,005	94,734	105,692	*9.9%*	-1,684	*-1.6%*
Combined LT[2]	23,789	2,932	26,721	35,912	*3.4%*	-611	*-1.7%*
Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section							
Initial	37,644	5,311	42,955	42,955	*4.0%*	-4,245	*-9.0%*
Long-term	16,455	863	17,318	17,318	*1.6%*	-1,543	*-8.2%*
Combined IN[2]	58,168	34,005	92,173	103,131	*9.6%*	-4,245	*-4.0%*
Combined LT[2]	22,858	2,932	25,790	34,981	*3.3%*	-1,543	*-4.2%*
Alternative D: Directional Drilling							
Initial	31,138	5,311	36,449	36,449	*3.4%*	-10,751	*-22.8%*
Long-term	14,089	863	14,952	14,952	*1.4%*	-3,908	*-20.7%*
Combined IN[2]	51,662	34,005	85,667	96,625	*9.0%*	-10,751	*-10.0%*
Combined LT[2]	20,492	2,932	23,424	32,615	*3.0%*	-3,908	*-10.7%*
Alternative E: No Action							
Initial	0	0	0	0	*0.0%*	-47,200	*-100.0%*
Long-term	0	0	0	0	*0.0%*	-18,861	*-100.0%*
Combined IN[2]	20,524	28,694	49,218	60,176	*5.6%*	-47,200	*-44.0%*
Combined LT[2]	6,403	2,069	8,472	17,663	*1.7%*	-18,861	*-51.6%*

[1] Estimated future disturbance is unchanged under each alternative for "Related O&G Facilities," except for No Action, which assumes no future disturbance.

[2] "Combined IN" equals the sum of historic initial disturbance and future initial disturbance.
"Combined LT" equals the sum of historic long-term disturbance and future long-term disturbance.

Table ES-2. Comparison of impacts by alternative

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Physical Environment						
Geology	The intensity of impacts on geologic resources would vary in relation to the surface disturbance by alternative, but would be low in all cases providing that best management practices are followed. Impacts would not be significant.					
Paleontology	Paleontological resources have been identified in over 30 localities within the project area. Implementation of the **Proposed Action** or any of the **action alternatives** may impact paleontological resources—in a negative way by destroying or damaging them and making them unavailable for scientific inquiry—to the extent that the ground is disturbed by development activities, (see **Table ES-1** above). Disturbance could be beneficial by resulting in the discovery and preservation of fossils that add to scientific knowledge. Pre-disturbance surveys and disturbance mitigation where appropriate would minimize adverse impacts. The impact significance criterion would not be exceeded.					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Lowest impact*	*No impact*
Soils	Impacts would be similar for the **Proposed Action** and all **action alternatives** but the extent would vary with the amount of project-related disturbance, from a high of 61,696 acres under **Alternative A** to a low of 36,449 acres under **Alternative D**. The percentage of the CD-C project area soil surface that would be initially disturbed by the **Proposed Action** and the **action alternatives** is shown below. These figures should be considered in light of the 5.6 percent of the project area soil surface that has been disturbed previously. Successful implementation of mitigation measures and BMPs would insure that significance criteria were not exceeded.					
	4.4 %	*5.8 %*	*4.3 %*	*4.0 %*	*3.4 %*	*0 %*
Water Resources: Surface Water	Under the **Proposed Action** and all **action alternatives**, surface water impacts could include contamination of surface water from the authorized and accidental discharge (spill) of fluids and produced water and the impacts (including sediment loading) from surface disturbance related to the construction of pad sites, roads, and pipelines. The degree of potential impact and the risk of adverse impacts is related directly to the amount of initial surface disturbance in each alternative. Each action alternative exceeds at least one of the 8 significance criteria. The number of criteria exceeded for each alternative is displayed below:					
	4 criteria	*8 criteria*	*1 criterion*	*2 criteria*	*2 criteria*	*No new impacts*
Water Resources: Groundwater	Significant impacts to groundwater are not expected under the **Proposed Action** or **Alternatives** because the formations targeted for gas development and produced water disposal are stratigraphically isolated from aquifers that host springs and flowing wells used for stock and domestic purposes, because of state-of-the-art construction techniques, and because of implementation of BMPs and COAs related to drilling.					

Table ES-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Physical Environment, continued						
Air Quality	Impacts from the **Proposed Action** and all **action alternatives** would not cause an exceedance of any ambient air quality standard and would not exceed the Prevention of Significant Deterioration (PSD) Class II Increments at a 250-meter distance from project sources. However, modeled impacts at a100-meter distance from field development project sources did result in short-term concentrations that were predicted to be above the 1-hour NO_2 National Ambient Air Quality Standard (NAAQS), the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} Wyoming Ambient Air Quality Standard (WAAQS). Impacts would not exceed the PSD Class I or Class II increments at any of the Class I and sensitive Class II areas. The visibility analysis indicated a maximum of 5 days with project emissions resulting in impacts greater than the 0.5 delta deciview (Δdv) threshold at any of the Class I and sensitive Class II areas; using the 98^{th} percentile value as a threshold, there are zero days above the 0.5 Δdv threshold. There would be no nitrogen and sulfur deposition impacts that exceed BLM critical load values at any Class I or sensitive Class II area. In addition there would be no impacts to sensitive lakes that exceed threshold values. All BLM-approved energy development projects will comply with applicable air quality regulations and standards, as determined by the WDEQ.					
Biological Environment						
Vegetation	Vegetation has already been strongly affected; historic disturbance equivalent to 5.6% of the area's surface has already occurred. Additional disturbance would produce combined historic and project-related disturbance for the **Proposed Action** and **each action alternative** equivalent to the surface area percentages shown below. Even with successful implementation of reclamation practices, about 40 percent of the disturbed area would remain in an unvegetated state during the production period for the project—45-55 years. The remaining 60 percent of the disturbed area would have reduced productivity while reclamation is in progress and would have an altered species composition and density for the life of the project and beyond, including a long-term loss of shrubs. Estimated percentage vegetation disturbance by alternative, including the historical 5.6% disturbance, is:					
	10.0%	*11.4%*	*9.9%*	*9.6%*	*9.0%*	*5.6%*
Invasive, Non-Native Species	Initial surface disturbance would create opportunities for invasive species and development activity would increase the degree to which such species spread throughout the project area. The principal difference in impacts for the **Proposed Action** and **each action alternative** is related to the amount of surface disturbance that would initially occur for each:					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Lowest impact*	*No impact*
Terrestrial Wildlife	Impacts would include loss of forage, as well as direct and indirect loss of habitat. The percentage of short-term disturbance of crucial winter range that would be disturbed includes historic plus new. Historic disturbance is 7.3% for pronghorn and 2.4% for mule deer. Significant impact can be reached by actions that result in disruption or irreplaceable loss of vital and high-value habitats such as crucial winter range and migration corridors, resulting in impacts that exceed the *High* or *Extreme* impact definitions. Big game species in the area are expected to be significantly affected by the **Proposed Action** and **Alternatives A, B,** and **C** but not by **Alternative D**.					

Table ES-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Biological Environment, continued						
***Pronghorn*[1]**	*High Impact*	*Extreme Impact*	*High Impact*	*High Impact in High Density Area*	*Moderate Impact*	*No New Impact*
***Mule Deer*[1]**	*High Impact*	*Extreme Impact*	*High Impact*	*High Impact in High Density Area*	*Moderate Impact*	*No New Impact*
Aquatic Wildlife	For the **Proposed Action** and all **action alternatives**, impacts to aquatic wildlife are primarily associated with increased sediment entering aquatic habitats from ground-disturbing activities and road building adjacent to or crossing aquatic habitat but significant effects are not expected. Alternative B has additional protections for the Muddy Creek/Bitter Creek watersheds and other aquatic habitats such as the Chain Lakes wetlands and playas.					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Least impact*	*No new impact*
Special Status Wildlife	Those Special Status wildlife species that have potential impacts from the **Proposed Action** or any of the **action alternatives** approaching or reaching the level of significance are identified below. Sage-grouse within core areas are not expected to be affected to a degree that approaches significance because of the SGEO's application on private and state lands as well as federal lands.					
Sage-grouse (non-core area only)	*Likely to exceed in non-core areas*	*Likely to exceed in non-core areas*	*Not expected to exceed*	*Less likely to exceed than Proposed Action*	*Not expected to exceed*	*No new impact*
Endangered Fish	Impacts to the four Endangered fish found downstream of the project area are not expected to occur under any alternative, except for minor water depletion. A determination on potential water depletions is contingent on consultation with the USFWS.					
Sensitive Fish	Sensitive fish are found primarily in the Muddy Creek drainage; the likelihood of impacts to these species exceeding the significance criteria under the **Proposed Action** and the **action alternatives** is:					
	Will exceed	*Will exceed*	*May exceed if actions on private lands offset public land restrictions*	*Likely to exceed*	*Less likely to exceed*	*No new impact*

[1] The impact levels noted for Pronghorn and Mule Deer are based on WGFD (2010) definitions.

Table ES-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Biological Environment, continued						
Special Status Plants	Measures aimed at avoiding and protecting special-status plants that would be implemented under the **Proposed Action** and all **action alternatives** would insure that special-status plants would be little affected directly. To the extent that surface disturbance decreases and the number of disturbance sites is reduced, the likelihood of adverse impact is diminished further.					
Wild Horses	Long-term AUM (animal unit month) loss in Lost Creek and Adobe Town HMAs is estimated at:					
	80 AUMs	*106 AUMs*	*77 AUMs*	*73 AUMs*	*63 AUMs*	*0 AUMs*
Human Environment						
Visual Resources	Under the **Proposed Action** and all **action alternatives**, adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with the management objectives for VRM Class III landscapes in the project area by partially retaining the existing character of the landscape. Development would be compatible per se with VRM Class IV objectives because VRM Class IV is meant to allow for major modification of the existing character of the landscape. There would be no new impacts under **Alternative E, No Action**.					
Recreation	The intensity of impacts to recreation would correlate to the variation in long-term surface disturbance by alternative:					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Least impact*	*No new impact*
Lands with Wilderness Character (LWC)	Under the **Proposed Action** and **all alternatives**, there would be no impact on LWCs.					
Cultural and Historical Resources	Pre-disturbance surveys and avoidance would minimize adverse impacts and remove the potential for significant impacts for all alternatives; the number of sites that might be identified (and the number potentially eligible for NRHP), are described by alternative:					
	1,888 (434)	*2,467 (568)*	*1,821 (418)*	*1,718 (395)*	*1,455 (362)*	*No new impact*

Table ES-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Human Environment, continued						
Socioeconomics	The **Proposed Action** and the **action alternatives** would generate similar effects with minor differences. About 1,600 direct project-related jobs would be created by Year 15 of development. Total project-related employment (direct, indirect, and induced jobs) would climb to a peak of around 4,000 jobs in Year 14, an addition to existing project employment. Employment effects would continue during production after the field is fully developed, but be lower than those during development. Following completion of development and production, regional employment would decrease by over 4,300 jobs, including both new and existing jobs, a net job loss. Population changes would closely follow employment gains and losses, peaking at about 3,700 new residents and almost 1,000 temporary workers during Year 15 of development and falling to about 700 residents by Year 20. Community facilities should be adequate to accommodate the added population but may require expansion during the latter part of the 15-year development cycle. Demand for community facilities would substantially diminish after development is completed. Substantial government revenues would be generated by the natural-gas production—about $3.8 billion in federal royalties, an estimated $530 million in state mineral royalties, and $3.1 billion in ad valorem and gross products taxes. Project-related employment, population, and revenue generation effects would not occur under **Alternative E, No Action**.					
Transportation	Development-related estimated peak annual average daily traffic (AADT) by alternative is as follows (estimated long-term production-related AADT is the same for all alternatives, 1,360):					
	> 3,900	*>4,217*	*Reduced from PA 1-2%*	*Reduced from PA 3-4%*	*Reduced from PA 3-11%*	*0*
Noise	The **Proposed Action** and **Alternatives** would generate similar types of noise from construction and operations, including traffic-related noise. The volume of noise would be directly related to the number of well pads for each alternative, as follows:					
	6,126	*8,950*	*5,798*	*5,299*	*4,032*	*0*
Management Environment						
Range Resources	Estimated long-term forage loss (AUM equivalent) and number of allotments at risk of exceeding significance criteria (10% decrease in AUMs), by alternative, are as follows:					
	*1,985 AUMs (**four** allotments at risk)*	*2,540 AUMs (**more** allotments at risk than PA)*	*1,921AUMs (**fewer** allotments at risk than PA)*	*1,832 AUMs (**fewer** allotments at risk than PA)*	*1,574 AUMs (**fewer** allotments at risk than PA)*	*No new impact*

Table ES-2. Comparison of impacts by alternative, *continued*

<table>
<tr><th>Feature/Resource</th><th>Proposed Action</th><th>Alternative A: 100-Percent Vertical Drilling</th><th>Alternative B: Enhanced Resource Protection</th><th>Alternative C: Cap (High and Low Density Areas)</th><th>Alternative D: Directional Drilling</th><th>Alternative E: No Action</th></tr>
<tr><td colspan="7">Management Environment, continued</td></tr>
<tr><td>Oil and Gas and Other Minerals</td><td colspan="6">Under the Proposed Action and all action alternatives, the natural gas resources of the project area would be developed fully. Natural gas reserves produced over the life of the project are estimated at 12.02 trillion cubic feet. Under Alternative E, the Operators would still possess lease development rights but it is assumed that fluid mineral resources would not be developed under this proposal.</td></tr>
<tr><td>Health and Safety</td><td colspan="6">The Proposed Action and all action alternatives would result in similar impacts to the public and site workers, including increased risk of vehicle collisions on interstate highways and local road systems.</td></tr>
<tr><td>Waste and Hazardous Materials</td><td colspan="6">Currently authorized and approved actions are already exerting stress on the permitted and authorized disposal facilities proximal to the project area. Authorization of the Proposed Action or Alternatives A through C would result in further stress to the capacity of permitted waste management units used by the operating companies, including those used for management of solid waste, produced water, and drilling mud. Alternative D may serve to extend the life of some existing disposal facilities.</td></tr>
</table>

SUMMARY DESCRIPTIONS: IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

Geology. The project area straddles the Continental Divide and lies within the southern and eastern parts of the Great Divide and Washakie sub-basins of the Greater Green River Basin. The project area has surface sedimentary exposures of Quaternary, Tertiary, and Late Cretaceous age including the Green River, Battle Spring, Wasatch, Fort Union, and Lance Formations. These deposits are underlain by sedimentary rocks of the Late Cretaceous age, including Fox Hills Sandstone, Lewis Shale, Mesaverde Group, Steele Shale, Niobrara, Frontier, and Mowry Shale. Petroleum products are generally targeted within the Almond, Ericson, Rock Springs, and Blair formations of the Mesaverde Group.

Under the Proposed Action and action alternatives, there is a remote possibility that alteration of existing topography for well pad and access road construction could result in initiation of mass movement and landslides. Removal of surface vegetation and soil could accelerate erosion of surface features and result in gullying and siltation. The extent of impacts would be directly proportional to the amount of surface disturbance and would therefore vary by alternative, but would be low in all cases and would not be significant. Alternative A has the potential for the most impact, followed by the Proposed Action, and Alternatives, B, C, D, and E (No Action).

Paleontology. The CD-C project area is underlain by geological units that have a moderate to very high potential to produce scientifically important fossils: the Battle Spring and Fort Union formations (moderate) and the Green River and Wasatch formations (very high). Paleontological resources have been identified in over 30 localities within the project area. Excavation of pipeline trenches and construction of well pads, access roads, and ancillary facilities associated with the Proposed Action or its alternatives could result in the exposure and destruction of these resources, either directly as a consequence of construction or indirectly as a result of increased erosion rates. If these newly discovered resources are properly recovered and catalogued, the Proposed Action and its alternatives could result in a better understanding and knowledge of this resource. Increased access would be available to professional, permitted paleontologists and geologists but could lead to increased illegal collection. Impacts to paleontological resources would be more likely with alternatives that have the greatest amount of concentrated surface disturbance, both spatially and temporally. Alternative A has the potential for the most impact, followed by the Proposed Action, and Alternatives, B, C, D, and E (No Action). The impact significance criterion would not be exceeded.

Soils. Soils in the project area were formed from erosion of bedrock exposed at the surface and from lacustrine, alluvium, loess, and eolian deposits. The parent material is dominated by tertiary shales and sandstones and uplifted cretaceous sedimentary rock. Soils on the tertiary bedrock are poorly developed with little clay accumulation. Sandy soils occur on stabilized sand dunes and in areas with active dunes. Saline soils exist in playas, and sodic soils occur on alluvial fans derived from high-sodium parent materials.

The analysis in the EIS focuses on five potential soil limitations: water erosion, wind erosion, road construction, runoff potential, and reclamation potential. For the first three of these limitations, soils in the project area were generally rated as having slight or low to moderate limitation. Nearly 70 percent of the project area soils are rated as having *Slight* potential for water erosion, 80 percent as having *Moderate* potential for wind erosion, and 63.5 percent as having a *Moderate* limitation for road construction. About half the area soils have a *Moderate* to *High* runoff potential. The most severe potential soil limitation is the reclamation potential. Fifty percent of the project area has *Poor* reclamation potential and only 21 percent is rated as *Good*. The principal reasons for the *Poor* reclamation potential are High Soil Salinity (42 percent) and Soils Too Clayey (27 percent). To date, 57 percent of the wells that have been drilled within the CD-C project area are located within soils with poor reclamation potential.

Impacts of the Proposed Action and the action alternatives on soils would be directly related to the amount of surface disturbance created. In decreasing order of magnitude, impacts would be greatest for Alternative A with an estimated 61,696-acre disturbance, and then sequentially less for the Proposed Action (47,200 acres), Alternative B (45,516 acres), Alternative C (42,955 acres), and Alternative D (36,449 acres). Alternative E would have no new disturbance. Full and successful implementation of required mitigation measures and BMPs would insure that the significance criteria would not be exceeded.

Water Resources. Approximately 70 percent of the project area is within the Great Divide Basin, a closed basin that is bounded by the Continental Divide on all sides and has no surface hydrologic outlet; 29 percent is within the White-Yampa Basin that includes the Muddy Creek Sub-basin; and 1 percent is within the Upper Green Basin. Muddy Creek is a high-elevation, cold-desert stream and a major drainage system within the project area. Streamflow varies with location along the drainage. Muddy Creek exhibits perennial flow for the majority of its length, and in some years flows intermittently because of irrigation water removal south of the George Dew/Red Wash wetlands complex. In years with high runoff amounts, Muddy Creek flows perennially throughout its length. Flow in the tributaries to Muddy Creek is predominantly ephemeral, responding to localized snowmelt and rainfall events, but tributaries may also experience some intermittent flow due to contributions from springs and seeps. Tributary channels are generally dry and prone to flashy, periodic flood events from isolated thunderstorm systems from May to October.

The Upper Muddy Creek Watershed/Grizzly Wildlife Habitat Management Area (WHMA) is located primarily east of the CD-C project area but the western-most portion lies within the CD-C project area. The goal of the WHMA is to “manage habitat for the Colorado River fish species unique to the Muddy Creek watershed” In the Grizzly WHMA, the WGFD has been working with the BLM, the grazing permittee, and the Little Snake River Conservation District (LSRCD) to implement similar measures. According to the Rawlins RMP, the area is open to oil and gas leasing with intensive management of surface-disturbing and disruptive activities.

Few streams in the Great Divide Basin exhibit perennial flow. Numerous ephemeral streams flow toward the center of the Basin and terminate in natural or artificially constructed impoundments or disappear because of losses to diversions, evaporation, and/or infiltration. Since a majority of the project area is within this closed basin, a majority of the surface water flow originating in the CD-C project area terminates within the project boundary. The Chain Lakes wetlands are located in the Basin, in the north central portion of the CD-C project area. The Chain Lakes WHMA consists of 30,560 acres of public lands surface in a checkerboard pattern.

Groundwater resources in the project area include unconfined aquifers, generally shallow, blanket-type deposits of Quaternary or Tertiary age found within 400–600 feet of the ground surface, and confined aquifers, bound by relatively impermeable rocks and in the deeper formations. The project area is located over the Great Divide (northern half of the project area) and Washakie (southern half) structural basins, with the Wamsutter Arch separating the two.

Quaternary age aquifers within the CD-C project area likely do not qualify as Underground Sources of Drinking Water (USDW) since there are no wells designated for such use. The yields from these aquifers are not likely sufficient to sustain a public water system. Tertiary age aquifers within the CD-C project area qualify as USDW based on the presence of Wamsutter municipal wells and on the suitability of the groundwater quality. Upper Cretaceous, Lower Cretaceous, Jurassic, and Pennsylvanian age and older aquifers may qualify as USDW based on water quality and on the quantity. However, due to the depth of the aquifers in the CD-C area (2,000 to 18,000 feet) and the low population density of the area, these aquifers are not likely to be the target for domestic or public water system wells.

Impacts to water resources resulting from project construction and operation could include: increased water runoff and downstream sediment loading as a result of surface disturbance; contamination from accidental releases of fluids associated with exploration and production operations, produced water, and other hazardous liquids to soils and surface-water systems; removal of groundwater; improper drilling and completion operations; and subsurface disposal of produced water.

Impacts to surface water resulting from the Proposed Action and the action alternatives would be considered significant under at least one and as many as seven of the eight significance criteria, depending on the amount of overall surface disturbance and the locations of drill pads and associated roads and pipelines. Impacts for Alternative A would be the most severe and would be reduced for the Proposed Action and Alternative B, C, and D. Alternative D, with the least surface disturbance of the action alternatives and the fewest disturbance locations, would have the least significant impact.

Impacts to groundwater are not expected to be significant because the aquifers targeted for gas development and produced-water disposal are located in formations below and isolated from the aquifers that produce springs and flowing wells utilized for stock and domestic purposes. In addition, existing federal and state laws and regulations provide protections that limit the potential for significant impacts on groundwater.

Air Quality. The CD-C air quality analysis addressed the impacts on ambient air quality and Air Quality Related Values (AQRVs) from potential air emissions due to the Proposed Action and alternatives and from other regional emissions sources within a defined study area. Potential ambient air quality impacts were quantified and compared to applicable state and federal ambient air quality standards and Prevention of Significant Deterioration (PSD) increments, hazardous air pollutant (HAP) thresholds, and AQRV impacts (impacts on visibility, atmospheric deposition, and potential increases in acidification to acid-sensitive lakes).

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts within and near the CD-C project area using EPA's Guideline (EPA 2005) model, AERMOD, to estimate maximum potential impacts of carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter greater than 10 microns or 2.5 microns in diameter (PM_{10}, and $PM_{2.5}$) from project emissions sources. Near-field HAP (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde) concentrations were 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.

A far-field ambient air quality impact assessment was carried out using CAMx (Comprehensive Air Quality Model with Extensions) to quantify potential air quality impacts to both ambient air concentrations of CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$, and ozone, and AQRVs from air pollutant emissions of CO, nitrogen oxides (NO_x), SO_2, PM_{10}, $PM_{2.5}$, and volatile organic compounds (VOCs) expected to result from the development of the CD-C project as well as the combined effects of the CD-C project and other new sources of emissions in the region.

The modeling relied on an emission inventory developed for the project for each year over the expected life of the project. Emission inventories for all regional emissions sources from human activities and natural sources (e.g. wildfires) were compiled for use in the far-field modeling.

Near-field modeling indicated that production and field development source emissions of the Proposed Action and alternatives would not cause an exceedance of any ambient air quality standard and would not exceed the PSD Class II Increments at a 250-meter distance from project sources. However, modeled impacts at a100-meter distance from field development project sources did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. Far-field and mid-field modeling using CAMx showed that the Proposed Action and alternatives would not cause any exceedances of the ambient air quality standards for ozone or any other criteria pollutant and would not exceed the PSD Class I or Class II increments at any of the Class I and sensitive Class II areas. The visibility analysis indicated a maximum of 5 days with project emissions resulting in impacts greater the 0.5 delta deciview (Δdv) threshold at any of the Class I and sensitive Class II areas; using the 98th percentile value as a threshold, there would be zero days above the 0.5 Δdv threshold.

Vegetation. The CD-C project area is located within the Omernik Level III "Wyoming Basin" Ecoregion 18, described generally as a broad intermontane basin dominated by arid grasslands and shrublands and interrupted by high hills and low mountains. Three vegetative cover types make up 78 percent of the project area: Wyoming Big Sagebrush (the most common at 39 percent), greasewood flats and fans (23 percent), and saltbush flats and fans (16 percent).

Within the project area, the ecoregion is further divided into two Level IV ecoregions: Rolling Sagebrush Steppe and Salt Desert Shrub Basins. The Rolling Sagebrush Steppe is a semiarid region of rolling plains, alluvial and outwash fans, hills, cuestas, mesas, and terraces, with average annual precipitation from 10–12 inches. The dominant vegetation in this ecoregion is sagebrush, often associated with various wheatgrasses or fescue. The ecoregion is interspersed with desert shrublands, dunes, and barren area in more arid regions (e.g., Red Desert); and with mixed-grass prairie at the eastern limit. The Salt Desert Shrub ecoregion includes disjunct playas and isolated sand dunes. The plains, terraces, and rolling alluvial fans of this ecoregion have soils that tend to be more alkaline and less permeable than soils in the Rolling Sagebrush Steppe. Vegetation is a sparse cover of xeric-adapted species such as shadscale, greasewood, and Gardner's saltbush. This arid region is sensitive to grazing pressure, which may promote the spread of invasive weeds.

Direct impacts to native shrub/grassland communities within the CD-C project area would be similar under the Proposed Action and all action alternatives—an initial reduction of herbaceous vegetation and a long-term loss of shrubs due to soil disturbance and related construction activities. These impacts could be mitigated by successful implementation of reclamation practices, but about 40 percent of the disturbance would remain in an unvegetated state for the life of the project—30–40 years at each individual well site—while used for access roads and well pad facilities. The remaining 60 percent would have reduced productivity while reclamation is in progress and would have an altered species composition and density for the life of the project and beyond, including a long-term loss of shrubs.

Vegetation could be impacted indirectly as a result of soil compaction, mixing of soil horizons, loss of topsoil productivity, and increased soil-surface exposure resulting in soil loss due to wind and water erosion. Other indirect impacts could occur as a result of altered runoff hydrology due to roads, well pads, and other facilities, particularly on moderate to steep slopes. Additional indirect impacts would occur due to deposition of dust on vegetation near roads and construction sites, reducing plant productivity and vitality. The increased surface disturbance produced by project implementation would also provide opportunities for invasive plant species to establish and spread.

As with soils, the principal difference in impacts among alternatives is related to the amount of surface disturbance that would initially occur for each. In decreasing order of magnitude, impacts would be greatest for Alternative A with an estimated 61,696-acre disturbance, and sequentially less for the Proposed Action (47,200 acres), Alternative B (45,516 acres), Alternative C (42,955 acres), and Alternative D (36,449 acres). Alternative E, with no new development, would have no new disturbance.

Non-native, Invasive Plant Species. The principal invasive weeds known to occur on or near, or which have been treated within, the CD-C project area include: Russian knapweed (*Centaurea repens*), houndstongue (*Cynoglossum officinale*), halogeton (*Halogeton glomeratus*), hoary cress (whitetop) (*Cardaria draba* and *Cardaria pubescens*), perennial pepperweed (giant whitetop, *Lepidium latifolium*), spotted knapweed (*Centaurea maculosa*), common burdock (*Arctium minus*), and saltcedar (*Tamarix* spp.). The primary impact of these invasive species to the range resource is their ability to out-compete native species, reducing the quality of available forage for wildlife and livestock and also diminishing the long-term productivity, diversity, and aesthetic values of lands within the project area. In addition to their competitive nature, leafy spurge, Russian knapweed, halogeton, and houndstongue are poisonous.

Halogeton was selected as a worst-case example of non-native invasive species known to exist in the CD-C project area and a survey was conducted in 2007. At that time an estimated 13,353 acres (about 1.2 percent of the project area) were infested with halogeton. Halogeton has continued to spread since the survey was made and the infestation as of 2012 is likely greater.

Impacts to vegetation and range resources would occur on public lands under the Proposed Action and all action alternatives, due to an increase in surface disturbance that could provide more suitable habitat for invasive weed infestations. The risk of infestation and spread of invasive, non-native plant species within the CD-C project area would be similar under all alternatives because initial surface disturbance would create opportunities for new infestations and new development activity would increase the degree to which such species spread throughout the project area. The extent of impact from invasive, non-native species is directly related to the amount of surface disturbance that would initially occur for each alternative. Alternative A has the potential for the most impact, followed by the Proposed Action and Alternatives B, C, D, and E (No Action). In addition to the CD-C project, several other natural gas projects located adjacent to the project area could provide cumulative invasive species impacts. Additionally, three transmission-line projects are proposed to cross the project area and vehicles/ equipment associated with the planning and construction of those projects provide other potential seed sources and seed vectors.

Wildlife. At least 396 wildlife species occur in and around the project area including: 77 mammal, 273 bird, six amphibian, 10 reptile, and 30 fish species. Most are common and have wide distribution in the region. Species considered in the EIS include big game species, upland game birds, raptors, neotropical birds, and fish. The big game species in the project area are pronghorn, mule deer, and elk. Crucial winter and crucial winter/yearlong ranges of pronghorn and mule deer collectively comprise approximately 92,842 acres (8.7 percent) of the project area. Greater sage-grouse, Columbian sharp-tailed grouse, and mourning doves occur within the project area. Twenty-six raptor species are known to occur in or around the project area, including 14 that breed or potentially breed in the project area, two that over-winter, and ten that have been recorded as transients or migrants. Many species of neotropical songbirds utilize the project area for breeding, feeding, migration, and as year-round habitats. About 30 species of fish may occur in the project area or in streams upstream or downstream of the project area, including ten game-fish species and 20 non-game fish species.

Because of the long timeframe for recovery of shrub habitats after vegetation removal, terrestrial wildlife dependent on shrub habitats would be impacted most by habitat loss. In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for critical times of year have been developed for the most sensitive species and would generally be implemented during the development phase, but no restrictions would apply during the production phase. Other impacts from natural gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collisions involving vehicles and wildlife.

Pronghorn and mule deer are the wildlife species most impacted by development, particularly in their winter range where previous development has already reduced the quality of the habitat. Impacts from the Proposed Action and Alternatives A and C are likely to reach the level of significance for pronghorn and mule deer CWR and associated migration routes.

Because the BLM places buffers around active raptor nest sites and restricts other activities around raptor nests and because most raptor prey use habitat that can be reclaimed in a timely fashion, the impact from the Proposed Action or the action alternatives is not expected to exceed the significance criteria.

The project could result in some unintentional, direct mortality of small birds and small mammals from vehicle collisions; however, this mortality is expected to be negligible and is not likely to reduce populations within the project area. If standard prescribed environmental protection measures and BMPs are implemented under the Proposed Action or the action alternatives, the impacts on songbird and small-mammal populations are not expected to exceed the impact significance criteria.

All of the fish species that are not BLM Sensitive Species have wide distribution within Wyoming. Consequently, the project and other human activities within the Muddy Creek and Great Basin watersheds may have localized population impacts but should not impact their status range-wide.

The cumulative impact of multiple individual projects may result in a large area potentially exposed to increased fragmentation, disturbance of wildlife and their habitats, disruption of migratory corridors, and the loss of refuge areas. Additional effects are expected on wildlife dispersal, the reduction of non-fragmented habitats, competition with livestock, and competition with other wildlife species. The generalized increase of human presence and associated disturbance across such a broad scale are a concern.

Special Status Species. The greater sage-grouse, a candidate for federal listing as Threatened or Endangered, is present within the CD-C project area. Four species of Endangered fish are present downstream of the project area, including the Bonytail (*Gila elegans),* Colorado pikeminnow (*Ptychocheilus lucius),* humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus).* Potential habitats for the Endangered blowout penstemon (*penstemon haydenii*) and the Threatened Ute ladies'-tresses (*spiranthes diluvialis*) are present, and therefore the species are potentially present. The Endangered black-footed ferret is unlikely to occur within the project area; however, white-tailed prairie dog colonies in the Continental Divide, Dad, and Desolation Flats areas provide potential habitat and prey for this species and those areas have not been surveyed to confirm whether black-footed ferrets are present.

The following species listed by the BLM as Sensitive are present or potentially present within the CD-C project area: pygmy rabbit, swift fox, white-tailed prairie dog, Wyoming pocket gopher, bald eagle, Brewer's sparrow, loggerhead shrike, sage sparrow, sage thrasher, burrowing owl, ferruginous hawk, long-billed curlew, mountain plover, trumpeter swan, white-faced ibis, Great Basin spadefoot, northern leopard frog, roundtail chub, bluehead sucker, and flannelmouth sucker.

The Proposed Action and action alternatives would disturb and alter wildlife habitat during the 15-year development period, in addition to the 60,176 acres previously disturbed by natural gas and other development. Reclamation of disturbed habitats should recover grass-dominated habitats in one to several years, depending on precipitation. Shrub habitats would not reach pre-disturbance levels during the life of the project. The greater sage-grouse, loggerhead shrike, sage sparrow, and sage thrasher, which are dependent on shrub habitats, would be impacted most by habitat loss.

In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for the critical times of year have been developed for the most sensitive species and would generally be implemented during the development phase, but no restrictions would be in place during the production phase. Other impacts from natural gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collision between vehicles and wildlife. The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would insure that potential impacts to special status plants would be minimized or eliminated.

Because of the protections provided by the BMPs, COAs, and occupancy/timing restrictions required for many special status species, the impact level of significance would likely only be reached under one or more of the action alternatives, but not all, for sage-grouse in non-core areas, and sensitive fish. Sage-grouse in core areas would not be significantly affected under any alternative because impacts would be substantially ameliorated by the application of the Core Population Area density and disturbance limitations and mitigations (IM WY-2012-019 and Statewide Executive Directive 2011-05 for protection of Greater Sage-grouse Core Areas [SWED 2011]) on private and state lands as well as federal. Given the application of this guidance, development activity would not lead to a significant impact on the sage-grouse core area populations.

It is expected that for the Proposed Action and Alternatives A and C, significance criteria could be exceeded for sage-grouse outside the core area. Ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone but it is not expected that significance criteria would be exceeded as other factors such as topography could decrease the size of the needed buffer around nests. Other special status species should be protected sufficiently by the COAs, RMP requirements, and BMPs to avoid exceeding the significance level.

Alteration of sensitive fish habitat suitability from sedimentation would result in significant impacts to sensitive fishes under the Proposes Action and Alternatives A and C, but not under Alternative B and possibly not under Alternative D.

The cumulative effect of the CD-C project and other reasonably foreseeable future projects on greater sage-grouse would be substantially ameliorated by the application of the Core Population Area density and disturbance limitations and mitigations on private and state lands as well as federal.

Wild Horses. The BLM protects, manages, and controls wild horses within Herd Management Areas (HMAs). Portions of two HMAs are located within the CD-C project area: 119,600 acres of the 251,000-acre Lost Creek HMA in the northwest corner, and 5,826 acres of the 472,812-acre Adobe Town HMA along the southwest perimeter west of Baggs. Both HMAs are located within livestock grazing allotments, and each allotment has an allocated number of Animal Unit Months (AUMs). The primary direct impact to wild horses would be loss of available forage as a result of surface disturbance. Indirect impacts could result from increased potential for horse/vehicle collisions and increased dust as a result of increased traffic. Alternative A has the potential for the most impact to wild horses, followed by the Proposed Action, and Alternatives, B, C, D, and E (No Action). For both the Proposed Action and Alternative A, long-term loss of forage is estimated at less than 0.2 percent of the total forage in the allotment for the Lost Creek HMA and less than 0.1 percent for the Adobe Town HMA. Because the relative loss of forage would be so small, however, none of the grazing allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

Visual Resources. The CD-C project area is part of a semiarid desert dominated by patches and thickets of sagebrush. Colors of gray, brown, and olive characterize the vegetation, with grasses and forbs changing to shades of brown as they cure in the summer and fall. Soils and rock strata are shades of red, gray, and brown. The landscape is generally unbroken, so visual contrast draws attention wherever it occurs. Dune fields, playas, cuestas, occasional escarpments, and eroded streambeds create some visual contrast.

Visually prominent features in the project area are the Red Desert Basin, the Chain Lakes Basin, the extended Delaney Rim-Wamsutter Rim cuesta-and-valley complex, and North Flat Top, the high point in the project area. North Flat Top, Little Robbers Gulch, and The Bluffs are prominent geologic features visible from Wyoming Highway (WY) 789, the major north-south road through the southern part of the project area. Interstate 80 (I-80) bisects the project area from east to west. Because of high traffic volumes, I-80 is the vantage point from which potentially the most viewers see the project area. Because of the extensive road network, all land within the project area is in the foreground or middle ground of major or other roads.

The potentially affected scenic quality in the project area is currently low to moderate overall. Cultural modification due to oil and gas development has negatively affected scenic quality in seven of 15 identified landscape-rating units that are contained wholly or in part within the project area. This is generally because oil and gas development disturbs existing vegetation and introduces structures whose unnatural forms, lines, colors, and textures contrast with the natural landscape character.

Sixty percent of the project area is classified by the BLM as Visual Resource Management (VRM) Class III. The objective of Class III is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate; management activities may attract the attention of the casual observer but should not dominate the view of the casual observer. The remainder of the project area is classified as VRM Class IV, where the objective is to provide for management activities that require major modifications to the existing character of the landscape and the level of change to the landscape can be high.

Visual mitigation in the form of BMPs and COAs would allow oil and gas development to be compatible with the management objectives for VRM Class III landscapes in the project area. Development would be compatible *per se* with VRM Class IV objectives because VRM Class IV is meant to allow for major modification of the existing character of the landscape. Less degradation of landscape quality would potentially occur under Alternatives B, C, and D and more would occur under Alternative A, when compared to the Proposed Action. The combination of CD-C project impacts and the Gateway South and TransWest transmission line right-of-way systems could create a high cumulative impact in some viewsheds in the VRM Class III parts of the CD-C project area. Visual impacts from CD-C and other planned or reasonably foreseeable development may add up to a high enough level of incompatible contrast with existing settings to be non-compliant with VRM Class III.

Recreation. Big game hunting and associated off-highway vehicle use constitute the primary recreational uses of public lands within the project area. Pleasure driving to view wildlife, especially wild horses, is a secondary use that occurs mainly within the Red Desert area. There is one undeveloped recreation site at Little Robbers Gulch Reservoir near the southern boundary of the project area that has been in historical use as a group hunting camp and fishing hole.

Impacts to recreation resulting from the Proposed Action and action alternatives would directly correlate to impacts to wildlife, wild horses, the visual setting, traffic, and noise. In turn, these impacts would be directly related to the amount of surface disturbance and the increase in surface disturbance in relation to existing disturbance. Overall, Alternative A has the potential for the greatest amount of impact to recreation, followed by the Proposed Action, and Alternatives, B, C, D, and E (No Action). The intensity of impacts to recreation would potentially be highest in the northern part of the project area, where natural gas development is less dense to date and where the Chain Lakes Wildlife Habitat Management Area and the large block of public land to the northwest are a resource for big game hunting and other wildlife-based recreation.

Lands with Wilderness Characteristics (LWCs). The RFO maintains an inventory of LWCs on a continuing basis and relies on this inventory in the development and revision of land use plans and when making subsequent project level-decisions. No LWCs are located within the boundaries of the CD-C project area.

Cultural and Historical Resources. Portions of the Overland and Cherokee Trails, the 1868 Union Pacific Railroad Grade, and the Lincoln Highway (US 30 and I-80 corridor) are located within the CD-C project area and eligible for listing on the National Register of Historic Places (NRHP). The BLM has designated a quarter-mile buffer around these linear resources and associated sites as highly sensitive. Natural gas development within this buffer would not be permitted. A 2-mile analysis area surrounding these trails and associated sites is considered as the setting. Where the setting of historic trails and associated sites contributes to eligibility for listing on the NRHP, actions resulting in the introduction of visual elements that diminish the integrity of the property’s significant historic features would be mitigated. BMPs would be implemented to reduce visual impacts to the setting, such as consolidation of facilities, use of low-profile tanks, and paint colors that blend with surrounding terrain. Increased access to and activity within the project area during construction associated with the Proposed Action and alternatives could result in increased indirect impacts to archaeological sites such as changes in erosion patterns, soil compaction, or vegetation removal; fugitive dust; off-road vehicle traffic associated with construction or maintenance activities; and increased vandalism, including illegal artifact collection.

The amount of potential impact to historic and archaeological resources is related to the amount of surface disturbance. Impacts under Alternative A would be the greatest, with a potential 2,467 sites that could be affected. Impacts would decrease proportionately for the Proposed Action (1,888 potentially affected sites), followed by Alternatives B (1,821 potentially affected sites), C (1,718 potentially affected sites), and D (1,458 potentially affected sites). No impacts would occur under Alternative E, No Action, because there would be no new surface disturbance. Avoidance and mitigation would remove the potential for significant impacts on public lands for all alternatives.

Socioeconomics. Implementation of the Proposed Action or other action alternatives would allow substantially more and higher-paced development and production activity in the CD-C project area. The additional development activity is assumed to extend over 15 years, and production would continue for 30–40 years thereafter. This activity would be accompanied by increased employment associated with development and production activities for companies that service gas field development and production activities, and in other sectors of the local economy. The additional employment would result in concurrent increases in temporary and long-term population for communities in Carbon and Sweetwater counties. In turn, the additional population would require temporary and long-term housing, place demands on local public facilities and services, and generate increases in revenues for local business establishments.

The added development and production would generate substantial tax revenues for local and state governments, which could fund higher public-sector operating costs and facility and service expansion in response to development-related demands. But the timing of the receipt of those revenues and their distribution would not in all cases coincide with the timing and location of demand.

Continued natural gas development within the CD-C project area would also increase the potential for conflicts between natural resource development and outdoor recreation and grazing activities. Given the existing level of development, the incremental effects of potential conflicts and displacement are likely to be minor to moderate across most of the project area. However, conflicts with important environmental values could arise in several areas.

All action alternatives have the potential to both positively and adversely affect local and regional economic diversity. Positive effects would include sustained support for existing businesses and possible expansion of the commercial and service sectors in response to natural gas-related increased demand; such expansion could also serve increases in tourism, outdoor recreation, and interstate travel. Similarly, the development of community and commercial infrastructure to support development-related demand would enhance the capacity to accommodate other economic activities in the long run. Adverse effects that could limit economic diversification would include increased competition for labor, increased housing costs, and potential effects on regional environmental amenities, particularly during the 15-year development period.

The level of development contemplated by the Proposed Action and other action alternatives is contingent upon natural gas prices being sufficiently high to support that level of development from an economic perspective. The natural-gas reserves in the project area are part of a larger regional resource base. Consequently, periods of faster or slower-paced development would generally occur in the context of regional energy development expansion and decline in southwest Wyoming and indeed across much of the Rocky Mountain west. In other words, extended periods of elevated demand for natural gas and resultant high gas sales prices would generally correlate with periods of accelerated development activity in the project area and in other natural-gas fields in Carbon, Sweetwater, and adjacent counties. Conversely, extended periods of lower natural-gas demand or relatively higher availability of gas from other sources would result in regional slowdowns in development activity. The effects of such regional potentials are discussed in the 2008 Baseline Socioeconomic Technical Report and in Chapter 5 of this EIS.

The BLM and Operators consider the natural gas production volumes forecast for this assessment technically recoverable given current technology and knowledge. The ultimate level of recovery would depend on natural gas prices, future improvements in technology for developing and producing gas resources, markets for the gas, and delivery capacity to collect, process, and deliver the gas to market. This assessment assumes that the forecast natural gas production volumes would be recovered, while acknowledging the potential for lower gas prices and corresponding lower levels of development and production. This assumption provides a basis for assessing reasonable potential upper bounds of effects on socioeconomic conditions including the fact that natural gas sales prices to support this level of development would also provide tax revenues to aid the state and communities in responding to development-related effects, as well as continued support for existing programs and services locally and throughout the state.

Transportation and Access. The Proposed Action and all action alternatives would result in natural gas development and production-related increases in traffic on federal and state highways and county and BLM roads that provide access to and within the CD-C project area. The pattern of traffic increases would be similar for all alternatives but the level of increase would vary moderately by alternative. Each action alternative would result in temporary increases in annual average daily traffic on federal and state highways resulting from construction of ancillary facilities such as field compression facilities, a central pipeline compression facility, a central gas-processing/stabilization facility, and a high-pressure gas line. For I-80, the level of increase would be relatively modest compared to existing levels of traffic. A number of other reasonably foreseeable projects could generate cumulative effects on I-80; wind farm construction; other, smaller oil and gas development projects; power transmission lines; and an in-situ uranium project. The effect would be greatest during construction of the projects and the overall effect would depend greatly on the relative timing of the construction of the projects.

The Proposed Action and all action alternatives would accelerate highway maintenance requirements on county, BLM, and private roads. The timing and level of improvements and maintenance requirements would be driven by the magnitude and characteristics of traffic increases on specific highways and roads. Some temporary increases in congestion could occur on local streets in some communities in Carbon and Sweetwater counties and there would be a statistical potential for increases in motor vehicle accidents, primarily during the 15-year development period. All action alternatives would generate similar amounts of revenue that could be used to fund highway and road-maintenance needs.

Noise. Existing sources of noise in the CD-C project area include gas compression stations, livestock grazing operations, wind, well workover operations, and traffic along area access roads, state highways, and I-80. Additional noise would be generated under the Proposed Action and action alternatives by well site and access road construction, drilling and completion, pipeline construction, and surface-disturbing reclamation operations. Noise levels may at times temporarily exceed EPA thresholds in specific locations. The duration of noise-generating activity and dispersal of noise-generating equipment across the project area would be greatest under the Proposed Action.

Directional wells are considered in the Proposed Action and Alternatives B, C, and D. Directional drilling may require a larger rig with larger engines operating at higher decibel and lower frequency levels compared to rigs for vertical drilling. Alternative A, 100-Percent Vertical Drilling, would result in the greatest number of generation sources. The number of days needed for drilling and completion may be slightly fewer compared to directional wells; however, the time savings could be negated by the amount of time required for a rig move. Design features of Alternative B (Enhanced Resource Protection) would serve to reduce noise in sensitive environments, but these reductions could be negated by the noise of semi/haul trucks moving drilling rigs. Alternative C could result in areas with concentrated development activity, where noise levels would be greater than those found in areas of more dispersed operations. The surface disturbance cap could slow the pace of development, especially in the high-density development areas, and extend development noise levels over a longer time than the Proposed Action. Alternative D (Directional Drilling) would result in an overall reduction in well pads and roads built and provide only localized areas of noise.

Range Resources. Impacts to livestock and grazing resources would occur under the Proposed Action and all action alternatives. Impacts could include those caused by a reduction of total available forage due to road, well pad, and pipeline construction and maintenance; improperly fenced open pits; vehicle traffic; fugitive dust deposited on potential forage; accidental spills of potentially hazardous materials; and creation of suitable habitat for invasive/noxious weed infestations. Livestock may be injured or killed by vehicle collision, become trapped in open pipeline trenches, stray from pastures through gates left open, and ingest poisonous invasive species. Additionally, existing range improvements can be damaged by equipment and vehicles. The level of impact resulting from the Proposed Action and action alternatives would be related to the amount of surface disturbance that would initially occur for each alternative.

Loss of forage in a grazing allotment due to oil and gas development could result in a long-term reduction of the stocking rate for the allotment if the total long-term surface disturbance exceeds 10 percent of the allotment area. Of the 44 allotments within or overlapping the CD-C project area, two already have disturbance in excess of 9 percent, and nine more have disturbance in excess of 5 percent. The Proposed Action and alternatives have the potential to result in a long-term reduction in the stocking rate for these allotments until existing and new disturbance is successfully reclaimed. For the Proposed Action, it is estimated that an initial forage loss equivalent to 5,488 of the total 123,910 AUMs within the CD-C project area could occur. AUMs lost would be recovered with successful reclamation of initial disturbance. Estimated forage equivalent lost for Alternative A would be 7,174 AUMs; for Alternative B, 5,293 AUMs; for Alternative C, 4,995 AUMs; and for Alternative D, 4,238 AUMs. Under Alternative E, No Action, no forage loss would occur.

Oil and Gas and Other Minerals. Under the Proposed Action and all action alternatives, recoverable natural gas reserves produced over the life of the project are estimated at 12.02 trillion cubic feet (Tcf); liquid condensate is estimated at 167.3 million barrels. With this amount of production from the target formations, it is expected that the oil and natural gas resource in the CD-C project area would have been substantially depleted, pending new technology or the discovery of new reserves. Under Alternative E, No Action, no more natural gas or liquid condensate would be produced in the CD-C project area.

Health and Safety. Implementation of the Proposed Action and all action alternatives would likely result in an increased risk to the workforce due to the increased number of personnel in the field, the increase in heavy equipment use and drilling operations, and the resultant increase in vehicle traffic. Compliance with the State of Wyoming Department of Employment Workers Occupational Health and Safety (WOSHA) program rules and regulations for construction and oil and gas well drilling, well servicing, and well special servicing operations would aid in reducing project-related occupational hazards. Risks to the project workforce would decline substantially once construction, drilling, and completion are concluded and the project enters the production phase. The Proposed Action and all action alternatives would result in similar impacts to the public and site workers with regard to increased risk of vehicle collisions on interstate highways and local road systems during the development and production phases.

Waste and Hazardous Materials. With the exception of produced water, most waste materials that would be generated at project locations are considered to be solid and classified as non-hazardous, and are disposed of at approved facilities offsite. Some operators recycle drilling mud between wells for re-use, reducing the volume to be disposed of. Completion fluids are also recycled to the extent possible to minimize waste disposal but are generally produced to an open pit onsite for disposal. Produced water within the project area would continue to be managed through the use of private and commercially permitted evaporation ponds and injection/disposal wells. Hazardous wastes and disposal sites are permitted and managed in compliance with Wyoming Department of Environmental Quality regulations.

Currently authorized and approved actions are already exerting stress on the permitted and authorized disposal facilities near to the project area. Authorization of the Proposed Action or Alternatives A, B, or C would result in further stress to the capacity of permitted waste management units, including those used for management of solid waste, produced water, and drilling mud. Alternative D may serve to extend the life of some existing disposal facilities if it results in higher levels of recycling and reuse of drilling materials.

1. PURPOSE AND NEED

1.1 INTRODUCTION AND REGIONAL SETTING

BP America Production Company (BP), representing itself and more than 20 others (collectively referred to as the "Operators") submitted a proposal to the U.S. Department of the Interior (USDI) Bureau of Land Management (BLM) Rawlins Field Office (RFO) to expand development of natural gas and condensate resources within two previously developed project areas described as the Continental Divide/Wamsutter II and Creston/Blue Gap project areas. The BLM has designated the new consolidated proposal the Continental Divide-Creston (CD-C) Natural Gas Development Project.

The proposed project combines two separate proposals submitted to the BLM:

- In April 2005, the RFO received a proposal from Devon Energy Corporation and other federal leaseholders to drill up to 1,250 infill natural gas wells and associated facilities. A total of 275 natural gas wells had previously been approved for the area in the 1994 Record of Decision (ROD) for the earlier Creston/Blue Gap Environmental Impact Statement (EIS) (BLM 1994). The Devon proposal was initiated as the Creston/Blue Gap II Natural Gas Project.
- In November 2005, the RFO received a proposal from BP and other federal leaseholders to drill up to 7,700 additional wells and associated facilities within a portion of the previously approved Continental Divide/Wamsutter II natural gas project area. The May 2000 ROD for the Continental Divide/Wamsutter II Environmental Impact Statement had approved up to 3,000 wells (BLM 2000).

After reviewing both the Continental Divide and Creston/Blue Gap II proposals, and considering their concurrent timing, their proximity, and the similarity of the Proposed Actions, the BLM determined that the two projects should be combined into one infill project with up to 8,950 wells.

The BLM has prepared this draft Environmental Impact Statement (EIS) to analyze the effects of the project's proposed infill drilling and field development in compliance with the National Environmental Policy Act of 1969 (as amended) (NEPA) (42 United States Code [U.S.C.] 4321 *et seq.*) and the Council on Environmental Quality (CEQ) regulations. This EIS describes the direct, indirect, and cumulative impacts of existing and new development in the CD-C project area.

The project area consists of approximately 1.1 million acres (1,672 square miles, or mi^2) located in Townships 14 through 24 North, Ranges 91 through 98 West, Sixth Principal Meridian, Carbon and Sweetwater counties (**Map 1-1**). The eastern boundary of the CD-C project area is about 25 air miles west of the city of Rawlins; the western boundary is roughly 50 miles east of the city of Rock Springs. Interstate 80 (I-80) generally bisects the project area. The checkerboard[2] pattern of land ownership in the central portion of the project area is a result of early land grants from the federal government to the Union Pacific Railroad Company. The BLM, the State of Wyoming, and private owners issued the oil and gas leases covering these lands. The RFO manages BLM surface lands and the federal mineral estate in the project area. The BLM manages approximately 626,932 surface acres (58.6 percent), the State of Wyoming owns approximately 48,684 acres (4.5 percent), and private landowners own approximately 394,470 acres (36.9 percent), as shown in Map 1-1. The map also shows all natural gas development to date within and adjacent to the project area. **Table 1-1** describes both the surface and mineral ownership within the project area.

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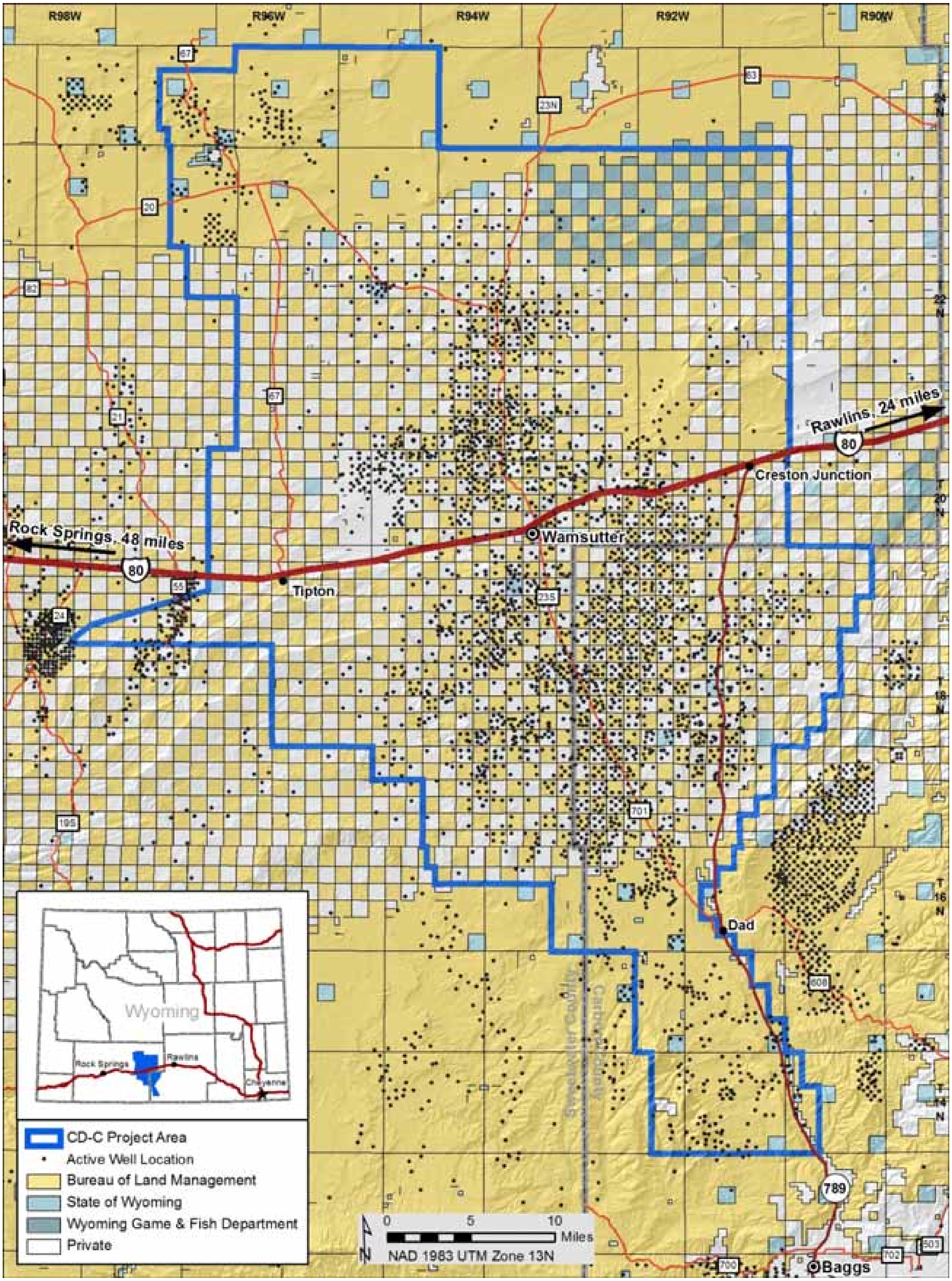
[2] The checkerboard refers to the generalized land ownership pattern, characterized by alternating private and public ownership of sections, 20 miles either side of the Union Pacific Railroad.



Map 1-1. Project boundary and existing natural gas development

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Table 1-1. Estimated surface and mineral ownership in the CD-C project area

Ownership	Surface	% of Project Area	Mineral	% of Project Area
ACRES				
Federal	626,932	58.6	579,533	54.2
Wyoming	48,684	4.5	74,470	7.0
Fee	394,470	36.9	416,083	38.9
Total	1,070,086	100.0	1,070,086	100.0
SQUARE MILES				
Federal	980	58.6	905	54.2
Wyoming	76	4.5	116	7.0
Fee	616	36.9	650	38.9
Total	1,672	100.0	1,672	100.0

The State of Wyoming is a Cooperating Agency in this EIS, with active participation from many state agencies including the State Planning Office, Wyoming Game and Fish Department (WGFD), State Historic Preservation Office (SHPO), Wyoming Department of Environmental Quality (WDEQ), and Wyoming Department of Agriculture (WDA). Regional cooperating agencies include Sweetwater County, the Little Snake River Conservation District, and the Sweetwater County Conservation District.

1.2 OVERVIEW OF THE PROPOSED PROJECT

Based on current knowledge of natural gas reservoir characteristics (geology, flow from existing wells, anticipated recovery rates, and economics), the Operators propose drilling up to 8,950 infill natural gas wells, including up to 500 coalbed natural gas (CBNG) wells, in addition to the more than 4,400 wells already drilled in the project area (**Map 1-1**). The precise locations of these additional wells have not been identified at this time. The Operators anticipate drilling at well densities of up to one well per 40 acres. Wells may be drilled conventionally with a vertical well bore on a single pad, or with multiple directional bores from a single pad. The proposed project also includes construction and operation of ancillary facilities such as: roads; gas, water, and condensate-gathering pipelines; overhead and buried power lines; and separation, dehydration, metering, and fluid-storage facilities.

The total number of wells drilled would depend largely on variables outside of the Operators' control, such as production success, appropriate engineering technology, economic factors, commodity prices, availability of commodity markets, and lease stipulations and restrictions. The Proposed Action is explained in more detail in Chapter 2 and in **Appendix B, Plan of Development**. **Appendix B** includes details on project site planning, development, and operations including general plans and descriptions for transportation, reclamation, and hazardous materials management. Wyoming BLM standard operating procedures and practices currently used in all surface-disturbing activities throughout the Rawlins Field Office would be employed for this project (see **Appendix C, Best Management Practices and Conditions of Approval)**. Additional appendices containing information related to project scoping, operations and procedures, mitigation, and resource-specific issues include:

- Appendix A, Summary of Scoping Comments by Category
- Appendix D, Paleontological Resources Program Guidance
- Appendix E, Reclamation Guidance
- Appendix F, Water Resources Supplemental Data
- Appendix G, Energy by Design – Cooperative Mitigation Planning for the CD-C Gas Field
- Appendix H, Occurrence Potential of Wildlife in the CD-C project area
- Appendix I, Wildlife Inventory, Monitoring, and Protection Plan
- Appendix J, Cultural Resources Management
- Appendix K, Hazardous Materials Management Summary

Construction, development, production, and abandonment would comply with all applicable federal, state, and county laws, rules, and regulations (see **Section 1.7**). Best Management Practices committed to by the Operators on public lands include the design and construction of all new roads to a safe and appropriate standard to accommodate their intended use, painting of all new facilities a color that best allows the structures to blend in with the background, interim reclamation of well locations and access roads, and final reclamation and recontouring of all disturbed areas.

1.3 PREVIOUS AND EXISTING OIL AND GAS DEVELOPMENT IN THE AREA

The CD-C project lies in the center of a large area that has seen extensive natural gas exploration and development. **Map 1-2** shows the boundaries of the most recent natural gas projects. The Continental Divide project and then the Continental Divide/Wamsutter II project were two predecessors of the CD-C project, both with much greater area. The Creston/Blue Gap project was another predecessor. Four other projects lie adjacent to, or even within, the CD-C project area: Atlantic Rim to the east, Desolation Flats to the southwest, Table Rock at the center west, and Luman Rim at the northwest corner. Table Rock at and Luman Rim are two relatively small projects approved by the Rock Springs Field Office in the last two years. The other and much larger predecessor and neighboring projects are summarized in **Table 1-2**.

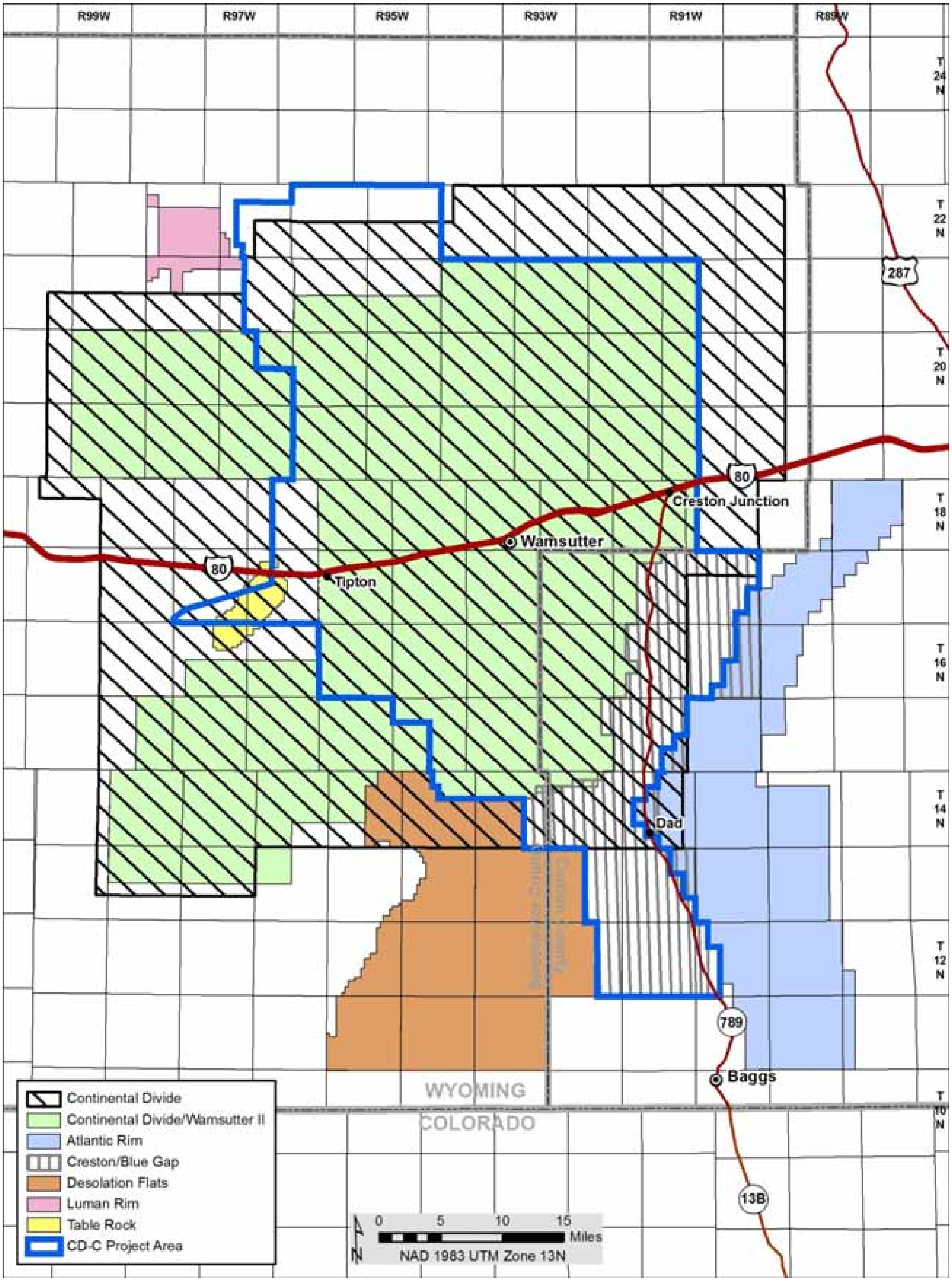
Table 1-2. Oil and gas development in and near the CD-C project area

Project	Date Approved	Drilling to be Complete	Project Acres	Project Wells
Creston/Blue Gap	1994	2014	207,746	275
Continental Divide/Wamsutter II	2000	2015	1,061,200	3,000
Atlantic Rim	2006	2026	270,080	2,000
Desolation Flats	2004	2018	233,542	385

Creston/Blue Gap Natural Gas Project. Natural gas development and production in the southeastern portion of the project area (**Map 1-2**) was analyzed and approved under the Creston/Blue Gap EIS and ROD (BLM 1994). The decision allowed a maximum of 275 wells on 250 locations on a 160-acre spacing pattern. This project is fully constructed and the CD-C Proposed Action includes infill development associated with the same project area.

Continental Divide/Wamsutter II Natural Gas Project (CDW2) . The CDW2 project comprised approximately 1,061,200 acres—531,400 acres of federal surface, 9,800 acres of state surface, and 520,000 acres of private surface (**Map 1-2**). The Proposed Action analyzed in the EIS included up to 3,000 wells at 3,000 well locations, with approximately 1,500 miles of new roads, 1,500 miles of new pipeline, five compressor stations, one gas-processing facility, 10 evaporation ponds, five disposal wells, and 50 water wells. The ROD (BLM 2000) approved up to 2,130 wells, with the remaining 870 wells (not more than 435 wells or well locations on federal lands and/or federal mineral estate) to be reviewed pending revision of the Rawlins Resource Management Plan (RMP). With the approval of the Rawlins RMP in 2008, the remaining wells were authorized. This project is fully constructed and the CD-C Proposed Action includes infill development associated with the same project area.

Desolation Flats Natural Gas Field Development Project. The EIS analyzed a proposal to conduct exploratory drilling and development of up to 385 wells and associated production and transmission facilities within the area known as Desolation Flats. The project area is approximately 233,542 acres, located within the BLM Rawlins and Rock Springs Field Offices, immediately to the southwest of the CD-C project area (**Map 1-2**). The 2004 ROD (BLM 2004) approved 385 wells at 361 locations. After an initial period of development, drilling activity has fallen off in recent years.



Map 1-2. Oil and gas development in and near the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Atlantic Rim Natural Gas Development Project. This project is located on the southeastern boundary of the CD-C project area, encompassing approximately 270,080 acres (**Map 1-2**). The 2006 ROD (BLM 2006a) called for drilling and development of approximately 1,800 CBNG wells and 200 conventional gas wells on state, private, and federal lands with a density of eight wells per 640 acres. Drilling is expected to occur for approximately 15 years. New wells are expected to have an operational life of 30 to 40 years. Associated facilities include access roads, gas and water collection pipelines, compressor stations, and electrical/power system development. After an initial period of development, drilling activity has fallen off in recent years.

1.4 PURPOSE AND NEED FOR THE ACTION

The Operators propose to develop, produce, and market natural gas and other fluid minerals from the CD-C project area that are needed to meet the national domestic energy demand. Under its authority to issue oil and gas leases and consistent with the Great Divide Resource Management Plan (RMP), updated and renamed in December 2008 as the Rawlins RMP (BLM 2008a), the RFO has leased federal minerals within the entire project area. The BLM oil and gas leasing program encourages development of domestic oil and gas reserves, consistent with the BLM's multiple-use mission.

The BLM's purpose and need is to determine the conditions under which the applicant's valid existing rights from federal oil and gas leases within the CD-C project area may be exercised in accordance with the BLM's multiple-use mandate, the Mineral Leasing Act (MLA) of 1920 as amended, the Federal Land Policy and Management Act of 1976 (FLPMA), and the Federal Onshore Oil and Gas Leasing Reform Act of 1987. The MLA, as amended, provides that exploration and development of domestic oil and gas is in the best interest of the United States. The intent of the MLA and its implementing regulations is to allow, and essentially encourage, lessees or potential lessees to explore for oil and gas or other mineral reserves on federally-administered lands.

The BLM is also directed by the FLPMA to manage public lands for multiple use including recreation, wildlife habitat, development of timber and forest products, livestock grazing, and energy and mineral production such as the CD-C proposal. The BLM must consider the proposal for exploratory actions and full-field development of natural gas resources within the CD-C project area in a manner that meets the multiple-use mandate of the agency and sustains the health and productivity of public lands for the use and enjoyment of present and future generations. The BLM will consider approval of the proposed drilling in a manner that reduces impacts on water and wildlife resources throughout the CD-C project area, consistent with the lease rights granted to the applicant.

1.5 DECISIONS TO BE MADE

As a result of the analysis presented in this EIS, the BLM will decide whether to allow, and under what conditions to allow, the development, operation, maintenance, and reclamation of expanded development on federal lands and the federal mineral estate within the project area. The BLM will determine what levels of impacts are approved, and what Conditions of Approval, Best Management Practices, mitigation, monitoring, and surveying would be required. The ROD associated with this EIS will not be the final review or the final approval for all actions associated with this project. The BLM must review and authorize each component of the project that involves the disturbance of federal lands on a site-specific basis. The methods normally used to evaluate and authorize surface-disturbing activities are an Application for Permit to Drill (APD), right-of-way grant, or Sundry Notice, with supporting environmental record of review, which would be required before any construction could occur. Evaluations at this level include site-specific analyses of proposed well locations, tiered to the broad-scale level analysis included in this EIS.

1.6 REGULATORY SETTING

This EIS incorporates key provisions of the FLPMA of 1976, which directs the BLM to manage public lands and their resource values to "best meet the present and future needs of the American people" (Section 103 [43 USC 1702]) and to coordinate resource management "without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or greatest unit output" (Section 103(c) [43 USC 1702]). The FLPMA also states that it is appropriate that some lands be used "for less than all of the resources" (Section 103 (c) [43 USC 1702]).

The BLM RFO is the lead agency for this EIS because the federal lands proposed for development are under its jurisdiction. The BLM has provided guidance, input, participation, and independent evaluation during EIS preparation. Previously listed federal and state agencies and local governments participated in the preparation of this EIS as cooperators. The BLM, in accordance with 40 Code of Federal Regulation (CFR) 1506.5(a) and (c), is in agreement with the information and analyses presented in this EIS and approves and takes responsibility for the scope and content of this document.

This EIS was prepared in accordance with NEPA, and CEQ regulations implementing NEPA (40 CFR 1500–1508), and is in compliance with all applicable regulations and laws subsequently passed, including: USDI requirements (Department Manual [DM] 516 [516 DM 1 through 6, 11]); Environmental Quality (U.S. Department of the Interior 2005); guidelines listed in the BLM National Environmental Policy Act Handbook H-1790-1 (BLM 2008c); Guidelines for Assessing and Documenting Cumulative Impacts (BLM 1994); CEQs Considering Cumulative Effects under the National Environmental Policy Act (Council on Environmental Quality 1997).

1.7 AUTHORIZATIONS AND PERMITS

This section describes the general federal, state and county permitting environment in which the CD-C natural gas development project will operate. **Table 1-3** contains a full listing of the pertinent federal, state and county authorizing actions and the agencies that administer them.

Oil and gas leases on federal mineral estate are issued by the BLM consistent with regulations regarding federal oil and gas leasing and operations (43 CFR, Parts 3100 and 3120, respectively). Stipulations may be added as terms of a lease when the lease is issued to reflect management guidance established in the Rawlins RMP.

Once a lease is issued, the leaseholder/operator must apply for and receive site-specific authorization(s) prior to drilling within the leasehold area. To meet required environmental obligations, the leaseholder/operator must submit to the BLM an APD or its associated application for right-of-way so that the appropriate environmental review may be prepared. Environmental documents such as an Environmental Assessment, Categorical Exclusion, or the appropriate environmental record of review for APD or right-of-way authorizations often include site-specific Conditions of Approval that add further operational requirements.

Drilling of federal minerals is subject to the BLM's Onshore Oil and Gas Orders (43 CFR Subpart 3164 – Special Provisions). BLM Onshore Order Nos. 1 and 2 require an applicant to comply with the following conditions:

- Operations must result in the diligent development and efficient recovery of resources;
- All activities must comply with applicable federal, state, and local laws and regulations applicable to federal leases;
- All activities must include adequate safeguards to protect the environment;
- Disturbed lands must be properly reclaimed; and

- All activities must protect public health and safety.

Onshore Order No. 1 specifically states that lessees and operators are held fully accountable for their contractors' compliance with the requirements of the approved permit and/or plan (Part IV; March 7, 2007).

Pipeline and road rights-of-way on federal lands would be issued under the authority of the Mineral Leasing Act of 1920, as amended, or the FLPMA. Right-of-way grants authorizing construction of ancillary facilities, access roads, and pipelines would grant operators certain rights subject to the terms and conditions incorporated into the grant by the BLM.

Several Executive Orders (EOs) also affect implementation of the proposed project. These EOs, which are binding on all government agencies, place restrictions on government approval of construction activities and apply to wetlands, floodplain management, migratory birds, environmental justice, and invasive species.

The BLM must adhere to specific provisions regarding the draining of federal minerals from adjoining non-federal lands. These provisions are codified in 43 CFR 3100.2, which states that, upon determination that lands owned by the U.S. are being drained of oil or gas by wells drilled on adjacent lands, the BLM may execute agreements with the owners of adjacent lands whereby the U.S. and its lessees shall be compensated for such drainage. In addition, where lands in any lease are being drained of their oil and gas content by wells either on another federal lease, issued at a lower rate or royalty, or on non-federal lands, the lessee shall both drill and produce all wells necessary to protect the lease lands from drainage.

In lieu of drilling necessary wells, the lessee may, with the consent of the BLM, pay compensatory royalty. These provisions are also incorporated in the lease terms contained in all federal oil and gas leases (Form 3100-11). A list of the major permits, approvals, and authorized actions necessary to construct, operate, maintain, and abandon project facilities for the Continental Divide-Creston Natural Gas Development Project is provided in **Table 1-3**. Please note that this list is intended to provide an overview of the key regulatory requirements that would govern project implementation. Additional approvals, permits, and authorizing actions may be necessary.

Table 1-3. Federal, state, and county authorizing actions

AGENCY	NATURE OF ACTION
Federal Agencies	
Office of the President of the United States	Executive Orders • Protection and enhancement of the cultural environment (EO 11593) • Floodplain management (EO 11988) • Protection of wetlands (EO 11990) • Environmental justice (EO 12898) • Native American sacred sites (EO 13007) • Invasive species (EO 13112) • Protection of migratory birds (EO 13186) • Trails for America in the 21st century (EO 13195) • Preserve America (EO 13287) • Facilitation of Hunting Heritage and Wildlife Conservation (EO 13443)
Advisory Council on Historic Preservation	• National Historic Preservation Act of 1966, as amended (Regulations at 36 CFR Part 800, Protection of Historic Properties (amended August 5, 2004)
BLM (Rawlins Field Office)	• Approves APDs, Sundry Notices and reports on wells, production facilities, disposal of produced water, gas venting or flaring, and well plugging and abandonment for federal wells (MLA of 1920 [30 USC 181 *et seq.*]; 43 CFR 3162, Onshore Oil and Gas Orders No 1 and No 2, Approval of Operations) • Grants rights-of-way to operators for gas-field development actions on BLM surfaces outside of federal lease or unit boundaries, and to third-party applicants (i.e., non-unit operator or non-lease holder) both within and outside of the unit boundary (MLA of 1920, as amended [30 USC 185]; 43 CFR 2880; FLPMA [43 USC 1761–177 1]; 43 CFR 2800) • Reviews inventories of, and impacts to, cultural resources and antiquities affected by undertakings and consults with the State Historic Preservation Office and the Advisory Council on Historic Preservation as required by Wyoming State Protocol (Antiquities Act of 1906 [16 USC Section 431–433]; Archaeological Resources Protection Act of 1979 [16 USC Section 470aa–470ll]; Preservation of American Antiquities [43 CFR 3]; National Historic Preservation Act [NHPA[);Section 106 [36 CFR 60.4]) • Approves disposal of produced water from BLM/federal oil and gas wells (MLA of 1920 [30 USC 181 *et seq.*]; 43 CFR 3164; Onshore Oil and Gas Order No. 7) • Reviews impacts on federally listed or proposed-for-listing Threatened or Endangered species of fish, wildlife, and plants, and consults with U.S. Fish and Wildlife Service (Endangered Species Act of 1973, as amended *et seq.* [16 USC 1531]) • Grants Unit Area Agreements and subsequent actions relative to the unit
BLM Wyoming (Reservoir Management Group)	Administers drainage protection and protection of correlative rights on federal mineral estate
U.S. Army Corps of Engineers	Issues permit(s) for placement of dredged or fill material in, or excavation of, waters of the U.S. and their adjacent wetlands (Section 404 of the Clean Water Act of 1972 [40 CFR 122-123, 230])
U.S. Department of Energy	Regulates interstate pipeline product transportation (various sections of the USC and CFR)
U.S. Environmental Protection Agency	• Requires Spill Prevention, Control, and Countermeasure Plans (40 CRF 112) • Regulates hazardous wastes treatment, storage, and/or disposal (Resource Conservation and Recovery Act, 42 USC 6901)
Federal Agencies	
U.S. Fish and Wildlife Service	Reviews impacts on federally listed or proposed-for-listing Threatened or Endangered species of fish, wildlife, and plants; coordinates impacts to migratory birds (Fish and Wildlife Coordination Act, 16 USC Sec. 661 *et seq.*; Section 7 of the ESA of 1973, as amended [16 USC *et seq.*]; Bald Eagle Protection Act, as amended [16 USC 668–668dd]); Migratory Bird Treaty Act of 1898

Table 1-3. Federal, state, and county authorizing actions, *continued*

AGENCY	NATURE OF ACTION
U.S. Department of Transportation	Controls pipeline maintenance and operation (49CFR 191 and 192)
State of Wyoming	
Wyoming Department of Agriculture	Regulates weed and pest control by county agency (Wyoming Weed and Pest Control Act, Wyoming Statute WS 11-5-102)
Wyoming Board of Land Commissioners/Land and Investment Office	Approves oil and gas leases, rights-of-way for long-term or permanent off-lease/off-unit roads and pipelines, temporary use permits, and developments on state lands (WS 37-1-101 *et seq.*)
Wyoming Department of Environmental Quality (WDEQ), Water Quality Division	• Issues Wyoming Pollution Discharge Elimination System (WYPDES) permits for discharging wastewater and stormwater runoff (WDEQ Rules and Regulations, Chapter 18; Wyoming Environmental Quality Act, WS 35-11-301 through 35-11-311; Section 405 of the Clean Water Act, 40 CFR 122-124) • Provides administrative approval for discharge of hydrostatic test water (Wyoming Environmental Quality Act, WS 35-11-301 through 35-11-311) • Oversees conformance with all surface water standards, permits to construct, and permits to operate • Issues permits to construct settling ponds and wastewater systems including groundwater injection and disposal wells for non-oil and gas uses • Regulates off-lease disposal of drilling fluids from abandoned reserve pits (Wyoming Environmental Quality Act, WS 35-11-301 through 35-11-3111) • Grants small wastewater system permits, where applicable • Requires reporting of spills or releases of oil, hazardous substances and produced water
WDEQ, Air Quality Division	Issues New Source Review (NSR) permits to construct and operate all pollution emissions sources including compressor engines and portable diesel and gas generators (Clean Air Act; Wyoming Environmental Quality Act, WS 35-11-201 through 35-11-212)
Wyoming Department of Environmental Quality, Solid Waste Division	Issues construction fill permits and industrial waste facility permits for solid waste disposal during construction and operations (Wyoming Environmental Quality Act, WS 35-11-501 through 35-11-520)
Wyoming Department of Transportation (WYDOT)	Issues permits for oversize, overlength, and overweight loads (Chapters 17 and 20 of the Wyoming Highway Department Rules and Regulations)
Wyoming Oil and Gas Conservation Commission (WOGCC)	• Issues permits to use earthen pit (reserve pits) on nonfederal lands (WOGCC Regulations, Section III; Rule 305) • Authorizes flaring or venting of gas (WOGCC Regulations, Section III; Rule 326) • Issues permits for Class II underground injection wells (WOGCC Regulations, Section III; Rule 346) • Regulates well plugging and abandonment (40 CFR 146; 40 CFR 147.2551) • Issues permit to drill, deepen, or plug back as part of the APD process (WOGCC Regulations, Section III; Rule 315) • Regulates change in depletion plans, Wyoming Oil and Gas Act (WS 30-5-110) • Sets minimum safety standards for oil and gas activities (WOGCC Regulations (Rules 321-A, 327, and 328)

Table 1-3. Federal, state, and county authorizing actions, *continued*

AGENCY	NATURE OF ACTION
State of Wyoming	
Wyoming State Engineer's Office	• Issues permits to appropriate ground and surface water (WS 41-121 through 147 (Form UW-5) • Issues temporary water rights for construction permits to appropriate surface water (WS 41-201, Form SW-1)
Wyoming State Historic Preservation Office	Provides consultation concerning inventory of, and impacts to, cultural resources (Section106 of NHPA and Advisory Council Regulations, 36 CFR 800)
Carbon County	
	• Issues driveway access permits where new roads intersect with county roads • Prepares road use agreements and oversize trip permits when traffic on county roads exceeds established size and weight limits, or where the potential for excessive road damage exists • Issues construction and conditional use permits for all new structures • Administers zoning changes where applicable • Provides control of noxious weeds • Issues permits to bore or trench county roads or for any crossing or access off a county road
Sweetwater County	
	• Requires compliance with the International Fire Code (Wyoming State Statute 35-9-121) • Issues Construction/Use Permits to insure all structures and uses comply with the health, safety and welfare standards of the Sweetwater County Development Code. (Wyoming State Statute 18-5-201 et seq.) • Issues Conditional Use Permits to insure that uses such as man camps, storage of explosives, storage of radioactive material, temporary construction yards, gravel quarries, wastewater disposal facilities, solid waste disposal facilities, and similar uses comply with the health, safety, and welfare standards of the Sweetwater County Development Code. (Wyoming State Statute 18-5-201 et seq) • Approves zone changes as necessary to ensure that the proposed use of the land is coordinated with the Sweetwater County Zoning Map and Land Use Plan. (Wyoming State Statute 18-5-201) • Issues County Road permits and licenses including road access and road crossings. (Wyoming State Statute 24-3-101 et seq) • Requires coordination with the Sweetwater County Engineering Department regarding the movement of heavy equipment on county roads and the proper use and maintenance of said roads. (Wyoming State Statute 24-3-101 et seq) • Coordinates on natural resource issues in the context of the Sweetwater County Conservation District Land and Resource Use Plan and Policy
Sweetwater County Health Department	Issues small wastewater permits (Wyoming State Statute 35-11-101 et seq)
Local Emergency Planning Committee	Requires Hazardous Materials Inventory to ensure the storage of hazardous materials is properly coordinated with the emergency providers (Right to Know Act, EPCRA-42-116-101 et seq)
Sweetwater County Weed and Pest District	Provides control of noxious weeds (Wyoming Statute 1105-101 et seq)

1.8 CONFORMANCE WITH THE RAWLINS RESOURCE MANAGEMENT PLAN

The BLM issued its ROD for the Rawlins RMP in December, 2008. The Rawlins RMP provides direction for managing 3.5 million acres of BLM-administered public land and 4.5 million acres of BLM-administered federal mineral estate in Albany, Carbon, Laramie, and Sweetwater Counties, Wyoming, including the entire CD-C project area. The proposed CD-C development would be in conformance with the 2008 Rawlins RMP and the BLM decisions relating to the CD-C proposal will be in conformance with the RMP with one area of exception. Alternative B, Enhanced Resource Protection (**Section 2.2.3**) contains several provisions that, if included in the CD-C ROD, may require an RMP amendment. For example, the RMP requires "avoidance of surface-disturbing and disruptive activities within 500 feet of perennial waters, springs, wells and wetlands." For Muddy Creek and its tributaries that distance would be increased to 0.25 miles by Alternative B. If it is determined that this or other elements from Alternative B are to be included in the CD-C ROD, then the CD-C ROD would initiate the necessary RMP amendment procedures.

Two elements of the Rawlins RMP that affect public resource management within the CD-C project area may be revised before a ROD is issued on the CD-C project proposal: the management of visual resources and the management of greater sage-grouse habitat.

- The RFO's resolution of RMP protest issues required additional planning on visual resource management (VRM). On April 11, 2012, the RFO published a Notice of Intent to amend the RMP with regard to the VRM designations. Subsequent to the completion of the RMP, the RFO updated the visual resource inventory for the planning area and will use the update as a baseline for a revised designation of VRM classes. The potential effect of this revision on management of visual resources on public lands in the CD-C project area is described in **Section 4.11, Visual Resources**. Should the RMP amendment for VRM designations be completed before the CD-C EIS is completed, the CD-C ROD will reflect changes in VRM designations for the CD-C project area.
- On May 28, 2010, the BLM Wyoming State Office announced its intention to prepare RMP amendments to revise sage-grouse and sagebrush management for the Rawlins, Rock Springs, Kemmerer, Pinedale, Casper, and Newcastle RMPs. Amending the RMPs would provide consistency in applying the BLM Wyoming sage-grouse policy and also would assure consistency with the Wyoming Governor's Sage-Grouse Implementation Team's Core Population Area Strategy. Should the RMP amendment for sage-grouse management be completed before the CD-C EIS is completed, the CD-C Record of Decision (ROD) will reflect changes in management of greater sage-grouse called for by the RMP amendment.

Reasonably foreseeable development of oil and gas resources for the Rawlins Resource Area during the 20-year life of the RMP was estimated at 8,822 wells, resulting in gross surface disturbance of 57,819 acres and net surface disturbance of 15,472 acres including roads and pipelines. The number of wells drilled and the estimated disturbance acreage were included in the RMP for analysis purposes only. The estimates should not be construed as a cap or limit on the number of wells that could be drilled, or on the amount of surface disturbance resulting from the development of oil and gas resources within the resource area. No such constraints were intended and the RMP contains no decision that would cap drilling or disturbance.

1.9 PUBLIC PARTICIPATION

1.9.1 Scoping Process

Council on Environmental Quality (CEQ) regulations on implementing NEPA call for an early and open process to determine the scope and significance of issues to be addressed in the EIS (40 CFR Sec. 1501.7). One of the principal goals of this scoping process is to involve the public in the identification of issues, concerns, and potential impacts that may require detailed analysis in the EIS. The formal scoping process for the Continental Divide-Creston EIS began with a Notice of Intent (NOI) to prepare an EIS on additional drilling in the Creston/Blue Gap natural gas field. (As described in **Section 1.2, Overview of the Proposed Project**, the Continental Divide-Creston EIS began as an EIS on just the Creston/Blue Gap area.) That NOI was published in the *Federal Register* on September 8, 2005, inviting the public to comment on a proposal for more extensive development in the Creston/Blue Gap II natural gas field. A public meeting was held in Rawlins on October 13, 2005. During the scoping period on the Creston/Blue Gap II Project, the BLM received 29 individual comment letters, faxes, and e-mails.

Very soon after the Creston/Blue Gap scoping process had been completed, BLM RFO received a proposal from BP America Production Company (BP), representing themselves and other leaseholders, to further develop lease holdings in the Continental Divide/Wamsutter II natural gas area. The BLM decided to combine this project with the Creston/Blue Gap project into a single EIS and initiated another scoping process for the newly named Continental Divide-Creston EIS. The BLM published a NOI for the larger Continental Divide-Creston project on March 3, 2006. A public meeting to discuss the project was held in Rawlins on April 6. In addition to the 29 comments received during the original scoping period, 21 comment letters, faxes, and e-mails were received for the combined Continental Divide-Creston Project. Most of the respondents were the same for both projects.

As part of the scoping process, the BLM invited other federal, state, and local government agencies to participate in the EIS process as cooperating agencies. The RFO hosted an “interested Agency” briefing in January 2006 to bring the project to the attention of locally interested state, federal and local agencies. The State of Wyoming, Sweetwater County, the Little Snake River Conservation District , and the Sweetwater County Conservation District requested and received Cooperating Agency status.

The issues and concerns identified during the process described above are described in more detail in **Appendix A**. Key issues and concerns are summarized below.

1.9.2 Key Issues and Concerns

All comments received during the scoping process were reviewed and analyzed. The BLM identified nine key or driving issues based primarily upon the potential quantity, intensity, or duration of an impact, and/or the degree of agency or public interest in the issue. The range of alternatives was developed in response to these key issues, and the potential impacts associated with these issues.

- **Air Quality**: Potential project and cumulative impacts on air quality, including air quality-related values (AQRV).

  Estimate potential changes in emissions brought about by the project, including nitrogen oxides (NO_x), particulate matter greater than 10 microns in diameter (PM_{10}), and ozone. Estimate project-generated ozone using state-of-the-art scientific methods. Impact analysis should include evaluation of regional haze and visibility effects on Category I airsheds. Modeling should address cumulative emissions in the project area and regionally, assuming reasonably foreseeable natural gas and other development.

- **Cultural resources:** Estimate the impact on the historic trails and transportation corridors in the project area.

  The Overland Trail, Cherokee Trail, UPRR, and Lincoln Highway pass through the project area. These trails have been inventoried and evaluated for eligibility to the National Register of Historic Places (NRHP), and appropriate mitigation will be developed that would preserve the setting which contributes to that eligibility.

- **Hydrology:** Degradation of water quality by project construction and drilling activities, issues related to disposal of CBM-produced water.

  The project may increase salt and sediment loads to and depletions from Colorado River watersheds. What will be the selenium content of produced water? It should be no higher than 2 micrograms per liter (μ/L) to protect fish, waterfowl, shorebirds, and other wildlife. No surface disposal of produced water should be allowed due to increased salt loading within the Colorado River basin.

- **Land Ownership:** The great majority of the project area is in the "Checkerboard," greatly complicating impact reduction through mitigation.

  A number of respondents noted that mitigation efforts on public land may not be imposed on nearby private lands, thus undermining the success of that mitigation. Examples cited included wildlife winter range, surface disturbance, traffic management, and non-native species.

- **Non-native, Invasive Plant Species:** Evaluate the current and projected presence of non-native, invasive species.

  Already-extensive development in the project area has resulted in increased infestation by invasive species. The regional drought has exacerbated this situation. To what extent will further development of the project area increase the problem and what measures can be taken to control and manage the spread of invasive species? To what extent is wildlife habitat and rangeland diminished by invasive species?

- **Range Resources:** Loss of livestock forage and project-associated hazardous conditions to area livestock/livestock operations.

  Respondents indicated concerns for livestock operations in the project area. Concerns were generally associated with: the direct loss of forage and the associated potential for a reduction in permitted livestock numbers; water quality impairment; movement restrictions; alterations due to pipeline trenches, roads, and fences; management problems associated with the inability to access two-track routes from project-developed crowned-and-ditched roads; and livestock hazards from vehicle collisions, drinking contaminated water from project pits, entrapment in pipeline trenches, and the increase in fugitive dust emissions potentially causing dust-induced pneumonia.

- **Special Status Species**: What are the T&E and sensitive wildlife species that could be impacted by the project, and what would be the extent of the effects?

  There are resident populations of greater sage-grouse and mountain plovers and other special status species. If black-footed ferret populations were found in the project area, would they be affected if prairie dog populations were reduced? Could downstream habitat of Colorado River Endangered fish populations be affected by soil sedimentation or water depletions? The EIS should include identification and mapping of important habitats, and measures to avoid or mitigate loss of those habitats.

- **Socioeconomics:** Define the impact of the project on traditional socioeconomic indicators and examine the question of technical vs. economic recoverability of the resource.

  Some respondents expressed concern over the effect of the project on local employment, infrastructure, and public finance. Additional concerns focused on the development of oil and gas resources leading to the destruction of other economic activity like recreation and second-home development. One respondent questioned the advisability of complete recovery of the natural gas resource.

- **Surface disturbance/reclamation:** The extent of existing and proposed surface disturbance and its effects on all resources in the project area.

  Many respondents identified the volume and distribution of surface disturbance as an issue for several resources in the project area—wildlife and wildlife habitat, cultural resources, soils and vegetation, and range resources. Directional drilling was frequently cited as a method to minimize surface impacts. Proper reclamation of disturbed lands is critical to minimizing impacts on all area resources and reclamation in arid environments, especially during periods of drought, is challenging and may require specialized methods.

- **Wildlife Habitat:** The project has the potential to further fragment wildlife habitat and seriously diminish the value of that habitat for many species.

  Previous development in the project area has created a network of roads that has already fragmented habitat. The Proposed Action would quadruple the number of wells and has the potential to greatly increase fragmentation through proliferation of access roads. What impact will this have on the wildlife species in the area, and in particular, pronghorn, mule deer, and elk. Examine the effects of natural gas production on winter range within the project area. The analysis should fully explore mitigation efforts to minimize habitat fragmentation and to offset losses created by fragmentation; mitigation measures could include limiting use to existing roads, closure of some existing roads, and traffic controls. The need and methodology for wildlife and habitat monitoring should be fully explored.

2. THE PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

The BLM identified a range of alternatives to the Proposed Action based on issues, concerns, and opportunities raised in public comments during scoping; interdisciplinary interaction between resource professionals; and collaboration with cooperating and other interested agencies. Comments on the Proposed Action received during the public scoping period are summarized in **Section 1.9, Public Participation**. A more detailed description of the public comments is found in **Appendix A: Summary of Scoping Comments by Category**. The alternatives to the Proposed Action that are examined in detail in this Draft EIS include Alternative A: 100-Percent Vertical Drilling; Alternative B: Enhanced Resource Protection; Alternative C: Surface Disturbance Cap—High and Low Density Development Areas; Alternative D: Directional Drilling; and Alternative E: No Action. The Proposed Action and the alternatives are described in this chapter. The BLM NEPA Handbook (H-1790-1) calls for expression of the BLM's preferred alternative in the Draft EIS if one exists (BLM 2008c). The BLM does not have a preferred alternative for the CD-C Natural Gas Development Project at this time. The BLM believes that the Proposed Action and the action alternatives all have elements that would address the project purpose and need and will review public comment on the Draft EIS before determining a preferred alternative. A preferred alternative will be designated in the Final EIS.

Although the development activities anticipated in the Proposed Action and in the alternatives would take place on federal, state, and private lands, BLM authority applies only to the activities that would occur on BLM-administered lands. Those activities on BLM-administered lands and mineral estate for the Continental Divide-Creston (CD-C) Natural Gas Development Project must conform to the Rawlins RMP. The Rawlins RMP was completed in December 2008 (BLM 2008a) and is available at <http://www.blm.gov/rmp/wy/rawlins/documents.html>.

2.2 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.2.1 The Proposed Action

BP America Production Company and other operators (the Operators) propose to drill up to 8,950 wells on approximately 1.1 million acres of federal, private, and state mineral estate (**Map 1-1**). These wells would be in addition to the more than 4,400 wells that have already been drilled in the CD-C project area. Up to 500 of the proposed wells could be coalbed natural gas (CBNG) wells. The project, as defined by the Operators, is summarized here. For more detailed information, please see the Operators' detailed Plan of Development in **Appendix B**.

The proposed natural gas wells could be drilled either conventionally (with a single vertical well bore on each well pad) or with multiple directional well bores from a single pad. It is anticipated that all wells would be drilled during the 10- to 15-year period after project approval. Although actual operations are subject to change as conditions warrant, the Operators' long-term plan of development is to drill at the average rate of approximately 600 wells per year until the resource is fully developed. The Operators anticipate drilling infill wells at potentially up to 40 acres per down-hole well bore. Based on existing reservoir and well performance information, most gas wells will be completed in the Almond Formation (Mesa Verde Group), although secondary reserves may be encountered in other formations (e.g. Lewis, etc.). The average life of a well is expected to be 30 to 40 years. Combining well life with a 15-year production period produces a potential project life of 45 to 55 years. Factors outside of the Operators' control, including geologic characteristics, reservoir quality, engineering technology, and economic conditions could affect the Operators' ability to adequately drain the reservoir and could result in fewer than 8,950 wells being drilled.

The facilities required by the project would include: roads; gas, water, and condensate gathering pipelines; overhead and buried power lines; production facilities (separation, metering, treating, fluid storage, compression, artificial lift, etc.); disposal well and/or surface disposal facilities; equipment storage facilities; and other associated facilities. In general, gas would be transported via subsurface pipelines to centralized compression and treatment facilities, although some well-site compression may be included on an as-needed basis. Produced water would be transported by truck to water-disposal wells or evaporation ponds, or by pipeline to treatment facilities. Existing arterial roads would provide the main access to and within the project area.

2.2.1.1 Construction Activities

Since much of the project would largely be an infill development in an existing natural gas field, new road construction would not be extensive. The primary access to the project area is Interstate 80 (I-80). Existing arterial roads, including Wyoming State Highway (WY) 789 and several Sweetwater and Carbon county roads, provide access within the project area. New road construction would primarily be short sections of road from the existing road network to new well sites and support facilities. Some existing access roads may need to be improved to accommodate increased traffic. Specific locations for access roads are not known at this time but will be included in permit applications and will be evaluated by the BLM during onsite inspections.

The project would include the construction of 8,950 well bores from both single-well pads and well pads with multiple directional well bores. Construction of a typical single-well pad would require approximately 6.3 acres, which includes 0.9 acres for an access road. A typical multiple-well pad would disturb approximately 2.45 acres per well bore, which includes 0.45 acre for an access road. Operators will determine the locations of new wells according to the subsurface reservoir, the topography of the area, and Wyoming Oil and Gas Conservation Commission (WOGCC) spacing rules. Dimensions of drill pads will depend on topography and specific well needs.

Table 2.4-1 shows the estimated surface disturbance for the Proposed Action and the alternatives to the Proposed Action.

2.2.1.2 Drilling and Completion

Well-drilling and completion activities will be in compliance with Federal Onshore Oil and Gas Order No. 2. These guidelines specify the following:

> *…proposed casing and cementing programs shall be conducted as approved to protect or isolate all usable water zones, potentially productive zones, lost-circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use.*

The Operators anticipate that the drilling-rig count within the project area would be up to 25 rigs at any particular time in order to achieve development objectives. Wells would be drilled utilizing conventional, mechanically powered mobile drilling rigs. Drilling each gas well would take from 7 to 20 days, with additional time likely for directional wells and wells deeper than 10,000 feet. The Operators propose to drill year-round subject to environmental considerations.

Approximately 20,000 to 30,000 barrels (bbls) of water are needed to perform drilling operations for each well. Fresh water would be used for drilling the first 5,000–7,000 feet of each gas well, and water-based muds would be used for the remainder of the drilling operation. Water would come from existing and new water-supply wells within the project area, as well as from produced-water sources. The use of produced water to the greatest extent possible would conserve fresh-water aquifers. No water would be withdrawn from surface waters of the project area.

A fenced reserve pit, approximately 10 to 12 feet deep, would be excavated within the pad to temporarily store drilling fluids and cuttings. The reserve pit would be lined if so specified in the APD; in non-environmentally sensitive areas and when a fresh water-based drilling mud is used, the reserve pit may be unlined pending evaluation of the distance to surface water, depth to useable ground water, soil type and permeability, and anticipated types of fluids that would be contained in the pit. Reserve pits would be constructed so as minimize the potential to leak, break, or allow discharge and in accordance with APD Conditions of Approval (COAs). The reserve pit would be fenced on three sides during drilling operations and on the fourth side when the rig moves off the location. On producing wells, the reserve pit would be reclaimed per the requirements specified in the approved APD. Reserve pits may be re-used for multiple wells being drilled from a single pad. Although not specified in the Operators' Plan of Development, the use of closed-loop drilling systems that allow for reuse of drilling fluid and remove the need for a reserve pit may be implemented.

Drilling operations require approximately 8 to 10 personnel and six vehicles on location at any given time each day during normal operations. An additional 10 to 15 personnel and six vehicles would be required on location during the running and cementing of production casing. A cementing plan is submitted with the drilling plan as part of the Application for Permit to Drill (APD). This plan is reviewed by the BLM and/or the WOGCC.

When production casing has been cemented in place, completion operations would begin. In general, completion consists of perforating the production casing, pressure testing, stimulation of the formation utilizing hydraulic fracturing technology, flow-back of fracturing fluids, flow testing to determine post-fracture productivity, and installation of production equipment to facilitate hydrocarbon sales.

Hydraulic fracture stimulation is required on the majority of wells in the project area during completion operations in order to enhance productivity. Combinations of fluids and proppants are pumped down the well bore through the perforations in the casing, and into the formation to optimize stimulation. One common stimulation technique utilizes gelled fresh water (with CO_2 and/or N_2 frequently added for reservoir protection and enhanced flowback) and fracture proppants to provide bridging and increased permeability. Sand, resin-coated sand, ceramics, or bauxite can be used as proppants. Gels and other chemical additives provide fluid viscosity. Sufficient rate and pressure are reached to induce a fracture in the target formation. The proppant carried in the fluid serves as a bridge to keep the created fracture open and to provide a flow path that allows reservoir fluids to move more readily into the well bore. Water used for stimulation purposes generally comes from water supply wells. Stimulation fluids recovered during flow back and subsequent production operations are temporarily contained in the completion, flare, or reserve pit. As discussed under **Drilling Operations** in **Section 4.4.4.1**, the hydraulic fracturing process is currently being regulated or is being evaluated by the EPA, the BLM, and the WOGCC.

In May of 2012, the BLM proposed a new rule under 43 CFR Part 3160 (BLM 2012a) to regulate hydraulic fracturing on public and Indian lands. The rule would (1) provide disclosure to the public of chemicals used in hydraulic fracturing on these lands, (2) strengthen regulations related to well bore integrity, and (3) address management and storage of flowback water. In April of 2012, the EPA issued final rules that include the first federal air quality standards for natural gas wells that are hydraulically fractured, along with requirements for several other sources of pollution in the oil and gas industry (EPA 2012a).

Completion and testing operations typically require approximately 10 to 20 (up to 30) days to perform, 2 to 30 personnel, and 1 to 20 vehicles on location. Approximately 4,000–12,000 bbls of water per well would be needed for completion and testing operations. Drilling and completion activities together would require 24,000-42,000 bbls of water per well.

2.2.1.3 Production Facilities

Production facilities on the well pad would typically include wellhead valves and piping, separation, dehydration, metering equipment, oil and water production tanks, a methanol storage tank and pump, and telemetry equipment. Production equipment would be fueled by natural gas or electricity. Telemetry equipment is currently used or planned for use by most Operators to improve well evaluation and operational efficiency, and to minimize well visits. Production pits would not be used. Well-site compression could be utilized on an as-needed basis. Buried natural gas gathering lines would be installed to transport produced gas from new wells to the existing gas-gathering pipeline system. The Operators would continue to use existing natural gas transmission pipelines that serve the project area. New natural gas transmission pipelines are not included as a component of the proposed project.

The project may also include the development of an overhead electrical system to provide commercial power to portions of the field, as well as lower-voltage, buried power utilities to individual well pads. The overhead system is estimated to include approximately 36 miles of line.

2.2.1.4 Pipelines

The Operators would use existing natural gas transmission lines that serve the project area. Operators are not responsible for the construction or operation of gas transmission lines, and new transmission lines are not included as a component of the CD-C project.

Gathering lines would be installed below the surface to transport the produced gas from the new wells to the gas gathering pipeline system. The gas production lines would be located adjacent and parallel to well access roads where possible to minimize surface disturbance. New pipelines would cross federal, state, and private surfaces in a route developed to minimize both resource conflicts and development costs.

Pipeline construction consists of trenching, pipe stringing, bending, welding, coating, lowering pipeline sections into the trench, and backfilling. In general, construction widths would be 50 to 75 feet when not adjacent to a road and 25 to 50 feet when adjacent to an existing or new road. Newly constructed pipelines would be hydrostatically tested to ensure structural integrity. As an example of water requirements, approximately 2,700 gallons of water would be required to test one mile of four-inch pipeline. Hydrostatic test water would be disposed of as approved by the BLM and/or the State.

2.2.1.5 Compression, Gas Treatment, and Ancillary Facilities

Because the existing compression infrastructure in the project area would not provide sufficient capacity to compress the additional gas volumes anticipated from the CD-C project, supplemental compression would be required at various locations throughout the project area. An estimated 24,936 horsepower (hp) of additional compression may be needed as the project is developed for dedicated compressor sites and at well sites. The additional compressor sites, including a large central pipeline compression facility and possibly some well-site compression, could add up to 60 acres of disturbance.

It is anticipated that one additional central gas-processing/stabilization facilities would be needed within the project area, affecting up to 30 acres.

2.2.1.6 Produced-Water Disposal

Produced water from conventional natural gas production may be stored in tanks at the well site prior to transport by water-hauling trucks or transported in flowlines to collection facilities for disposal. All produced water disposal would be in accordance with applicable WOGCC and WDEQ requirements and approved under BLM Sundry Notice, as appropriate. An estimated 30 new injection wells and 20 produced water handling facilities would be constructed to dispose of produced water. The Operators have no plans for surface discharge of produced water. Conventional wells in the project area average 18 bbls/day of produced water. Produced water, condensate, and gas would be separated at the well site or at central facilities. Depending on the method of disposal, permits are required from WDEQ-WQD (surface) or WOGCC (subsurface) for disposal of produced water.

This document does not analyze the disposal of produced water from CBNG development. The volume of water produced in CBNG development is typically and initially much greater than for conventional gas production. CBNG-produced water might be stored onsite in a lined pit or storage tank, or water-collection lines might be installed to transport water to a water-treatment facility, evaporation ponds, injection wells, subsurface drip areas and/or approved discharge points. The actual volumes produced and the methods by which the produced-water would be managed are greatly dependent on the site-specific development proposals, and it would be speculative for the BLM to analyze this aspect of CBNG development in detail in this EIS. For that reason, this document does not contain any description of produced-water disposal for CBNG development and does not analyze the impacts of such development. When the BLM receives site-specific CBNG proposals in the CD-C project area, those proposals, including their produced water treatment, will be analyzed in a future NEPA document.

Interim reclamation on well pads and roads would begin as soon as possible after the well is put into production. The reserve pit, that portion of the well location and access road not needed for production operations, and pipeline corridors would be reclaimed according to the requirements specified in the approved APDs. Well pads and roads would be reclaimed and reseeded back to the minimum size required.

When production at a well site is completed, the Operators would cut off the casing three feet below the final graded ground level and cap it. All surface equipment would be removed from the site and the surface would be recontoured to its original appearance, to the extent possible. Topsoil would be distributed over the location to blend the site in with its natural surroundings. All surface disturbance would then be planted with an appropriate seed mixture. Reclaimed sites would be monitored to ensure erosion is prevented and/or controlled and the desired plant species are being re-established. Monitoring would continue until the reclamation is deemed successful.

2.2.1.7 Operator-Committed Practices

Plan of Development. The Operators' Plan of Development indicates that they would adhere to all lease and APD conditions, as well as all federal and state laws, regulations, and policies implemented through statute and/or resource management planning decisions implemented through NEPA. The Operators specifically cite BLM Instruction Memorandum No. 2004-194, *Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights-of-Way,* and note that Best Management Practices (BMPs) to be considered in nearly all circumstances include the following:

- Interim reclamation of well locations and access roads soon after the well is put into production;
- Painting of all new facilities a color which best allows the facility to blend with the background, typically a vegetated background;
- Design and construction of all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use; and
- Final reclamation recontouring of all disturbed areas, including access roads, to the original contour or a contour that blends with the surrounding topography.
- The Operators commit to performing these environmental protection measures during the implementation of their proposed project. **Appendix C** includes a summary description of the BMPs and APD COAs typically used by the BLM in the Rawlins Field Office to implement the federal laws, regulations, and policy aimed at mitigating environmental impacts.

Air Quality. During preliminary near-field air dispersion modeling analyses of CD-C project emissions it was apparent that the nitrogen dioxide (NO_2) concentration impacts were above the 1-hour NO_2 National Ambient Air Quality Standards (NAAQS) for modeling scenarios that included drill rig engines with Tier 0 emissions levels, and it was necessary to consider drill rig engines with at least Tier 2 emissions levels in order to demonstrate compliance with the 1-hour NO_2 NAAQS. Therefore the CD-C Operators committed to using a minimum of Tier 2 drill rig engines for drilling operations. This commitment will be included and become enforceable in the Record of Decision.

2.2.2 Alternative A: 100-Percent Vertical Drilling

Although not stated explicitly, the Operators' Proposed Action assumes a substantial amount of directional drilling. Approximately 42 percent of the 8,950 wells to be drilled would be located on multiple-well pads and drilled to the target formation directionally; the other 58 percent would be located on single-well pads and drilled vertically. The estimated surface disturbance that would result from the Proposed Action would be reduced because of the directional drilling. However, the proposal contains no commitment on the part of individual Operators or the group as a whole to implement that amount of directional drilling. The directional drilling included in the proposal is tied to the current plans of individual Operators and could change as Operators, leaseholders, or conditions change.

In order to examine the possibility that all 8,950 wells would be drilled from single-well pads, the BLM developed Alternative A, with 100-percent vertical drilling. All other elements of the CD-C project would remain as described in the Proposed Action. With the assumption of 100-percent vertical drilling, the estimated surface disturbance is increased by 31 percent, from a project total of 47,200 acres to 61,696 acres.

Table 2.4-1 shows the estimated surface disturbance for this alternative along with the Proposed Action and the other alternatives.

2.2.3 Alternative B: Enhanced Resource Protection

Environmental protection and mitigation of environmental impacts are important aspects of the BLM's management of natural gas development on public lands. The RFO has a suite of basic protections that are used to minimize the effects on resources. Restrictions and limitations called for by the Approved Rawlins Resource Management Plan (RMP) are imposed prior to development activities. Additionally, a number of standard operating procedures and Best Management Practices are implemented as needed. These are described below and throughout the description of Alternative B as ***Basic Protections***. The premise of the Enhanced Resource Protection Alternative is that intensive natural gas development may increase the risk of adverse impact for some resources and thus those resources may require protections and mitigation beyond the Basic Protections. This alternative identifies the resources that may be more at risk from natural gas development and the ***Enhanced Resource Protections*** that would be implemented for these resources, which include enhanced protections and mitigation.

The alternative also recognizes that future development may be more intensive than currently expected or may have unintended consequences, resulting in impacts on wildlife habitats and populations in areas that were not anticipated or impacts that occur at a faster pace than anticipated. For that reason, the alternative describes disturbance and population thresholds that, if crossed, would signal the need for still more protections and mitigation. The thresholds are described below and throughout the alternative description as ***Surface Disturbance Thresholds*** and ***Population Thresholds***.

The resources that would receive enhanced protection under this alternative are:

- Mule deer crucial winter/yearlong range and migration corridors;
- Pronghorn antelope crucial winter/yearlong range and migration corridors;
- Greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas;
- Ferruginous hawk nesting habitat;
- The Muddy Creek and Bitter Creek corridors and watersheds;

- Chain Lakes alkaline wetland communities and other playas; and
- Livestock grazing.

Basic Protections

Most of the above resources already have protective measures specified in the RMP or applied as standard operating procedures. Such measures would apply to oil and gas operations within the CD-C project area under all alternatives. These Basic Protections are described below in each section for the resources receiving enhanced protections as a reminder that these requirements apply at all times regardless of alternative. For example, no activity is permitted within 0.25 mile of the perimeter of an occupied sage-grouse lek year-round. During the sage-grouse nesting/early brood-rearing season, March 1 – July 15, no activity is permitted within all identified sage-grouse habitat. Other RMP measures are provided in detailed guidelines for resource management such as those found in RMP Appendix 11 – Water Quality and Watershed Management.

Standard operating procedures for resource protection can be found in Conditions of Approval (COAs) placed on an APD or in terms and conditions placed on a right-of-way grant (see **Appendix C**). In addition to items aimed at minimizing soil and water erosion and promoting successful reclamation, those measures may include such things as pre-disturbance surveys, consultation on facility location, signage, and constraints on traffic.

Recently, interim conservation measures for sage-grouse have been proposed by Wyoming BLM Instruction Memorandum (IM) WY-2012-019 (February 10, 2012), which provides new statewide measures for protection of greater sage-grouse habitat. The IM provides interim program direction consistent with Washington Office IM No. 2012-043 until BLM Wyoming's effort to evaluate effective greater sage-grouse conservation measures through amendment of RMPs is completed. The protective measures identified in the IMs referenced above, or their functional equivalents, were analyzed within the range of alternatives.

Enhanced Resource Protections

Alternative B builds on the basic protections that are currently in effect in the project area, expanding the scale of some measures or adding new measures. An example of an expanded measure is increasing the avoidance zone around the Chain Lakes wetlands and other playas from 500 feet to 0.25 mile. Examples of new measures are burying new power lines within 1 mile of an occupied lek or in winter concentration areas, and extending the current monitoring program in Upper Muddy Creek to Lower Muddy Creek.

Specific expanded resource protections are described for each of the high-value resources but several general protections apply to all. Three of these are:

1. Uniform application of dust-abatement procedures during construction and drilling operations year-round and seasonally, as needed, on well sites, pipelines, and collector and well access roads.
2. Environmental awareness training during orientation for all employees and subcontractors, including information about native wildlife, sensitivity to various kinds of impacts, Wyoming wildlife laws, etc.
3. BLM will require remote monitoring at well pads when a surface disturbance threshold of 5 percent is reached for the resources that have that threshold.

In addition, Applications for Permit to Drill (APDs) that would affect any of the described resources except livestock forage would be submitted with an overall development plan. The development plan would be submitted either for an individual lease or several leases. It should aim at reducing surface disturbance and disturbance associated with vehicle traffic and other human activity and should include, at a minimum:

- Consideration of cluster development of production facilities;

- A road system that minimizes construction of new roads;
- Individual road design that minimizes surface disturbance while still meeting safe standards for the intended use;
- Reconstruction of access roads to a lower standard once drilling is completed and the operation phase has begun;
- Reclaiming of all but one road once production starts if more than one road is built within the lease;
- A travel plan that minimizes vehicular traffic for monitoring and servicing wells and other facilities and that includes closures and/or time-of-day restrictions for production roads during the winter season;
- Consideration of pipelines for transporting liquids offsite or installation of larger-capacity storage tanks to reduce the number of truck trips to well sites; and
- A snow-removal plan to ensure protection of resources.

Plans for development within the entire Muddy Creek and Bitter Creek watersheds should include, at a minimum, the following additional road/pipeline requirements:

- Detailed development, transportation, and reclamation plans, including road design, culvert placement, steep slopes, etc.;
- Design of improvements to existing roads or construction of new roads to minimize hydrologic alteration;
- No new road crossings of Muddy Creek;
- Development of specific road design criteria based upon site-specific review and likely including a combination of mitigation options; and
- Submission of data from inspections of erosion control BMP's within the Muddy Creek and Bitter Creek watersheds would be required. The format and frequency of submission of these data would be coordinated with the BLM and could use the same information collected under the Stormwater Pollution Prevention Plan (SWPPP) or other BLM-approved monitoring method.

Surface Disturbance Thresholds

There may be instances in the future where natural gas development is even more intense locally than currently anticipated or where the overall impacts are greater than expected. In such cases, the Enhanced Resource Protection Alternative includes surface disturbance thresholds for five of the seven high-value resources: mule deer crucial winter/yearlong range and migration corridors; pronghorn antelope crucial winter/yearlong range and migration corridors; greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas; ferruginous hawk nests; and livestock grazing.

Generally, two threshold levels are specified:[3]

- A lower level, usually 5 percent of protected habitat within a lease and/or right-of-way, that signals a potential problem and mandates an evaluation of reclamation success. If reclamation success is limited, a revised plan would be required to address the failings. The initial level also calls for an assessment of the disturbance to determine if mitigation is needed. If it is, APDs will not be processed or approved until the BLM has received and approved a mitigation plan that will effectively mitigate the impact to the affected resource.

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[3] The 5% and 10% thresholds rely on WGFD guidance on mitigating oil and gas development and its references to High and Extreme impacts on habitat. High is generally referred to as 20-60 acres of disturbance within a section, and 5% is a proxy for that (640 acres X .05 = 32 acres); Extreme is 60 acres or more per section and 10% is a proxy for that (640 acres X .10 = 64 acres). Percentages have more utility than absolute figures when areas less than or larger than a section are under discussion.

- A higher threshold level, usually 10 percent of protected habitat within a lease, would require habitat improvement projects in addition to the above requirements.

Disturbance that is counted against the threshold includes all disturbance, both current and pre-existing, that is associated with natural gas access roads, pipelines, well pads, or other facilities that serve the Operator's lease and off-lease rights-of-way on adjacent BLM lands that also service the lease. Rights-of-way that cross a lease but service other Operators' leases would not count in the percentage calculation. The details of the surface disturbance thresholds for each of the five resources are described in the sections below.

Population Thresholds

Additionally, there are population thresholds for four resources: mule deer crucial winter/yearlong range and migration corridors; pronghorn antelope crucial winter/yearlong range and migration corridors; greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas; and ferruginous hawk nests and potential nesting substrate. If the Wyoming Game and Fish Department (WGFD) were to express formal written concern that a species population within the project area were declining at an accelerated rate compared to the rest of the population, a technical team would be assembled to prepare a mitigation plan as described above. APDs would not be processed or approved until the BLM has received and approved a mitigation plan that will effectively mitigate the impact to the affected resource. The plan would include, but not be limited to:

- Evaluation of reclamation success and a request that the Operator provide a revised reclamation plan to address any failed reclamation.
- Implementation of BLM-approved habitat-improvement projects such as water developments or vegetation treatments. (The BLM may coordinate habitat improvement projects among multiple Operators.) New well pads would not be authorized without Operator participation in habitat-improvement projects.
- Limitation of the number of well pads per section to maintain habitat effectiveness.

The preferred mitigation would be site-specific. If a species status were to change in the future, additional data, especially seasonal habitat use and condition data, would be collected and additional protective measures would be developed.

2.2.3.1 Pronghorn Antelope and Mule Deer

Area of Concern: Pronghorn Antelope Crucial Winter Range/Yearlong Range (referred to as "CWR" in the description of this alternative) and Migration Corridors (**Map 3.8-2**) and Mule Deer Crucial Winter and Crucial Winter/Yearlong Range (also referred to as "CWR") and Migration Corridors (**Map 3.8-4**).

Basic Protections:

RMP Requirements

- Seasonal restrictions on construction, drilling, and other activities from November 15 – April 30.
- Disruptive activities within big game crucial winter range would require the use of BMPs designed to reduce the amount of human presence and activity during the winter months (Appendix 15 of the ROD).
- Surface-disturbing and disruptive activities would be managed on a case-by-case basis in identified big game migration and transitional ranges to maintain their integrity and function.
- Fences identified to be a problem for big game migration would be modified to meet BLM fence standards. New fences would be allowed in big game migration corridors, provided they meet BLM fence standards.

- Standard site-specific requirements
- Appendix 15 of the RMP includes other BMPs that can be considered to reduce impacts from gas development, some of which are included as requirements in this alternative (e.g., remote well monitoring).

Enhanced Resource Protections:

- Applications for Permit to Drill (APDs) within mule deer or pronghorn antelope crucial winter or crucial winter/yearlong range and migration corridors would be submitted as part of an overall development plan for an entire lease or several leases. The plan is described above under the general requirements for the alternative.

In addition, the following requirements would be implemented throughout mule deer and pronghorn antelope crucial winter range or crucial winter/yearlong range and migration corridors:

- Man camps would be prohibited on BLM land;
- Noise-reduction technology, such as hospital grade mufflers, sound walls or soundproof buildings, or adding silencers to cooling fans, would be required at compressor stations; and
- Migration corridors would be monitored to determine which fences restrict movement and fences modified to reduce impacts to migrating big game species.

Surface Disturbance Thresholds:

When surface disturbance for natural gas access roads, pipelines, well pads or other facilities exceeds 5 percent of pronghorn antelope or mule deer CWR and migration corridors within a lease, BLM would:

- Evaluate reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of CWR is needed at this time. If so, begin implementation.
- Require installation of remote monitoring at all well pads.

If surface disturbance reached 10 percent of pronghorn or mule deer CWR and migration corridors in a lease, habitat improvement projects would be required in addition to the requirements above. The BLM would establish an interagency CD-C working group and consult with them to determine which projects would be beneficial. These projects could include, but would not be limited to:

- Water developments.
- Vegetation treatments such as herbicide treatments, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs or trees, fencing, establishing food plots, etc.

Population Thresholds:

Mule deer and pronghorn antelope in the project area are managed by the WGFD on a Herd Unit basis. Three mule deer Herd Units overlap the project area (**Map 3.8-3**). The resource of concern in this alternative for mule deer is CWR and migration corridors which only occur in the project area within the Baggs Herd Unit (**Map 3.8-3**). In 2010, the Baggs herd population was estimated at 22,000 animals, which is well above the WGFD population objective of 18,700 (**Table 3.8-1**). The project area includes less than 25 percent of the total Baggs Herd Unit acreage and only 6.3 percent of the crucial winter range and crucial winter/yearlong range.

For pronghorn, there are also three Herd Units that overlap the project area (**Map 3.8-1**). The Baggs and Red Desert Herd Units each contain a portion of pronghorn CWR. Migration corridors are found in all three units. The Red Desert Herd Unit's CWR lies north of I-80 along the majority of its route across the project area. The CWR for the Baggs and Bitter Creek Herd Units is adjacent to WY 789 in the southeastern portion of the project area (**Map 3.8-1**), overlapping the majority of the mule deer CWR.

Aerial surveys of the three Herd Units are done on a rotating basis, typically every two to three years. All three of the Herd Units are much larger than the portion within the project area; 26 percent of the Red Desert Herd Unit, 23 percent of the Bitter Creek Herd Unit, and 9 percent of the Baggs Herd Unit lie within the project area. Only 16 percent of the combined CWR for these Herd Units occurs in the CD-C project area.

If the WGFD were to express formal written concern that any of the herds within the project area was declining at an accelerated rate, all new APDs on leases within mule deer and pronghorn antelope CWR in the CD-C project area would require an approved mitigation plan if the population decrease in those Herd Units were attributable in whole or in part to oil and gas development. The plan would include, but not be limited to:

- Evaluation of reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation.
- Implementation of BLM-approved habitat-improvement projects such as water developments or vegetation treatments. (BLM may coordinate habitat improvement projects among multiple Operators.) New well pads would not be authorized without Operator participation in habitat-improvement projects in the affected Herd Unit.
- Limitation of the number of well pads to no more than four per section within CWR to maintain habitat effectiveness.

If the population status of a species were to change in the future, additional data would be collected and additional protective measures would be developed.

2.2.3.2 Greater Sage-Grouse

Area of Concern: Greater sage-grouse lek, nesting/brood-rearing habitat (**Map 3.9-2**), and winter concentration areas occur throughout the project area. Protections for the small parts of the project area that are within sage-grouse core areas (Map 3.9-2), for which IM WY-2012-019 (February 10, 2012) prescribes more stringent protections, are described separately. In addition, the BLM has entered into an effort to revise all RMPs to address sage-grouse conservation efforts. As this process unfolds and the RFO RMP amendment is finalized, the requirements for sage-grouse conservation in the RFO may change from the current condition. The Wyoming Core Area strategy (SWED 2011) applies to all activities, proposed in a designated core area, that require a permit from any State of Wyoming regulatory agency. The Wyoming conservation strategy for greater sage-grouse continues to evolve and the requirements that would be applied to proposed activities in all seasonal sage-grouse habitats will change as the strategy changes.

Basic Protections:

- RMP Requirements:
    - Surface-disturbing activities or occupancy are prohibited on and within 0.25 mile of the perimeter of an occupied (or undetermined) greater sage-grouse lek. In addition, disruptive activities are prohibited between 6:00 p.m. and 9:00 a.m. from March 1 to May 20 on and within 0.25 mile of the perimeter of an occupied greater sage-grouse lek. (Disruptive activities are those that would require people and/or the activity to be in nesting habitats for a duration of 1 hour or more during a 24-hour period.[IM WY-2010-029])
    - Avoid surface-disturbing and/or disruptive activities in all identified nesting and early brood-rearing habitat from March 1 to July 15.
    - Authorization of high-profile structures would be granted on a case-by-case basis from within 0.25 to 1 mile of the perimeter of an occupied sage-grouse lek.

    - Surface disturbing and other activities potentially disruptive to delineated greater sage-grouse winter concentration areas are prohibited during the period of November 15 to March 14.
- IM WY-2012-019 Requirements summarized:
    - West Nile Virus - Artificial water impoundments would be managed to the extent of BLM's authority to prevent the spread of West Nile virus where the virus poses a threat to sage-grouse. (See specific provisions in the IM.)
    - Timing and Distance Restrictions **Within Core Areas**
        - Surface occupancy and/or disruptive activities are prohibited on or within 0.6 mile of the perimeter of occupied sage-grouse leks.
        - Surface-disturbing and/or disruptive activities are prohibited or restricted from March 15 to June 30[4] within all suitable sage-grouse nesting and early brood-rearing habitat.
        - Surface-disturbing and/or disruptive activities in delineated sage-grouse winter concentration areas are prohibited from December 1 to March 14 to protect core populations of sage-grouse that use these winter concentration habitats. Not all these WCAs that support core area populations, are located within current core area boundaries.
    - Timing and Distance Restrictions **Outside Core Areas**
        - Surface occupancy and/or disruptive activities are prohibited on or within a 0.25 mile radius of the perimeter of occupied sage-grouse leks.
    - Density and Disturbance **Within Core Areas**
        - For authorization of new proposed actions within sage-grouse core areas, including where there are valid existing rights, the BLM will consider an alternative that would limit activities to an average of no more than one oil and gas or mining location per 640 acres and an average of no more than 5 percent habitat disturbance (related to all programs or applicable sources of "disturbance" using the SGEO [Greater Sage-grouse Core Area Protection Program] Disturbance Density Calculation Tool). In addition, the BLM has entered into an effort to revise all RMPs to address sage-grouse conservation efforts. As this process unfolds and the RFO RMP amendment is finalized, the requirements for sage-grouse conservation in the RFO will change from the current condition.
- Noise – The BLM will work with Operators to limit noise where it could reduce functionality of habitats that support core area populations. The BLM will evaluate limitation of new noise sources on a case-by-case basis. The BLM's near-term goal is to limit noise sources that would negatively impact core area sage-grouse populations and to support the establishment of ambient baseline noise levels for occupied core area leks.
- Standard site-specific requirements – Appendix 15 of the RMP includes other BMPs that can be considered to reduce impacts from gas development, some of which are included as requirements in this alternative, e.g., remote well monitoring.

Enhanced Resource Protections:

Applications for Permit to Drill (APDs) within greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas would be submitted as part of an overall development plan for an entire lease or several leases. The plan is described previously in the general requirements portion of the alternative.

In addition, the following requirements would be implemented throughout sage-grouse habitat:

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[4] IM WY-2012-019 allows for the Governor's Executive Order Timing Restriction (March 15-June 30) to be expanded by up to 14 days prior to or subsequent to these dates where credible data support different timeframes.

- Burying new power lines and using low-profile facilities within 1 mile of an occupied lek or in winter concentration areas;
- Use of noise-reduction technology so that noise would not exceed 49 decibels measured at 30 feet from the source at all drilling, production and compressor sites;
- No more than one oil and gas or mining location per 640 acres and no more than 5 percent habitat disturbance (related to all programs or applicable sources of disturbance).
- Surface Disturbance Thresholds:

The BLM has authority to apply a number of protective measures to minimize impacts upon sage-grouse and their habitat. This surface disturbance threshold requires that certain of those measures go into effect on a lease if surface disturbance for natural gas roads, pipelines, well pads or other facilities has exceeded 5 percent of **non-core** sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas in a lease or right-of-way or one oil and gas or mining location per 640 acres within **core areas**, the BLM would:

- Require remote well-monitoring at all well pads;
- Evaluate reclamation success in the section and request from the Operator a revised reclamation plan to address any failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of sage-grouse habitat is needed at that time. If so, begin implementation.

If surface disturbance were to reach 10 percent or 2 oil and gas or mining locations per 640 acres of **non-core** sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas in a lease, habitat improvement projects would be required. Projects could include, but would not be limited to:

- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, establishment of food plots, etc.
- Water developments.

Population Thresholds:

If WGFD were to express formal written concern that the population of sage-grouse is declining at an accelerated rate, all Operators on public lands within sage-grouse lek, nesting/early brood-rearing habitat or winter concentration areas would implement a mitigation package identified by BLM that would include, but not be limited to:

- Evaluation of reclamation success in the lease or right-of-way and a request to the Operator to provide a revised reclamation plan to address any failed reclamation.
- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, establishment of food plots, etc. (BLM may also coordinate habitat improvement projects among multiple Operators.)
- Timing and Distance Restrictions (Non-core areas to conform with core areas):
- When the threshold is reached, surface-disturbing activity or surface occupancy would be prohibited or restricted on or within a 0.6 mile of the perimeter of occupied sage-grouse leks. In addition, disruptive activities within 0.6 mile of the perimeter of occupied sage-grouse leks are restricted from 6:00 pm to 9:00 am from March 1 – May 15.
- Avoid surface-disturbing and disruptive activities in suitable greater sage-grouse nesting and early brood-rearing habitat within 2.5 miles of the perimeter of an occupied lek from March 15 – June 30.
- Prohibition of surface-disturbing and disruptive activities within 0.5 mile of sage-grouse winter concentration areas (non-core areas) from November 15 – March 14.

Density Restrictions:

- Core Area APDs would be limited to the density disturbance calculation tool thresholds (see density restrictions in IM 2012-019). When thresholds are exceeded BLM would work to collocate or minimize disturbance for valid and existing rights.
- When the population threshold is reached in non-core areas, strive to maintain <3 pads per square mile within 2 miles of the perimeter of occupied sage-grouse leks
- If the population status of the species changes in the future, additional data would be collected and additional protection measures would be developed.

2.2.3.3 Ferruginous Hawks

Area of Concern: Nests and potential nesting substrate **(Map 3.8-8**)

Basic Protections:

- RMP Requirements:
  - No disturbance within 1,200 feet of a ferruginous hawk nest. The distances could vary depending on factors such as nest activity, species, natural topographic barriers and line-of-sight distances.
  - Seasonal restriction from March 1 – July 31 within 1 mile of a ferruginous hawk nest.
- Standard site-specific requirements:
  - Surveys of previous active ferruginous hawk nests to determine if they are in use that season. Lack of occupancy by a certain date could shorten the seasonal restriction.
  - If drilling activity within the seasonal distance restriction were started prior to the nesting period and a ferruginous hawk started utilizing a nest, additional mitigation as determined by the BLM could be required. This mitigation could include, but would not be limited to:
    - education sessions for employees regarding avoidance of the nest;
    - reducing speeds and being aware of foraging raptors;
    - utilization of alternate access routes to the well that are further away from the nest, etc.

Enhanced Resource Alternative Protections:

No additional protections would apply to ferruginous hawk nests and potential nesting substrate unless one of the thresholds described below were reached.

Surface Disturbance Threshold:

Operators in all leases that exceed 10 percent of surface disturbance within 1 mile of ferruginous hawk nests would be required to participate in a development/mitigation plan before additional APDs would be issued.

Population Thresholds:

If WGFD were to express formal written concern about the ferruginous hawk population, the following mitigation measures would be implemented immediately:

1. All existing development features and facilities (pads, pipelines, roads, holding yards, compressor stations, etc.) within 1 mile of ferruginous hawk nests would be inspected to determine reclamation success. If reclamation has been unsuccessful, measures would be taken to improve the reclamation of the facilities.

2. Ten man-made[5] nests would be built outside of existing monitoring territories on natural substrates, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following receipt of WGFD's letter of concern.
   a. The farther the nest is constructed from existing disturbances the better; nest placement would take into consideration potential conflicts with sage-grouse seasonal habitat use of the area.
   b. These nests would be incorporated into the annual monitoring efforts.
   c. Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.
3. Two artificial nesting structures [6] would be placed outside of existing monitoring territories, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following. receipt of WGFD's letter of concern.
   a. Priority for placement of these nests would be determined based on information regarding extant nests located on man-made infrastructure, or where there are known repeated attempts at nesting on man-made infrastructure; nest placement would take into consideration potential conflicts with sage-grouse seasonal habitat use of the area.
   b. These nests would be incorporated into the annual monitoring efforts.
   c. Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.

If the species population continues to decline, additional data would be collected and additional protection measures would be developed.

2.2.3.4 Muddy Creek and Bitter Creek Corridors/Watersheds

Area of Concern: Muddy Creek (including the Red Wash/Muddy Creek Sensitive Fish Habitat), and the Muddy Creek and Bitter Creek watersheds for water quality (salinity, selenium, and 303d listed waters), aquatic physical habitats, and sensitive fish habitat (**Map 3.9-5**).

Basic Protections:

- RMP Requirements:
  - For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 500 feet of perennial waters, springs, wells and wetlands, and areas within 100 feet of the inner gorge of ephemeral channels.
  - Design of road crossings of water bodies that potentially support fish for a portion of the year to simulate natural stream processes.
  - Design of impoundments and instream structures to minimize impacts on Special Status fish species and their habitats.
  - Intensive management of surface-disturbing activities within those portions of the Muddy Creek drainage that contribute to degradation of reaches previously or currently on the 303d list.
  - All basic watershed protections in Section 2.3.16, Water Quality, Watershed, and Soils Management, and Appendix 13, Reducing Nonpoint Source Pollution with Best Management Practices, of the RMP ROD.
- Standard site-specific requirements:

[5] Man-made nests are nests that are built in appropriate habitat and are intended to attract ferruginous hawks.

[6] Artificial nesting structures are built to attract hawks that would build their own nest on the structure.

- o Maintenance of existing roads to ensure they are not contributing sediment to Muddy Creek or adjacent wetlands.
- o Boring of all pipeline crossings of riparian areas.
- o Appendices 13 and 15 of the RMP include several BMPs that can be considered to reduce impacts from gas development, a number of which are included as requirements in this alternative.

Enhanced Resource Alternative Protections:

- For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 0.25 mile of Red Wash, springs, wells, and wetlands. The required avoidance distance would be further increased on perennial streams to 0.5 mile. Exceptions would only be granted by the BLM based on environmental analysis and site-specific engineering and mitigation plans. Only actions within areas that could not be avoided and that would provide protection for the resource identified would be approved. In-channel activities would be restricted to the low-flow period.
- Current monitoring on upper Muddy Creek would be extended to Lower Muddy Creek in the CD-C area. This requirement would bring lower Muddy Creek into conformance with the monitoring being done for upper Muddy Creek and other drainages within the Atlantic Rim project area. If results of the monitoring program showed impacts to sensitive fish habitat, the BLM and an interagency CD-C consultation group would determine whether habitat-improvement projects should be implemented. The projects could include, but would not be limited to: increasing the number of drainage features along roads, increasing in-stream cover for fish, etc.
- A monitoring plan for Bitter Creek watershed will be designed by the RFO.
- A risk level analysis will be conducted for the Muddy Creek and Bitter Creek watersheds using the existing Rosgen 2008 WARSS process and data to determine the risk of additional sedimentation. This will permit identification of areas of high erosion potential.

The following requirements related to **selenium and salinity** for well locations and operations would also be implemented:

- No surface discharge of produced waters within the Muddy Creek and Bitter Creek watersheds.
- Line all reserve pits in the Muddy Creek and Bitter Creek watersheds with BLM-approved materials.

2.2.3.5 Chain Lakes Alkaline Wetland Communities and Other Playas

Area of Concern: Chain Lakes Alkaline Wetlands and other playas

Basic Protections:

- RMP Requirements – For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 500 feet of perennial waters, springs, wells, and wetlands (defined here as 500 feet from the ordinary high water mark of the playa).
- Standard site-specific requirements – None

Enhanced Resource Alternative Protections:

- A transportation and development plan to avoid the alkaline wetland communities at Chain Lakes.
- Avoidance of surface-disturbing and disruptive activities within 0.25 mile of any Chain Lakes alkaline wetland community or the ordinary high water mark of other playas.

2.2.3.6 Livestock Grazing

Area of Concern: Public land grazing allotments (**Map 3.18-1**)

Basic Protections:

- RMP Requirements – Wyoming Standards and Guidelines for Rangeland Health.
- Standard site-specific requirements – Immediate repair of any damages to existing range improvements, fences, cattleguards, gates, etc. caused by natural-gas operations, with such repairs to be made by the natural-gas Operators in consultation with the grazing permittee.

Enhanced Resource Alternative Protections:

- Mitigation of impacts on existing livestock water features such that there would be no adverse effects on water availability, water quality, or livestock management (trailing routes, fencing, etc.); mitigation of impacts on water wells, springs, or surface water improvements by new water well development. If water features are adversely affected by activities of natural gas Operators, the Operators would be responsible for drilling, maintaining, and monitoring new stock water wells and/or improving existing water wells, as determined by BLM and the grazing permittees.
- Annual meetings conducted by BLM with Operators and grazing permittees to discuss project-specific impacts and required mitigation. Natural gas Operators will describe their proposed drilling and maintenance schedules during these meetings.
- When APDs are submitted to BLM, notification of the affected grazing permittees and provision to permittees of a map showing the location of new well pads and access roads.
- Thorough power-washing by Operators of all field vehicles—particularly their undercarriages—before entering the project area or when moving from one part of the project area to another.
- During the production phase, as well as the construction phase, control by Operators of fugitive dust on well sites, pipelines, and access roads as needed.

Surface Disturbance Thresholds:

If the surface disturbance due to natural gas development were to reach 5 percent of an allotment, several actions would be triggered (in this and later calculations, surface disturbance is used as a surrogate for available forage):

- A review of reclamation success in the allotment. If reclamation efforts had not achieved the required standards, Operators would be required to submit a revised reclamation plan for achieving reclamation success and begin implementing that plan.
- Planning for future natural gas development to avoid critical grazing areas (i.e. calving grounds, trailing routes, and identified summer and winter grounds), range improvements, and other important livestock areas.
- If planning were to identify the need for rangeland improvement projects, BLM would begin planning such projects in consultation with the grazing permittee and the Operators, and may begin implementing the projects, as warranted. Rangeland improvement projects with allotment-wide benefits could involve participation of all Operators within the allotment.

If the amount of unreclaimed surface disturbance due to natural gas development were to reach 8 percent of an allotment, the BLM would require that mitigation be implemented to avoid reaching the designated RMP significance criterion of a permanent 10-percent reduction in AUMs available for livestock grazing within the allotment. The type of mitigation would be determined by the BLM in concert with the grazing permittee and could include, but would not be limited to, the following:

- Construction of temporary fencing when necessary in order to protect reseeded areas and other fragile areas.

- Construction of temporary or permanent fences to create pastures to improve livestock distribution and/or minimize livestock and vehicle collisions (all fences would comply with BLM fence construction regulations).
- Water development projects to distribute livestock, when consistent with the RMP.
- Vegetation treatment projects to increase and improve forage for livestock.

2.2.4 Alternative C: Surface Disturbance Cap—High and Low Density Development Areas

This alternative designates parts of the project area as high-density development areas—those areas that have seen the greatest natural gas development to date (**Map 2-1**). Within the high-density development areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance at any one time in a section of public land or federal mineral estate. For the remainder of the project area—the low-density development areas—the cap would be 30 acres per section. The 60-acre cap represents the disturbance associated with a 9-well per section drilling program (80-acre spacing) achieved with vertical wells only, a typical development in the high-density area; a 30-acre cap represents the disturbance associated with a 16-well per section drilling program (40-acre spacing) achieved with directional drilling.

All prior surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap. For example, within a high-density development area, a section that had seen 40 acres of historical disturbance for natural gas development would start the development period with a reduced cap of 20 acres (60 acres less 40). Once interim reclamation on the development was determined to be successful, the acreage reclaimed could be *rolled over*, meaning counted again as undisturbed acreage, and the cap would be increased by the amount of successful interim reclamation. If, for example, 24 acres of interim reclamation were judged to meet the interim reclamation standard, it would be *rolled over* and the cap for that section would increase to 44 acres (20 acres plus 24). Only the 16 acres used for roads and production facilities would continue to count against the cap.

If there had been no natural gas development in a section within the high-density development area, the Operator would be able to develop the natural gas resources of that section until surface disturbance from well pad, access road, and pipeline construction reached 60 acres. At that point, no further disturbance could take place until acreage that had undergone interim reclamation had been determined to be successfully reclaimed. Outside the high-density development areas, the same conditions and the same process would apply, but the cap would be set at 30 acres.

Map 2-1 shows the high-density development and low-density development areas within the project area. Of the 1,697 sections within the project area, 744 sections (about 44 percent) are within a high-density development area. Average historic surface disturbance within the high-density development areas is 32.9 acres per section. The average number of wells per section is 5.1. Outside the high-density development areas, the average disturbance is 4.5 acres per section; the average number of wells per section is 0.7. Four hundred sections, about 24 percent, have had no development to date.

All public lands in the project area would be subject to the cap. Disturbance on private and state lands would not count against the cap. The Operators would be required to update their reported disturbance annually in order to certify the accumulated disturbance on their federal lease holdings to date and the amount of interim reclamation that had occurred. Under the alternative, the BLM, either on its own or using subcontractors hired by the Operators, would perform quality control on the reported data and evaluate the reported interim reclamation and the success of that reclamation. The BLM would then calculate net available surface disturbance under the cap for each section. As new drilling proposals were received, they would be evaluated against the net available surface disturbance within the section where the drilling was proposed. For oil and gas leases smaller than a section, the acreage cap would be adjusted on a pro-rata basis.

All pre-existing and current surface disturbance associated with natural gas well pads, their access roads, and gathering pipelines would count against the cap. Major natural gas processing and transmission facilities would not count against the cap. In addition, federal, state, county, and local roads and highways, railroads, and disturbances created by ranching operations would not count against the cap.

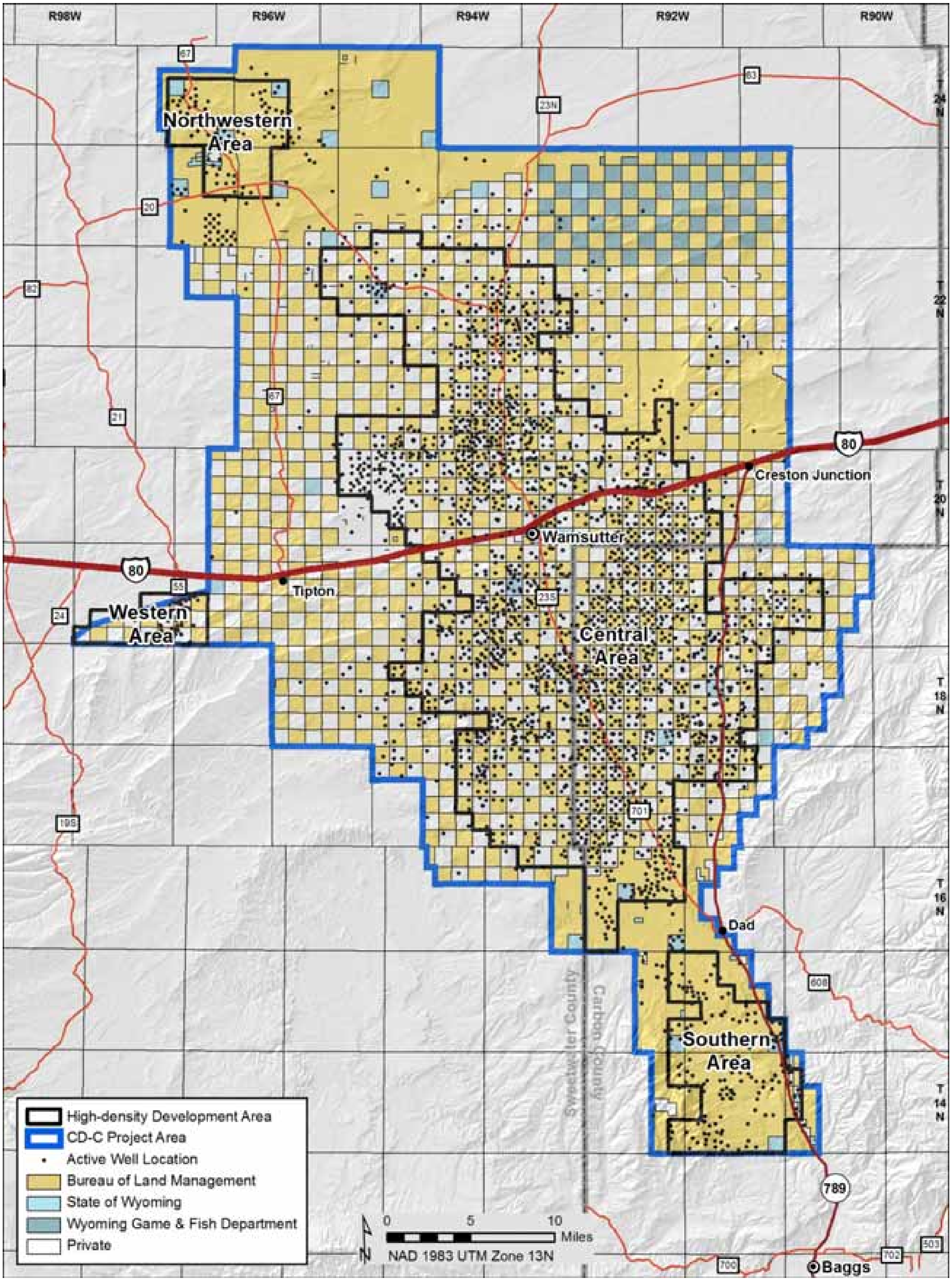
A central element of this alternative is the standard used to determine if interim reclamation efforts have been successful and if the reclaimed acreage can be rolled over. The standards to be met for successful final reclamation of surface disturbance on public lands are described in **Appendix E: Reclamation**, which includes Appendix 36 of the Rawlins RMP (BLM 2008b) and the Wyoming BLM Reclamation Policy IM WY-2012-032. Final reclamation of a natural gas well site occurs after a well has completed production and been plugged and abandoned. **Appendix E** also includes two other documents that apply to interim reclamation and the concept of rollover: the Proposed Interim Rollover Objective for the CD-C Natural Gas Project and the CD-C Rollover Criteria. These two documents would guide the evaluation of reclamation under the Alternative C surface cap and set the standard for potential rollover of acreage that had undergone interim reclamation. The Rollover Objective document provides guidance for how best to achieve interim reclamation that can be rolled over. The CD-C Rollover Criteria document lays out the standard that must be met if disturbed acreage is to be classified as successful interim reclamation. Disturbed acreage that met the standards could then be deducted from the number of acres counted as surface disturbance—that is, rolled over.

During the preparation of the Draft EIS, the State of Wyoming, local Conservation Districts, the University of Wyoming, participating leaseholders, several CD-C operators, and the BLM developed interim reclamation objectives (IRO). The purpose of the IRO is to identify when reconstruction and re-vegetation activities on disturbed lands are adequate for rollover credit. The objectives are to: establish vegetation cover sufficient to maintain a healthy, biologically active topsoil; control erosion; minimize loss of habitat, forage, and visual resources during the period of the disturbance; and control invasive non-native weeds. The specific reclamation success standards for the IRO are as follows:

- The area is revegetated with a stable, approved plant community.
- Vegetative cover is sufficient to maintain a healthy, biologically active topsoil.
- Erosion is controlled.
- Habitat, visual, and forage loss is minimized.
- No noxious weeds are present.

Reclamation of the disturbed surface would be monitored by the Operators. When an operator determined that a disturbed site had attained the IRO, the operator would propose to the BLM the rollover of the reclaimed acreage. If the BLM determined that the standards had been met, the acreage would be rolled over. If the BLM determined that the standard had not been met, then the operator could attempt to address the shortcomings of the reclamation and propose the acreage again at some time in the future. In the event areas that had met the criteria and been rolled over were re-disturbed, the acreage re-disturbed would again be counted against the cap.

Table 2.4-1 shows the estimated surface disturbance for this alternative along with the Proposed Action and the other alternatives.



Map 2-1. High-density and low-density natural gas development areas, CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

2.2.5 Alternative D: Directional Drilling

This alternative requires that all future natural gas wells on federal mineral estate be drilled from multi-well pads, which would require the employment of directional drilling technology. One new multi-well pad per section (or per lease if the lease area is less than a section) would be permitted. In sections that have already had oil and gas development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes on a lease would be permitted. Proposals for access across federal lands for oil and gas development on adjacent private and state parcels would still be considered as appropriate by the BLM.

In sections that have not had oil and gas development at all, one new well pad would be permitted for all future development. One road and pipeline corridor per well would be permitted. Proposals for access across federal lands for oil and gas development on adjacent private and state parcels would still be considered as appropriate by the BLM. No numerical disturbance caps, no rollover credits, and no new requirements on reclamation are part of this alternative.

The objective of this alternative is to minimize surface disturbance and to reduce habitat loss and wildlife disruption. A reduction in the number of well pads and associated roads, pipelines, and other facilities would result in less surface disturbance and thus reduce the amount of habitat directly lost. In addition, multiple-well pads would be distributed less densely than single-well pads, reducing the habitat fragmentation and ongoing disturbance created by the network of well-pad access roads.

Operators may request that an APD be excepted from the general rule. Examples of the types of exceptions that would be considered include:

- In sections that have already had some level of development, Operators may request that more than one existing well pad be used as a multi-well pad. The Operator must establish that the drilling objective cannot be achieved from any single well pad. In general, such requests would be considered by BLM after one single-well pad had been enlarged and efforts had been made to develop the entire section.
- In sections that have not had prior development, Operators may request that more than one multi-well pad be constructed. The Operator must establish that the drilling objective cannot be achieved from a single-well pad. In general, such requests would be considered by BLM after one multi-well pad had been constructed and efforts had been made to develop the entire section.
- Operators may request that road and pipeline routes be relocated. The request should demonstrate how the relocation would reduce vehicle traffic and increase the efficiency of product transportation.

It is expected that exception requests would largely be based on difficult surface conditions, topography, subsurface geology, or fluid mineral resource characteristics that would make it impossible to maximize the recovery of the gas resource in a lease. CBM proposals may well fall into an exception category. Requests based on the need to produce in the most economic and efficient manner will be considered.

Table 2.4-1 shows the estimated surface disturbance for this alternative along with the Proposed Action and the other alternatives.

2.2.6 Alternative E: No Action

NEPA regulations require that the EIS alternatives analysis "include the alternative of no action" (40 Code of Federal Regulations [CFR] 1502.14(d)). The No Action alternative does not respond to the purpose and need for the Proposed Action. Rather, it serves as a baseline for comparing the Proposed Action's environmental effects (including cumulative effects) and it illustrates the consequences of not meeting the need for the Proposed Action. Under the No Action alternative, no new Federal wells would be approved for development as part of the Operators' proposal to drill up to 8,950 wells on approximately 1.1 million acres of federal, private, and state mineral estate. However, existing lease rights granted by the BLM on federal lands or mineral estate would remain in effect. The BLM's analysis of the No Action alternative therefore assumes that previously authorized activities would continue but that no new development on federal lands or mineral estate would occur under the Operators' proposal. Previously authorized activities include approximately 14 pending APDs, 497 shut-in gas wells, 12 monitor wells, 530 plugged and abandoned wells, 3,292 producing gas wells, and 27 unapproved APDs, totaling 4,372 wells within the CD-C project boundary as of September 2012 (WOGGC 2012). As shown on **Table 4.0-1**, existing surface disturbance related to natural gas development is an estimated 49,218 acres.

Due to the intermingling of federal, state, and private lands within the CD-C, rejection of the Operators' proposal under the No Action alternative would not mean that no new oil and gas development in the project area would occur. Such development may be authorized on state and private lands, as the BLM does not approve or control development on these lands. In addition, the BLM may receive and consider proposals for access across federal lands for oil and gas development and production-related activities. The BLM also may receive and consider additional or supplemental proposals (such as pipelines, compressors, and power lines) to develop leased resources, such as natural gas, on federal lands in the project area. Individual proposals for geophysical exploration or development, including rights-of-way for access across federal lands, would be subject to site-specific analysis prior to approval or authorization by the BLM.

2.3 ALTERNATIVES CONSIDERED AND ELIMINATED FROM DETAILED STUDY

Two alternatives were considered and eliminated from detailed study. The alternatives and the reasons for eliminating them are described below.

2.3.1 Surface Disturbance Cap with Reclamation Credits and Debits

This alternative would place a 30-acre cap on the amount of future surface disturbance in a section of public land. If previous natural gas development had disturbed the surface in a section, the acreage that had been successfully reclaimed would be added to the 30 acres. If the disturbance had not been successfully reclaimed, the acreage would be subtracted from 30 acres. The aim is to provide additional incentive for successful reclamation and increased disincentive for slow or failed reclamation. For example, in a section in which 10 acres of surface disturbance had occurred and 6 acres had been reclaimed, the cap would be modified according to the success or failure of the reclamation on those 6 acres. (The 4 acres used for roads and on-pad facilities would not count one way or the other toward credits or debits, but would count against the cap.) If the 6 acres met the criteria for successful reclamation, the modified cap for that section would be 30 acres plus the 6 acres of reclaimed surface, a total cap of 36 acres (of which 4 had been used for roads and on-pad facilities, leaving 32 acres that could still be utilized). If, on the other hand, the 6 acres did not satisfy the criteria, the modified cap would be 24 acres—the 30-acre base less the 6 acres of unsuccessful reclamation (4 of which were already impacted, leaving 20 acres for future development). If half the reclamation met the criteria and half did not, the 30-acre cap would remain unchanged, as the failed 3 acres would offset the successful 3 acres, leaving the cap at 30 acres with 4 of those acres encumbered.

After closely considering this alternative, the BLM determined its actual operation would be unpredictable and that neither the BLM nor the Operators could rely on its results. In certain instances, the formulation could yield a cap in one section of perhaps 90 acres and in an adjacent section of minus 30 acres. The complexity of the alternative and the uncertainty of its results make it difficult to describe and there is a high likelihood that the result would be contention between the BLM and the Operators over the meaning of and the operation of the cap. Because of the complexity and the uncertainty about its effects, and because Alternative C already satisfied all the criteria for a surface disturbance cap, the BLM decided that the Surface Disturbance Cap with Reclamation Credits and Debits would not be carried forward for analysis in the EIS.

2.3.2 Focused Development

The Focused Development Alternative would include the same degree of overall natural gas development as the Proposed Action, but the drilling would be phased geographically, focusing first on one defined area and then moving to another area following completion of development in the initial area. The purpose of the geographical phasing would be to allow large areas of wildlife habitat to remain undisturbed for an extended period, during which other areas would undergo intense and continuous development. Several alternatives with this general formulation were considered during discussions between the Operators and the CD-C cooperating agencies between 2005 and 2009. The BLM was not a participant in those discussions. Discussions were aimed at identifying larger tracts of habitat that could remain undeveloped for a considerable period of time and other areas—areas of focused development—that would be completely developed during that same period. In exchange for agreeing to delay developing in one area, the Operators would receive exemption from seasonal wildlife stipulations on public lands in the area of focused development. Upon completion of development in the initial focus area, that area would in turn have no activity and development would shift to the previously undeveloped area.

The concept of focused development has two key elements: (1) that the leaseholders, property owners, Operators, and others with an interest in the production of oil and gas in both the area of focused development and those in the area of delayed development area be the same or at least have a shared interest, since all the parties would have to participate if the concept were to be effective; and (2) that the BLM would be able to exempt the federal oil and gas leaseholders from the seasonal wildlife stipulations. After considerable examination, it was determined that neither of the key elements could be provided.

In the case of developing a shared interest among those interested in developing the fluid mineral estate, the sheer number of interests (over 60 different leaseholders within the project area and over 20 different operators), and the diversity and complexity of their holdings presented legal, planning, and logistical problems that could not be overcome. Additionally, the substantial portion of the project area that is within the checkerboard would require participation by private property owners, many of whom are not federal leaseholders.

The creation of an oil and gas *unit* is one method of creating a shared interest among various parties. A unit agreement allows exploration and development of properties owned by multiple parties to proceed with a program paced to develop all lands within the unit, regardless of ownership boundaries. Unitizing the CD-C project area to create a shared interest would not work because: (1) The leaseholders, property owners, operators, and operating rights owners over such a wide geographical area—the whole project area or a large part of it—do not have sufficient interests in common for a single exploratory unit to be formed; (2) Developing exploration units requires certain levels of obligation to drill wells. Under the *Yates* decision, if the drilling is successful and yields a producing well, all leases covered by the unit are considered *held* by production (Yates Petroleum Corp. *et al.*, 67 IBLA 246, 1982). Holding hundreds of thousands of leasehold acreage without development is not in the best interest of the BLM as the federal lessor; and (3) Leases are offered and granted with certain time terms, during which leaseholders and Operators are obligated to develop the leases or the leases will expire. If a CD-C project unit were to form, then hundreds of thousands of leased acres could be held by production from only a few wells and the owners of these leases likely would not receive the returns needed to pay out the cost of acquiring the leases. This in turn could result in the operator not being able to drill and produce at adequate levels to meet their income requirements or returns on investment. This would be a major impact to stockholder value and the development of U.S. energy.

It was also determined that exempting the leaseholders from seasonal wildlife stipulations could not be done. The BLM reviewed the federal laws and regulations that govern the management of habitat of species protected under the ESA and those that were designated as Special Status by the BLM and concluded it could not agree to the necessary blanket exemptions, over such a large area, for such an extended period of time. With no ability to bring about either of the key elements of the Focused Development alternative, the participants in the discussion concluded that such an alternative could not be properly designed and implemented.

2.4 COMPARISON OF ALTERNATIVES

Table 2.4-1. CD-C project area disturbance: Proposed Action and alternatives (acres)

Category	Well Pads (incl. roads)	Related O&G Facilities	Total Disturbed Area	Change from Proposed Action	
	acres			acres	%
Proposed Action					
Initial	41,889	5,311	47,200	—	—
Long-term	17,998	863	18,861	—	—
Alternative A: 100-Percent Vertical Drilling					
Initial	56,385	5,311	61,696	14,496	30.7%
Long-term	23,270	863	24,133	5,272	28.0%
Alternative B: Enhanced Resource Protection					
Initial	40,205	5,311	45,516	-1,684	-3.6%
Long-term	17,386	863	18,249	-611	-3.2%
Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section					
Initial	37,644	5,311	42,955	-4,245	-9.0%
Long-term	16,455	863	17,318	-1,543	-8.2%
Alternative D: Directional Drilling					
Initial	31,138	5,311	36,449	-10,751	-22.8%
Long-term	14,089	863	14,952	-3,908	-20.7%
Alternative E: No Action					
Initial	0	0	0	-47,200	-100.0%
Long-term	0	0	0	-18,861	-100.0%

[1] *The project area is 1,070,086 acres.*

Table 2.4-2. Comparison of impacts by alternative

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Physical Environment						
Geology	The intensity of impacts on geologic resources would vary in relation to the surface disturbance by alternative, but would be low in all cases providing that best management practices are followed. Impacts would not be significant.					
Paleontology	Paleontological resources have been identified in over 30 localities within the project area. Implementation of the **Proposed Action** or any of the **action alternatives** may impact paleontological resources—in a negative way by destroying or damaging them and making them unavailable for scientific inquiry—to the extent that the ground is disturbed by development activities, (see **Table ES-1** above). Disturbance could be beneficial by resulting in the discovery and preservation of fossils that add to scientific knowledge. Pre-disturbance surveys and disturbance mitigation where appropriate would minimize adverse impacts. The impact significance criterion would not be exceeded.					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Lowest impact*	*No impact*
Soils	Impacts would be similar for the **Proposed Action** and all **action alternatives** but the extent would vary with the amount of project-related disturbance, from a high of 61,696 acres under **Alternative A** to a low of 36,449 acres under **Alternative D**. The percentage of the CD-C project area soil surface that would be initially disturbed by the **Proposed Action** and the **action alternatives** is shown below. These figures should be considered in light of the 5.6 percent of the project area soil surface that has been disturbed previously. Successful implementation of mitigation measures and BMPs would insure that significance criteria were not exceeded.					
	4.4 %	*5.8 %*	*4.3 %*	*4.0 %*	*3.4 %*	*0 %*
Water Resources: Surface Water	Under the **Proposed Action** and all **action alternatives**, surface water impacts could include contamination of surface water from the authorized and accidental discharge (spill) of fluids and produced water and the impacts (including sediment loading) from surface disturbance related to the construction of pad sites, roads, and pipelines. The degree of potential impact and the risk of adverse impacts is related directly to the amount of initial surface disturbance in each alternative. Each action alternative exceeds at least one of the 8 significance criteria. The number of criteria exceeded for each alternative is displayed below:					
	4 criteria	*8 criteria*	*1 criterion*	*2 criteria*	*2 criteria*	*No new impacts*
Water Resources: Groundwater	Significant impacts to groundwater are not expected under the **Proposed Action** or the **action alternatives** because the formations targeted for gas development and produced water disposal are stratigraphically isolated from aquifers that host springs and flowing wells used for stock and domestic purposes, because of state-of-the-art construction techniques, and because of implementation of BMPs and COAs related to drilling.					

Table 2.4-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Physical Environment, continued						
Air Quality	Impacts from the **Proposed Action** and all **action alternatives** would not cause an exceedance of any ambient air quality standard and would not exceed the Prevention of Significant Deterioration (PSD) Class II Increments at a 250-meter distance from project sources. However, modeled impacts at a100-meter distance from field development project sources did result in short-term concentrations that were predicted to be above the 1-hour NO_2 National Ambient Air Quality Standard (NAAQS), the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} Wyoming Ambient Air Quality Standard (WAAQS). Impacts would not exceed the PSD Class I or Class II increments at any of the Class I and sensitive Class II areas. The visibility analysis indicated a maximum of 5 days with project emissions resulting in impacts greater than the 0.5 delta deciview (Δdv) threshold at any of the Class I and sensitive Class II areas; using the 98th percentile value as a threshold, there are zero days above the 0.5 Δdv threshold. There would be no nitrogen and sulfur deposition impacts that exceed BLM critical load values at any Class I or sensitive Class II area. In addition there would be no impacts to sensitive lakes that exceed threshold values. All BLM-approved energy development projects will comply with applicable air quality regulations and standards, as determined by the WDEQ.					
Biological Environment						
Vegetation	Vegetation has already been strongly affected; historic disturbance equivalent to 5.6% of the area's surface has already occurred. Additional disturbance would produce combined historic and project-related disturbance for the **Proposed Action** and each **action alternative** equivalent to the surface area percentages shown below. Even with successful implementation of reclamation practices, about 40 percent of the disturbed area would remain in an unvegetated state during the production period for the project—45-55 years. The remaining 60 percent of the disturbed area would have reduced productivity while reclamation is in progress and would have an altered species composition and density for the life of the project and beyond, including a long-term loss of shrubs. Estimated percentage vegetation disturbance by alternative, including the historical 5.6% disturbance, is:					
	10.0%	*11.4%*	*9.9%*	*9.6%*	*9.0%*	*5.6%*
Invasive, Non-Native Species	Initial surface disturbance would create opportunities for invasive species and development activity would increase the degree to which such species spread throughout the project area. The principal difference in impacts for the **Proposed Action** and **each alternative** is related to the amount of surface disturbance that would initially occur for each:					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Lowest impact*	*No impact*
Terrestrial Wildlife	Impacts would include loss of forage, as well as direct and indirect loss of habitat. The percentage of short-term disturbance of crucial winter range that would be disturbed includes historic plus new. Historic disturbance is 7.3% for pronghorn and 2.4% for mule deer. Significant impact can be reached by actions that result in disruption or irreplaceable loss of vital and high-value habitats such as crucial winter range and migration corridors, resulting in impacts that exceed the *High* or *Extreme* impact definitions. Big game species in the area are expected to be significantly affected by the **Proposed Action** and **Alternatives A, B,** and **C** but not by **Alternative D**.					

Table 2.4-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Biological Environment, continued						
***Pronghorn*[7]**	*High Impact*	*Extreme Impact*	*High Impact*	*High Impact in High Density Area*	*Moderate Impact*	*No New Impact*
***Mule Deer*[7]**	*High Impact*	*Extreme Impact*	*High Impact*	*High Impact in High Density Area*	*Moderate Impact*	*No New Impact*
Aquatic Wildlife	For the **Proposed Action** and all **action alternatives**, impacts to aquatic wildlife are primarily associated with increased sediment entering aquatic habitats from ground-disturbing activities and road building adjacent to or crossing aquatic habitat but significant effects are not expected. Alternative B has additional protections for the Muddy Creek/Bitter Creek watersheds and other aquatic habitats such as the Chain Lakes wetlands and playas.					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Least impact*	*No new impact*
Special Status Wildlife	Those Special Status wildlife species that have potential impacts from the **Proposed Action** or any of the **action alternatives** approaching or reaching the level of significance are identified below. Sage-grouse within core areas are not expected to be affected to a degree that approaches significance because of the SGEO's application on private and state lands as well as federal lands.					
Sage-grouse (non-core area only)	*Likely to exceed in non-core areas*	*Likely to exceed in non-core areas*	*Not expected to exceed*	*Less likely to exceed than Proposed Action*	*Not expected to exceed*	*No new impact*
Endangered Fish	Impacts to the four Endangered fish found downstream of the project area are not expected to occur under any alternative, except for minor water depletion. A determination on potential water depletions is contingent on consultation with the USFWS.					
Sensitive Fish	Sensitive fish are found primarily in the Muddy Creek drainage; the likelihood of impacts to these species exceeding the significance criteria under the **Proposed Action** and the **action alternatives** is:					
	Will exceed	*Will exceed*	*May exceed if actions on private lands offset public land restrictions*	*Likely to exceed*	*Less likely to exceed*	*No new impact*

[7] The impact levels noted for Pronghorn and Mule Deer are based on WGFD (2010) definitions.

Table 2.4-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Biological Environment, continued						
Special Status Plants	Measures aimed at avoiding and protecting special-status plants that would be implemented under the **Proposed Action** and all **action alternatives** would insure that special-status plants would be little affected directly. To the extent that surface disturbance decreases and the number of disturbance sites is reduced, the likelihood of adverse impact is diminished further.					
Wild Horses	Long-term AUM (animal unit month) loss in Lost Creek and Adobe Town HMAs is estimated at:					
	80 AUMs	*106 AUMs*	*77 AUMs*	*73 AUMs*	*63 AUMs*	*0 AUMs*
Human Environment						
Visual Resources	Under the **Proposed Action** and all **action alternatives**, adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with the management objectives for VRM Class III landscapes in the project area by partially retaining the existing character of the landscape. Development would be compatible per se with VRM Class IV objectives because VRM Class IV is meant to allow for major modification of the existing character of the landscape. There would be no new impacts under **Alternative E, No Action**.					
Recreation	The intensity of impacts to recreation would correlate to the variation in long-term surface disturbance by alternative:					
	Intermediate impact	*Most impact*	*Intermediate impact*	*Intermediate impact*	*Least impact*	*No new impact*
Lands with Wilderness Character (LWC)	Under the **Proposed Action** and **all alternatives**, there would be no impact on LWCs.					
Cultural and Historical Resources	Pre-disturbance surveys and avoidance would minimize adverse impacts and remove the potential for significant impacts for all alternatives; the number of sites that might be identified (and the number potentially eligible for NRHP), are described by alternative:					
	1,888 (434)	*2,467 (568)*	*1,821 (418)*	*1,718 (395)*	*1,455 (362)*	*No new impact*

Table 2.4-2. Comparison of impacts by alternative, *continued*

Feature/Resource	**Proposed Action**	**Alternative A: 100-Percent Vertical Drilling**	**Alternative B: Enhanced Resource Protection**	**Alternative C: Cap (High and Low Density Areas)**	**Alternative D: Directional Drilling**	**Alternative E: No Action**
Human Environment, continued						
Socioeconomics	The **Proposed Action** and the **action alternatives** would generate similar effects with minor differences. About 1,600 direct project-related jobs would be created by Year 15 of development. Total project-related employment (direct, indirect, and induced jobs) would climb to a peak of around 4,000 jobs in Year 14, an addition to existing project employment. Employment effects would continue during production after the field is fully developed, but be lower than those during development. Following completion of development and production, regional employment would decrease by over 4,300 jobs, including both new and existing jobs, a net job loss. Population changes would closely follow employment gains and losses, peaking at about 3,700 new residents and almost 1,000 temporary workers during Year 15 of development and falling to about 700 residents by Year 20. Community facilities should be adequate to accommodate the added population but may require expansion during the latter part of the 15-year development cycle. Demand for community facilities would substantially diminish after development is completed. Substantial government revenues would be generated by the natural-gas production—about $3.8 billion in federal royalties, an estimated $530 million in state mineral royalties, and $3.1 billion in ad valorem and gross products taxes. Project-related employment, population, and revenue generation effects would not occur under **Alternative E, No Action**.					
Transportation	Development-related estimated peak annual average daily traffic (AADT) by alternative is as follows (estimated long-term production-related AADT is the same for all alternatives, 1,360):					
	> 3,900	*>4,217*	*Reduced from PA 1-2%*	*Reduced from PA 3-4%*	*Reduced from PA 3-11%*	*0*
Noise	The **Proposed Action** and **Alternatives** would generate similar types of noise from construction and operations, including traffic-related noise. The volume of noise would be directly related to the number of well pads for each alternative, as follows:					
	6,126	*8,950*	*5,798*	*5,299*	*4,032*	*0*
Management Environment						
Range Resources	Estimated long-term forage loss (AUM equivalent) and number of allotments at risk of exceeding significance criteria (10% decrease in AUMs), by alternative, are as follows:					
	*1,985 AUMs (**four** allotments at risk)*	*2,540 AUMs (**more** allotments at risk than PA)*	*1,921AUMs (**fewer** allotments at risk than PA)*	*1,832 AUMs (**fewer** allotments at risk than PA)*	*1,574 AUMs (**fewer** allotments at risk than PA)*	*No new impact*

Table 2.4-2. Comparison of impacts by alternative, *continued*

Feature/Resource	Proposed Action	Alternative A: 100-Percent Vertical Drilling	Alternative B: Enhanced Resource Protection	Alternative C: Cap (High and Low Density Areas)	Alternative D: Directional Drilling	Alternative E: No Action
Management Environment, continued						
Oil and Gas and Other Minerals	Under the **Proposed Action** and all **action alternatives**, the natural gas resources of the project area would be developed fully. Natural gas reserves produced over the life of the project are estimated at 12.02 trillion cubic feet. Under **Alternative E**, the Operators would still possess lease development rights but it is assumed that fluid mineral resources would not be developed under this proposal.					
Health and Safety	The **Proposed Action** and all **action alternatives** would result in similar impacts to the public and site workers, including increased risk of vehicle collisions on interstate highways and local road systems.					
Waste and Hazardous Materials	Currently authorized and approved actions are already exerting stress on the permitted and authorized disposal facilities proximal to the project area. Authorization of the **Proposed Action** or **Alternatives A through C** would result in further stress to the capacity of permitted waste management units used by the operating companies, including those used for management of solid waste, produced water, and drilling mud. **Alternative D** may serve to extend the life of some existing disposal facilities.					

3. AFFECTED ENVIRONMENT

■ PHYSICAL ENVIRONMENT

3.1 GEOLOGY

3.1.1 Physiography

The project area straddles the Continental Divide and lies within the Great Divide Basin of south-central Wyoming, a subsidiary basin of the Greater Green River Basin. Important natural landmarks in the area and their corresponding elevations are shown in **Table 3.1-1**.

Table 3.1-1. Important natural landmarks in the CD-C project area (north to south)

Landmark	Location	Elevation (feet)
Lost Creek Butte	NW ¼ Section 24, T23N:R95W	6,745
Stratton Knoll	N 1/2 Section 28, T23N:R91W	6,879
Ruby Knolls	Sections 26 and 27, T22N:R92W	7,165
Windy Hill (mesa)	Sections 1–5, 7–12, and 18, T21N:R91W	7,125
Latham Point	SW ¼ Section 32, T21N:R92W	7,235
Tipton Buttes	NE ¼ Section 27, T20N:R96W	7,094
Cow/Horse Butte	SE ¼ NE ¼ Section 5, T19N:R91W	7,170
High Point	SW ¼ SW ¼ SE ¼ Section 17, T19N:R92W	7,321
Sugarloaf	SE ¼ SW ¼ Section 5, T18N:R92W	7,088
Pine Butte	Center of NW ¼ Section 10, T17N:R92W	6,808
Baldy Butte	SW ¼ NW ¼ SW ¼ Section 12, T17N:R92W	6,920
North Flat Top	SW ¼ Section 35 T15N:R93W and NW ¼ Section 2, T14N:R93W	7,822
East Flat Top	Center of the E 1/2 Section 18, T14N:R92W	7,560

The Continental Divide splits the project area into approximately northern and southern halves and, to a greater or lesser degree, parallels the I-80 highway and utilities corridor. Along and just north of the I-80 corridor, Five Mile Ditch, Latham Draw, and Hansen Draw drain the western part of the Great Divide Basin, whereas Buck Draw and Creston Draw drain to the northeast, off Latham Mesa. Farther north and northwest, the physiography of the project area is dominated by eolian features, and most watercourses are short and drain into small to very large interior basins. North of Tipton, the topography of the Red Desert Basin, the Lost Creek Basin, Chain Lakes Flat, and Battle Springs Flat is typified by eolian flats and dry playas lying in broad topographic depressions surrounded by areas of vegetated sheet or dune sand. These larger depressions are developed between elevations of about 6,450 and 6,600 feet. Dozens of smaller, internally drained basins occur near and south of the I-80 corridor, most notably including the Wamsutter and Frewan Depressions (at about 6,600 to 6,700 feet in elevation), and basins southeast of the Creston I-80 exit (S ½ T20N:R92W and SE ¼ SW ¼ T20N:R91W). Hundreds of smaller, internally drained basins occur throughout the project area, especially in places in which the surface rock or soil has been covered by dunes or a veneer of windblown sand.

In the eastern part of the project area, Fillmore Creek is a primary drainage north of the Continental Divide. Its principal tributaries include Coal Gulch, Coal Bank Wash, and Badwater Creek. Muddy Creek—tributary to the Little Snake River—is the dominant drainage south of the Divide. Its tributaries include Holler Draw, Chicken Springs Creek, and Soap Hole Wash that flow south off the Continental

Divide, supplemented by the south-flowing Barrel Springs Draw and Antelope Creek, and the east-flowing Windmill Draw, Red Wash, Blue Gap Draw, Robbers Gulch, Little Robbers Gulch, and the North Fork of Cottonwood Creek. Surface elevations within the project area range from a high of 7,822 feet on North Flat Top in the NW ¼ Section 2, T14N:R93W, to a low of 6,340 feet in the lower drainage of Muddy Creek in Section 32, T14N:R91W, making project area relief about 1,482 feet. The slope of the land along the floodplain of Muddy Creek within and marginal to the project area is a gentle 400 feet in 26.2 miles, or about 0.29 percent. Limited areas of exposed rock forming rugged badland hills border the Muddy Creek valley to the east and west, and some of these badland hills exhibit slopes of up to 13.7 percent for short distances. The region of greatest physical relief in the study area—along North Flat Top in Section 35, T15N:R93W—has a slope of 18.9 percent, or about a 1,000-foot rise in elevation per mile. The majority of the project area, however, shows gentler slopes of 1.7 to 4.2 percent (about 90–220 feet/mile).

The project area is dominated by semiarid desert that receives an average of 7.1 inches of annual precipitation, ranging from 3.8 inches to 13.6 inches. The annual temperature ranges from -30 ºF in winter to more than 100 ºF in summer. Sagebrush (*Artemisia* sp.) is the dominant vegetation and grows in patches and thickets. Along the larger drainages sagebrush is supplemented by bunch grasses, cheatgrass, greasewood, rabbitbrush, lichens, cottonwood, and a variety of other plants (Roehler 1993). Vegetation is wholly absent in several areas of badlands, and gullying can be severe in areas of headward erosion derived from badland areas, in places where the overlying sediment has been disturbed, or on poorly vegetated slopes greater than 2 percent. Much of the lower reach of Muddy Creek is entrenched in a floodplain gully system up to 20 feet in depth.

3.1.2 Regional Geologic Overview

The project area lies within the southern and eastern parts of the Great Divide and Washakie structural basins, sub-basin regions of the Greater Green River Basin of southernmost central Wyoming. Structurally, rocks in the area dip in a curving fashion to the west, southwest, and south of the structural high of the Sierra Madre Range, and to the south off the Wamsutter Arch, into the Washakie structural basin.

The west flank of the Sierra Madre is bounded by a major eastward-dipping reverse fault system, along which it was elevated over the eastern edge of the Greater Green River Basin (including the Washakie Basin) during the Laramide Orogeny of the late Cretaceous to early Tertiary period. These reverse faults are not exposed at the surface, but rather lie buried beneath early Tertiary sediments that fill the basin. The Washakie and Greater Green River basins to the west, into which the surface rocks dip, are bounded by east-west oriented structural highs, the Wamsutter Arch to the north and Cherokee Ridge to the south, respectively. The structural axis of Cherokee Ridge trends along the Wyoming/Colorado state line and separates the extreme southeastern arm of the Greater Green River Basin of Wyoming from the Sand Wash Basin of Colorado. Numerous faults occur along Cherokee Ridge, many of which show evidence of recurrent motion throughout the last 20 million years. None of these, however, show indication of Quaternary movement (Case *et al*. 1994).

Geologic mapping by the U.S. Geological Survey (USGS) and Wyoming Geologic Survey (Weitz and Love 1952, Love 1970, Love and Christiansen 1985, Love *et al*. 1993, Roehler 1973, 1977, 1985; Honey and Hettinger, 2004; Hettinger and Honey, 2005) documents that the project area has surface sedimentary exposures of Quaternary, Tertiary, and Late Cretaceous age. These deposits are in turn underlain in the subsurface by Phanerozoic-age sedimentary rocks of Cretaceous to Cambrian age, which are in turn underlain by Precambrian metamorphic bedrock that comprises part of the ancient North American craton (continental core) and exceeds two billion years in age.

Information on geologic units preserved at the surface and in the subsurface within the project area is provided in **Table 3.1-2**; a generalized stratigraphic column of these rocks is provided in **Figure 3.1-1.** A diagram showing the complex stratigraphic relations of Eocene deposits is provided in **Figure 3.1-2**.

Table 3.1-2. Surface and subsurface geologic deposits in the CD-C project area

Geologic Deposit	Geologic Age	Environment/Lithology	Resources (PFYC=Probable fossil yield class)
Surface Deposits			
Unnamed Quaternary deposits	Holocene-Pleistocene	Eolian/fluvial/colluvial/ landslide. Sand, gravel, clays, weathered-in-place residuum from exposed outcrops	None reported within area, economic deposits of wind-blown sand reported 20–30 miles NNE of the town of Baggs, Wyoming, just east of the project area
Green River Formation • Laney Shale • Godiva Rim Member • Wilkins Peak Member • Tipton Tongue • Luman Tongue	Early – Middle Eocene	Lacustrine: near shore line/saline flats. Oil shale, carbonaceous shale, calcareous shale sandstone, mudstone, limestone, marlstone, oolitic and pisolitic limestone, stromatolites, trona, halite	Vertebrate (including abundant fish and flamingo), invertebrate and plant fossils (BLM PFYC 5 for Formation). Oil shale, Halite and trona east of Rock Springs.
Battle Spring Formation	Paleocene to early Eocene	Terrestrial/alluvial fan/fluvial. Arkosic (feldspar-rich) sandstone	Possible vertebrate fossils, but correlation uncertain (BLM PFYC 2-3); Gravel and uranium in Great Divide Basin
Wasatch Formation • Cathedral Bluffs Tongue • Main Body • Niland Tongue • Ramsey Ranch Member	Early Eocene	Terrestrial: fluvial/flood plain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale and coal	Vertebrate, invertebrate, and plant fossils (BLM PFYC 5); coal; petroleum in Table Rock fields; uranium reported in adjacent areas near Wamsutter, Creston, and Latham
Fort Union Formation	Paleocene	Terrestrial: fluvial/flood plain/swamp, chiefly somber-colored sandstones, mudstones, carbonaceous shales and coals	Vertebrate, invertebrate, and plant fossils (BLM PFYC 3); petroleum in Table Rock and Wild Rose fields; coal, coalbed methane
Lance Formation	Late Cretaceous	Terrestrial: fluvial/ floodplain/swamp, brown and gray sandstone, shale and mudstone, coals, and carbonaceous shales	Vertebrate, invertebrate and plant fossil (BLM PFYC 5); coal; coalbed methane, petroleum in Barrel Springs, Blue Gap, Bush Lake, Emigrant Trail, Great Divide, Hay Reservoir, Robbers Gulch, Wamsutter, and Wild Rose fields
Subsurface Deposits			
Fox Hills Sandstone	Late Cretaceous	Near-shore and marginal marine gray shale and interbedded grayish-orange sandstone	Petroleum in Table Rock Field, other production may be included with Lance Formation; potential petroleum reservoir rock

Source: Geologic mapping by the U.S. Geological Survey (USGS) and Wyoming Geologic Survey (Weitz and Love 1952, Love 1970, Love and Christiansen 1985, Love et al 1993, Roehler 1973, 1977, 1985; Honey and Hettinger, 2004; Hettinger and Honey, 2005.

Table 3.1-2. Surface and subsurface geologic deposits in the CD-C project area, *continued*

Geologic Deposit		Geologic Age	Environment/Lithology	Resources (PFYC=Probable fossil yield class)
Lewis Shale		Late Cretaceous	Marine shale and sandstone	Petroleum in Baldy Butte, Barrel Springs, Bastard Butte, Battle Springs, Blue Gap, Bush Lake, Coal Gulch, Continental Divide, Cow Creek, Creston, Delaney Rim Unit, Echo Springs, Emigrant Trail, Fillmore, Frewen, Gale, Great Divide, Hay Reservoir, Lost Creek Basin, Lost Creek, Nickey, Red Desert, Robbers Gulch, Salazar, Sentinel Ridge, Siberia Ridge, Standard Draw, Stock Pond, Strike, Table Rock, Table Rock SW, Tierney, Wamsutter, and Wild Rose fields
Mesaverde Group	Almond Formation	Late Cretaceous	Marine, terrestrial, deltaic: white and brown sandstone, sandy shale, coal, carbonaceous shale	Petroleum in Baldy Butte, Barrel Springs, Battle Springs, Blue Gap, Bush Lake, Coal Gulch, Creston, Creston Southeast, Delaney Rim Unit, Echo Springs, Emigrant Trail, Fillmore, Five Mile Gulch, Frewen, Hay Reservoir, Monument Lake, Nickey, Red Desert, Robbers Gulch, Sentinel Ridge, Shell Creek, Siberia Ridge, Standard Draw, Stock Pond, Strike, Table Rock, Table Rock SW, Tierney, Wamsutter, Wells Bluff, and Wild Rose, Windmill Draw fields; coal; coalbed methane
	Ericson Sandstone (a/k/a Pine Ridge or Williams Fork Formation)	Late Cretaceous	Marine: coastal plain, estuary/beach, white sandstone, lenticular conglomerate, coal	Petroleum in Battle Springs, Continental Divide, Creston, Echo Springs, Fillmore, Five Mile Gulch, Gale, Lost Creek Basin, Monument Lake, Sentinel Ridge, Siberia Ridge, Standard Draw, Stock Pond, Strike, Table Rock, Wamsutter, Wells Bluff, Wild Rose, and Windmill Draw Fields
	Rock Springs (a/k/a Allen Ridge or Iles) Formation	Late Cretaceous	Terrestrial, coastal plain white to brown sandstone, shale, mudstone, coal	Petroleum in Wamsutter Field; other production may be included in Mesaverde (undivided); potential petroleum reservoir rock
	Blair (=Haystack Mountains) Formation	Late Cretaceous	Marine	Petroleum in Creston and Table Rock Field; other production may be included in Mesaverde (undivided)
Steele Shale (includes Shannon, Sussex Sandstones)		Late Cretaceous	Marine: gray shale, with numerous bentonites, sandstone	None reported, potential petroleum source and reservoir rock
Niobrara Formation		Late Cretaceous	Marine: light-colored limestone, gray limey shale	None reported, potential petroleum source and reservoir rock
Frontier Formation		Late Cretaceous	Marine: deltaic, gray sandstone and sandy shale	Petroleum in Cow Creek and Table Rock fields; potential petroleum source and reservoir rock

Table 3.1-2. Surface and subsurface geologic deposits in the CD-C project area, *continued*

Geologic Deposit	Geologic Age	Environment/Lithology	Resources (PFYC=Probable fossil yield class)
Mowry Shale	Late Cretaceous	Marine: silver-gray, hard siliceous shale, with abundant fish scales and bentonites	None reported, potential petroleum source rock
Muddy Sandstone	Early Cretaceous	Marine: deltaic, gray to brown sandstone, conglomeratic	Petroleum in Cow Creek Field; potential petroleum reservoir rock
Thermopolis Shale	Early Cretaceous	Marine, black, soft, fissile shale	None reported, potential petroleum source rock
Cloverly Formation (=Dakota & Lakota Sandstones)	Early Cretaceous	Terrestrial, variegated mudstone, bentonitic, conglomeratic sandstone	Petroleum in Cow Creek Field; potential petroleum reservoir rock
Geologic Deposit	Geologic Age	Environment/Lithology	Resources (PFYC=Probable fossil yield class)
Morrison Formation	Jurassic	Terrestrial, varicolored mudstones, white sandstone, bentonite	None reported; potential petroleum reservoir rock
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone	None reported; potential petroleum reservoir rock
Nugget Sandstone	Triassic to Jurassic	Eolian, gray to red, massive to cross-bedded sandstone	Petroleum in Cow Creek and Table Rock fields; potential petroleum reservoir rock
Chugwater Formation	Triassic	Terrestrial/mud flat, red shale and siltstone, sandstone	Potential petroleum reservoir rock
Goose Egg Formation	Permian to Triassic	Marine, gray to olive dolomitic siltstone; red sandstone and siltstone, gypsum, halite, purple to white dolomite and limestone	None reported
Tensleep Sandstone	Pennsylvanian	Marine, white to gray sandstone with limestone and dolomite	Potential reservoir rock.
Amsden Formation	Mississippian to Pennsylvanian	Marine, red and green shale and dolomite, persistent red to brown sandstone at base	None reported
Madison Limestone	Mississippian	Marine, blue-gray massive limestone and dolomite	Petroleum in Table Rock Field
Flathead Sandstone	Cambrian	Marine/shoreline, red, banded, quartzose sandstone	None reported
Unnamed metamorphic rocks	Precambrian	Igneous/metamorphic, granitic and/or intrusive	None in area but Sierra Madre contain ores of uranium, copper, silver, lead, zinc, gold, and barium; and industrial (building and decorative) grades of quartzite, marble, and granite

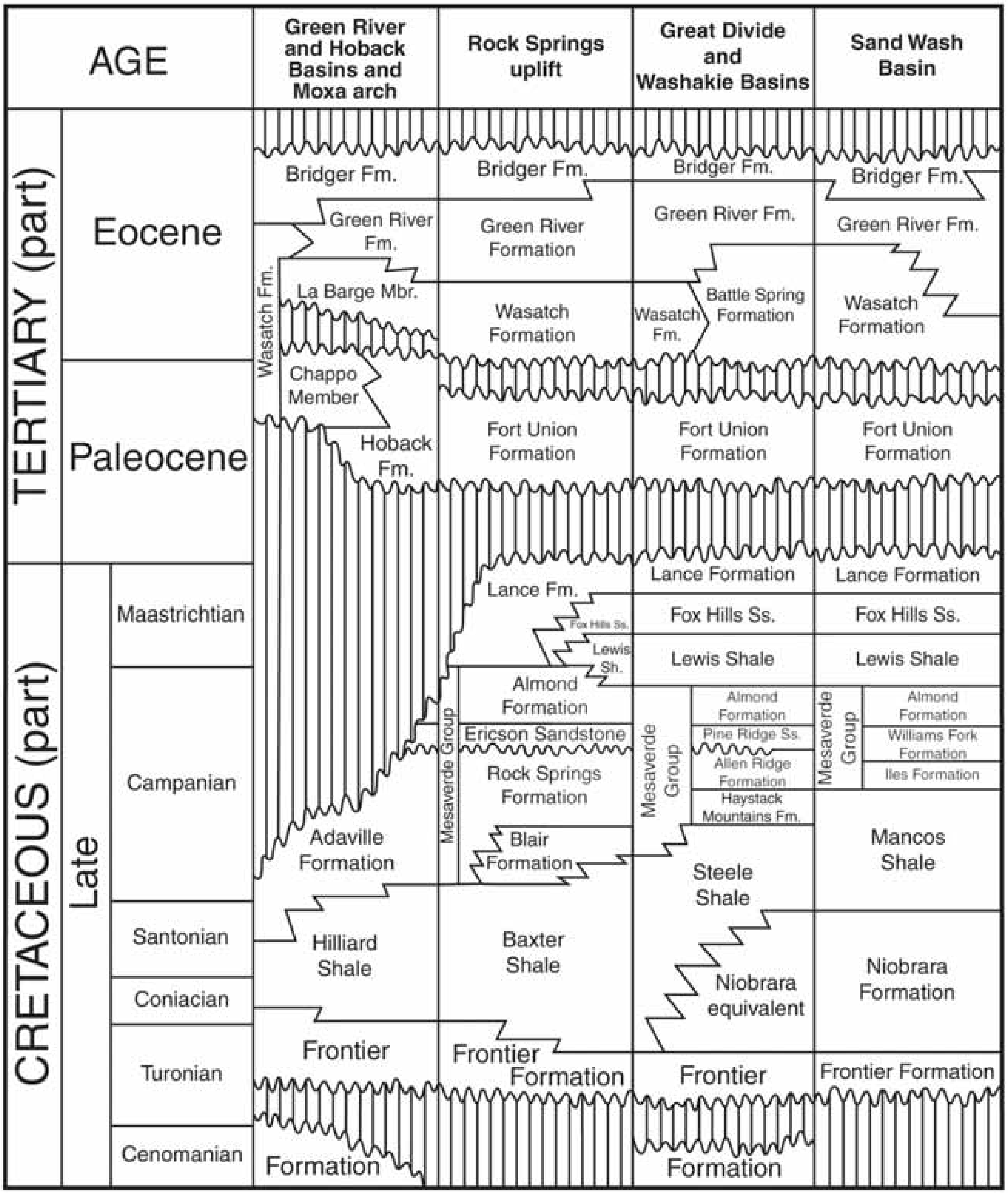


Figure 3.1-1. Generalized stratigraphic column

The Battle Spring Formation (not shown in this chart) is a coarse-grained deposit that accumulated along the southern flank of the Granite Mountains. It is equivalent to the Wasatch and Green River Formations and possibly part of the Fort Union Formation.

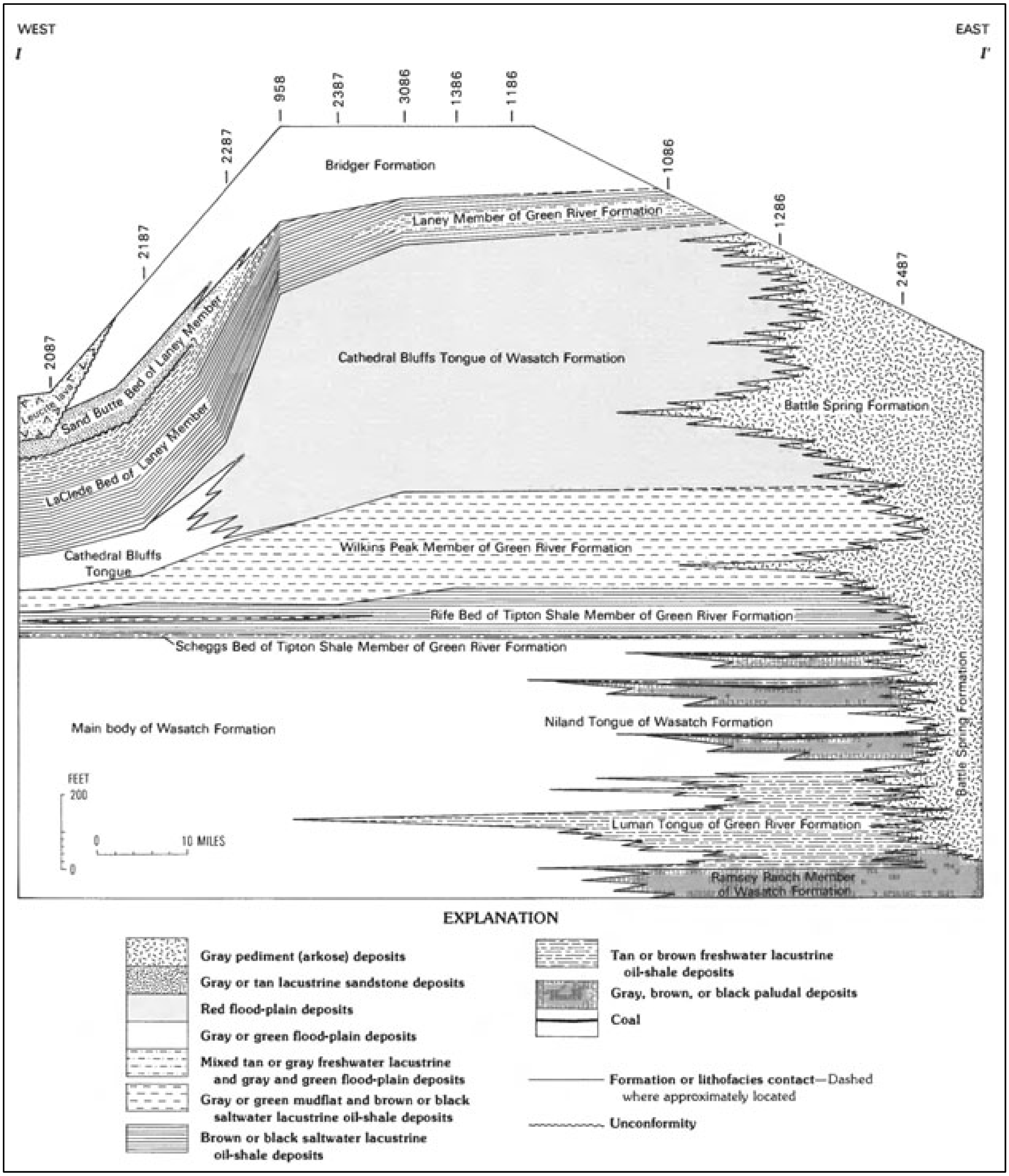


Figure 3.1-2. Eocene stratigraphic units, Greater Green River Basin

Source: Modified from Roehler (1989)

Rock terminology for the Cretaceous (Mesaverde Group, a subsurface unit in the project area) is complicated in that scientific studies of these rocks reference a number of different formations within the project area. Although the Wyoming Chart of Stratigraphic Nomenclature lists the Almond, Ericson, Rock Springs, and Blair formations within the Mesaverde Group in the Washakie Basin, alternative terminology has been used for these same rocks by authors describing the coals of the Mesaverde. Rock equivalent names for the Ericson Sandstone include the Williams Fork Formation or Pine Ridge Sandstone; for the Rock Springs Formation, the Allen Ridge Sandstone or Iles Formations; and for the Blair Formation, the Haystack Mountain Formation.

Additional details on surface deposits are provided in **Section 3.1.3**. Petroleum production targets are generally in the Mesaverde Group (undivided) in the following fields: Baldy Butte, Barrel Springs, Bastard Butte, Battle Springs, Blue Gap, Coal Gulch, Continental Divide, Cow Creek, Creston, Delaney Rim Unit, Echo Springs, Emigrant Trail, Fillmore, Five Mile Gulch, Frewen, Hay Reservoir, Lost Creek Basin, Monument Lake, Red, Red Desert, Robbers Gulch, Salazar, Sentinel Ridge, Shell Creek, Siberia Ridge, Stock Pond, Strike, Table Rock, Tierney, Wamsutter, Wells Bluff, Wild Rose, and Windmill Draw.

3.1.3 Quaternary Deposits

Quaternary deposits in the project area include widespread deposits of alluvium, colluvium, and slope wash; eolian sand dunes; and residuum developed on formations of Cretaceous (Lance Formation), Paleocene (Fort Union Formation), and Eocene (Battle Spring, Green River, and Wasatch Formations) ages.

Extensive deposits of windblown sand blanket bedrock exposures of Tertiary rocks in T15-17N:R93W, with more isolated deposits occurring in T15N:R92W (Love and Christiansen 1985). These deposits range in thickness up to about 30 feet, and the sediment has been partly stabilized by vegetation, dampness, and weak cementation in some areas. Relatively pure, naturally size-sorted eolian sand is an economic resource, and sand-quarry pits have been developed in Section 9, T15N:R92W and just to the southeast of that area, outside the project boundaries (Harris 1996). The northern part of the project area is dominated by eolian deposits and an eolian-created topography. The Red Desert, Lost Lake, and String Lake Basins are deflated playas surrounded by loess deposits.

Deposits of alluvium, at least up to 30 feet thick, are developed in the bed and floodplain of Muddy Creek in the central and southeast parts of the project area, and much thinner alluvial accumulations occur in the beds of tributary streams near where they join Muddy Creek. The alluvium consists for the most part of medium to fine sand, mud, and mudstone rip-up clasts, all derived from the surrounding badland hills. Chert pebbles, sandstone clasts, and weathered Eocene soil (paleosol) nodules commonly occur as part of streambed loads. Pebble to cobble-sized gravel forms some of the ancient terrace sediment above Muddy Creek on its east side, and these deposits are exploited locally as road metal or in making concrete filler (for example, in the SW ¼ SE ¼ Section 21, T18N:R91W). The site of the lauded "Rawlins Mammoth," discovered in 1961, is located near Chicken Springs in the NW ¼ SW ¼ SE ¼ Section 1, T18N:R91W.

Drapes of colluvial sediment, consisting mainly of mud with a lesser amount of fine sand and lag accumulations of Eocene soil nodules, border nearly all the badland hills and are derived from them.

Terrace gravel and gravel deposits of Holocene and perhaps Pleistocene age occur sporadically throughout the area along the former course of Muddy Creek and at higher elevations. Older high-level terrace gravels suggest that Muddy Creek and its subsidiary tributaries drained northward into the Great Divide Basin in the past and that its present southward drainage into the Little Snake River was the result of stream piracy.

3.1.4 Tertiary—Battle Spring Formation

The Battle Spring Formation (Pipiringos 1961) is a fluvial deposit of middle Eocene age that forms a foundation for most of the buttes and mesas bordering the playas in the project area north of the Continental Divide. The unit consists of gray, orange, and red mudstones, volcanic mudstones, carbonaceous mudstones, orange and brown sandstones, and stringers of gravel conglomerate, and it is especially well exposed in the area of Ruby Knolls and on the east side of Frewan Mesa. The Battle Spring Formation has yielded a small fauna of fossil vertebrates, including the fragmentary bone of a crane or a large, flightless bird discovered during reconnaissance fieldwork for this project.

3.1.5 Tertiary—Green River Formation

Within the project area, the Eocene Green River Formation (chiefly of middle Eocene age) is restricted to the area around the I-80 corridor (between Wamsutter and Tipton Buttes) and to the extreme southwest, where it makes up the upper part of the escarpment forming Flat Top Mountain. From oldest to youngest, the Green River consists of the Luman Tongue, the Tipton Tongue, Wilkins Peak Member (lower part only), Godiva Rim Member, and the Laney Member. Sediments comprising the Green River Formation accumulated in environments in and adjacent to Lake Gosiute (and its predecessor Lake Luman) in response to the rise and fall in lake level during the Early Eocene. Environments of deposition included fluvial, paludal, freshwater lacustrine, saltwater lacustrine, pond and playa lake, evaporate pans, mudflat, and volcanic and fluviovolcanic (Roehler 1993).

The Luman Tongue forms the base of the Green River Formation on the southern edge of the Great Divide Basin. The tongue is composed chiefly of organic-rich oil shales, carbonaceous shales, limestones, sandstones, and mudstones that accumulated in Lake Luman above deposits of the Ramsey Ranch Member of the Wasatch Formation (**Section 3.1.6**). The Luman deposits interfinger laterally to the north and south with varicolored (chiefly red) floodplain deposits of the Wasatch Formation. At its maximum extent, Lake Luman occupied an area of about 6,650 square miles.

The Tipton Tongue (including the Scheggs and Rife beds) of the Green River Formation conformably overlies the Niland Tongue of the Wasatch Formation, and is composed chiefly of marlstone, calcareous shale, and oil shale. The Scheggs Bed is predominantly oil shale and lesser algal limestones, sands, and muds that accumulated in lake and lake-shore environments during the first major expansion of ancient Lake Gosiute. Deep-lake oil shale in the Scheggs Bed preserves abundant fossils of ostracods and shallow-water lake sediments containing abundant stromatolites, the remains of calcareous algal reefs. The stromatolites exhibit a wide variety of bizarre forms that are related to ecological conditions such as water depth, temperature, salinity, and sedimentation rate, as well as other factors. The Rife Bed forms the top of the Tipton and consists chiefly of organic-rich oil shale, interbedded with a lesser amount of algal limestone, dolomite, sandstone, and mudstone. The oil shale of the Rife accumulated in the deepest parts of the lake during a 500,000-year period when Lake Gosiute dwindled to about half its former size (about 7,500 square miles) during deposition of the Scheggs Bed. The salinity of the lake must have increased dramatically as evidenced by thin layers of saline minerals such as nahcolite and disseminated crystals of shortite that occur in the upper part of the bed. Algal limestone and sands accumulated in shallower and shoreline areas.

The Wilkins Peak Member consists of many layers of cyclic sediments that include, in ascending order: oil shale, trona, halite, and mudstone that accumulated in Lake Gosiute. Only the lower part of the member is present in the project area. This part of the member consists chiefly of shales, sandstones, and trona and halite that accumulated in brackish Lake Gosiute as the lake shrank in size. The Godiva Rim Member consists chiefly of gray-brown kerogenous shale, ostracode-bearing sandstone, siltstone, and limestone that overlie and interfinger with the Cathedral Bluffs Member of the Wasatch Formation and is overlain and interfingers with the LaClede Bed of the Laney Shale.

The Laney Shale (including the LaClede and Hartt Cabin beds) forms the top of the Green River Formation and records in its sediments the greatest expansion of ancient Lake Gosiute followed by its final contraction and desiccation. At its peak the lake in which the Laney accumulated occupied more than 75 percent of the Greater Green River Basin, or about 15,000 square miles (Bucheim 1981,1986, Bucheim *et al.* 1977).The Laney Shale (including the LaClede and Hartt Cabin Beds) conformably overlies and interfingers with the Cathedral Bluffs Tongue of the Wasatch Formation, and is dominated by calcareous shale, oil shale, and shaley marlstone.

In the Piceance Basin of Colorado, the Green River Formation contains massive amounts of economically important oil shale, and elsewhere the formation is also known to yield economically important deposits of trona and gilsonite. The Green River is well known for its locally abundant remains of well-preserved fossil fish and much rarer specimens of other fossil vertebrates.

3.1.6 Tertiary—Wasatch Formation

The lower Eocene Wasatch Formation is the most extensively exposed geologic unit in the project area, with a distribution exceeding that of any other rock unit. Bedrock exposures of the Wasatch Formation, however, are generally limited to the steep, east-facing escarpments bordering much of the west side of Muddy Creek, especially beneath Flat Top Mountain, along “The Bluffs” north of Baggs, and in west-dipping cuestas north and south of the townsite of Dad. Other exposures are locally developed along and marginal to deeply incised streams on south Mexican Flats.

Within the project area, the Wasatch Formation is divided into the Main Body, Ramsey Ranch Member, Niland Tongue, and the Cathedral Bluffs Tongue. Regionally, the Main Body of the Wasatch Formation consists of up to 2,130 feet of variegated mudstone and sandy mudstone, gray sandstone, carbonaceous shale, and coal (Bradley 1964; Sullivan 1980; Roehler 1985) that were deposited in alluvial channels and back swamps, and on floodplains. Toward the basin center, the Main Body of the Wasatch conformably overlies the Paleocene Fort Union Formation, but farther east it overlaps the Fort Union and lies with angular unconformity on both the Fort Union Formation and the Upper Cretaceous Lance Formation. The floodplain deposits of the Main Body have two distinct color patterns. Around the basin edges the floodplain deposits range from red to varicolored, with some shade of red dominating. In the central parts of basin these red floodplain deposits are replaced laterally by green to gray floodplain deposits. Green to gray coloration appears to have been the result of accumulation of sediments in areas that were permanently water saturated, where iron compounds were reduced. In addition to floodplain deposits the main body of the Wasatch Formation includes some freshwater limestones that accumulated in ponds and marshes in low-lying areas and some coarse-grained sands and conglomerates that accumulated along the basin margin in alluvial fan environments. Deposits of the Main Body accumulated contemporaneously with deposits of the Ramsey Ranch Member of the Wasatch Formation and Luman and Tipton tongues of the Green River Formation.

The Ramsey Ranch Member consists of carbonaceous shale, coal, limestone, gray and green or red variegated sandstone and mudstones that accumulated in swamps, shallow lakes and ponds, and floodplains and rivers during the early stages of the development of Lake Gosiute. The member contains important deposits of oil shale, uranium, and coal.

The Niland Tongue of the Wasatch Formation consists of brown sandstone, drab mudstone, and carbonaceous shale that conformably overlie the Luman Tongue of the Green River Formation. The Niland Tongue has the same aerial distribution as the Luman Tongue of the Green River Formation. Where the Luman Tongue is absent the name Niland Tongue is discarded and those rocks are not separated from the underlying main body of the Wasatch.

The Cathedral Bluffs Tongue forms the uppermost rocks of the Wasatch Formation, overlying the Tipton Shale of the Green River Formation, and closely resembles those of the Main Body in the dominance of variegated mudstone and gray sandstone.

Economically important uranium deposits occur in coals of the Main Body and Ramsey Ranch Member of the Wasatch Formation north of Wamsutter, just west of the project area (Masursky 1962), and in the region around Creston and Latham (Harris *et al.* 1985; Harris and King 1993). Uranium is also known in arkoses of the Battle Springs Formation of the central Great Divide Basin (Pipiringos 1961), a unit approximately equivalent to the Cathedral Bluffs Tongue of the Wasatch within the report area.

Fossil vertebrates are locally abundant in the Wasatch Formation, including all the subunits that comprise the formation in the CD-C project area. Fossils are most abundant where they have weathered from immature through mature paleosols. However, about 10 miles north of Baggs, Wyoming, sandstones of the Cathedral Bluff Member that interfingers with the Tipton Shale have produced fossils of 11 mammalian species including primates, condylarths, tillodonts, dinocerates, and perissodactyls (Roehler 1988) as well as the fossils of mollusks, ostracodes, burrows, worm trails, and an unidentified tubular impression. The mollusks include very abundant shells of the gastropods *Goniabasis* and *Viviparus* as well as freshwater unionid bivalves.

The most important Wasatch Formation fossil vertebrate locality within the study area is the so-called "Dad Local Fauna" (Gazin 1962), which was collected from the east-facing exposures of the Main Body of the formation developed on bluffs north and south of the townsite of Dad. The University of Wyoming Geological Museum has 11 fossil vertebrate sites in the Wasatch Formation within the project area.

3.1.7 Tertiary—Fort Union Formation

Within the project area, the Paleocene Fort Union Formation is developed in a curved, westerly dipping outcrop. Regionally, the unit lies with erosional or angular unconformity atop the Upper Cretaceous Lance Formation (Roehler 1993). The best Fort Union exposures occur in the northeast part of the area, in Section 23, T18N:R92W; however, good but smaller and less-continuous Fort Union exposures occur beneath Wasatch-capped buttes developed just east of Muddy Creek, between the townsites of Dad and Baggs, Wyoming.

Regionally, the Fort Union Formation consists of up to 3,400 feet of drab mudstone, sandy mudstone, sandstone, carbonaceous shales, and coal. These rocks were deposited in alluvial channels and flood-basin backswamps (Sanders 1975), and up to 1,500 feet of Fort Union rocks are exposed in the Riner area, between Red Rim and Creston Junction (Sanders 1974).

Honey and Hettinger (2004) and Hettinger and Honey (2005) have mapped three members of the Fort Union Formation in the Blue Gap and Peach Orchard 7.5-minute quadrangles. These include, from youngest to oldest, the Overland, Blue Gap, and China Butte Members. The China Butte Member includes many mapped coalbeds included in five coal-bearing zones. These include the Fillmore Ranch, upper and lower Muddy Creek, Olsen Draw, and Red Rim coal zones.

The Fort Union Formation in the project area, as well as in all of south-central Wyoming, constitutes an enormous, largely untapped reserve of coal. Unfortunately, most of this resource occurs in thin and/or discontinuous beds (Smith *et al.* 1972; Sanders 1974, 1975; Beaumont 1979; Edson 1979; Hettinger and Brown 1979; Honey and Roberts 1989; Honey and Hettinger 1989a; Honey 1990; Jones 1991; Hettinger *et al.* 1991; Hettinger and Kirchbaum 1991) that are exceedingly difficult to mine economically. Sanders (1974, 1975) reports thin and discontinuous Fort Union coalbeds that thicken up to 9.8 feet in places, and units 5–25 feet thick are developed in the upper 600–700 feet of the formation just northeast of the project area. Edson (1979), Honey and Hettinger (1989a), Honey and Roberts (1989), and Honey (1990) named and/or numbered Fort Union coalbeds within and north and west of the project area, and provided subsurface correlations of coal-bearing units. Honey and Roberts (1989) recorded up to 75 feet of total coal thickness in the lower part of the Fort Union Formation in the Baggs area, and Honey and Hettinger (1989b) documented individual coalbeds up to 27.7 feet thick in the Fillmore Ranch Coal Zone (Edson 1979), within the project area.

The most recent coal-mining activity within the project area is in the Fort Union Formation at Cherokee Mine Number 1, in the SW ¼ SW ¼ NE ¼ Section 2, T19N:R92W, about 6 miles south of Creston Junction. Coal mining is also planned for the Creston Area (in T19N:R92W), and at the Chris Butte Mine Project area along the Continental Divide in Section 15, T18N:R91W.

Fossil vertebrates are well known from the China Butte Member of the Fort Union Formation within the study area, the most noteworthy locality being Swain Quarry, in the NE ¼ Section 3, T15N:R92W (Rigby 1980). Apart from Swain Quarry, the UW Geological Museum has one locality in the project area—Fort Union rocks—and an additional 13 Fort Union sites have been developed in recent years by M.C. McKenna and J.G. Honey.

The contact of the Fort Union Formation with the underlying Upper Cretaceous Lance Formation is everywhere marked by a pronounced angular unconformity and generally a thick-channel sandstone (Roehler 1993). It is unknown if the Tertiary-Cretaceous boundary is preserved in the area, but earliest Paleocene (Puercan age) rocks certainly are (see **Section 3.3 Soils**).

3.1.8 Upper Cretaceous—Lance Formation

Few exposures of Lance rocks extend into the project area, and the Lance Formation/Fort Union Formation contact in part forms the project area's eastern boundary over a short distance. However, patches of Lance are exposed in a few areas, notably in the SE ¼ Sections 13, 23, and 34, T17N:R92W, and in the E ½ Section 4, T16N:R92W.

The Lance Formation is a largely alluvial deposit made up of about 2,890 feet of interbedded gray sandstone and sandy mudstone, carbonaceous shale, and coal (Hettinger *et al.* 1991; Hettinger and Kirschbaum 1991). Honey and Hettinger (2004) and Hettinger and Honey (2005) recognize two subunits of the Lance Formation in the Blue Gap and Peach Orchard 7.5-minute Quadrangles. These include an upper Red Rim Member and an underlying unnamed member. The Red Rim Member is chiefly conglomeratic sandstone. The underlying unnamed member contains several coal units. The thickest of these, which is about six feet thick, occurs about 25 to 45 feet above the base of the formation.

Regionally, the Lance overlies the Fox Hills Sandstone (Smith 1961, Gill *et al*. 1970, Hettinger *et al*. 1991, Roehler 1993), which is included in the Lewis Shale on many maps. To the east the Fox Hills may be absent, and the Lance directly overlies the Lewis Shale (Weitz and Love 1952, Love and Christiansen 1985). Further eastward, Lance rocks correlate with the Medicine Bow Formation (Merewether 1971) and farther west, the Lance thins to less than 197 feet on the west side of the Washakie Basin (Roehler 1985).

The Lance Formation is well-known for its dinosaur remains and, within the project area, Lance rocks have yielded sparse remains of fish, crocodilians, and mammals (J.G. Honey, personal communication).

3.1.9 Geologic Hazards

Of known naturally occurring geologic hazards, fault-generated earthquakes, floods, landslides, or other mass movement, the most likely to affect the project area are mass movements that could be initiated on steep slopes. Flooding may be a hazard adjacent to steeply dipping rock outcroppings where high runoff may be expected; however, there are few such areas within the project boundaries.

There are no known faults with evidence of Quaternary movement mapped within the project area (NEIC 2003, WGS 2003); however, a number of unmapped faults are known to exist in the Washakie Basin area in southern Sweetwater and Carbon Counties. Further field investigation is necessary to determine if any of these faults should be deemed active (USGS 2012a).

Only one earthquake has been recorded within the project area. The earthquake, with a 4.3 Richter magnitude occurred April 4, 1999 and its epicenter was located near Baldy Butte in T17N:R92W (41.45˚N:107.74˚W). It was felt in Rawlins, Sinclair, Baggs, Wamsutter, and Rock Springs. Residents of Rawlins reported that pictures fell off walls. The most noteworthy damage occurred between Baggs and

Creston Junction, and at Wamsutter (USGS 2012a). The owner of a ranch house located approximately 30 miles north of Baggs reported that cinder-block walls in the basement of the home cracked, separated, and may have required replacement. A motel and associated residence in Wamsutter also suffered cracks in the cinder-block walls of the basement. No other earthquake epicenters have been recorded in or immediately adjacent to the area in the past 100 years, indicating that earthquakes are probably an unusual event and that the area may not be very seismically active (USGS 2012a).

Carbon County is primarily in Seismic Zone 1 of the Uniform Building Code. Effective peak accelerations (90 percent chance of non-exceedance in 50 years) in this zone can range from 5%g–10%g, where g = the gravitational acceleration constant (see Glossary). New probabilistic acceleration maps for Wyoming are available from the USGS (USGS 2012a). These maps assume accelerations based on what would be expected if firm soil or rock were present at the surface.

Ground accelerations shown on the USGS maps in Wyoming may be affected by local soil conditions. If fairly soft, saturated sediments are present at the surface, and seismic waves pass through them, surface-ground accelerations will usually be greater than would be experienced if only bedrock were present. Thus, ground accelerations shown by the USGS maps may underestimate the local hazard.

The USGS maps indicate that in the southern part of Carbon County: (1) for the 500-year map (10 percent probability of exceedance in 50 years), the estimated peak horizontal acceleration in Carbon County is about 4%g; (2) for the 1,000-year map (5 percent probability of exceedance in 50 years) is about 3.9%g; and (3) for the 2,500-year map (2 percent probability of exceedance in 50 years) is about 11%g. These accelerations are roughly comparable to intensity V and VI earthquakes. An intensity VI earthquake can result in fallen plaster and damaged chimneys.

The historic record of earthquakes is limited and it is nearly impossible to determine when a 2,500-year event last occurred in the county. This uncertainty, coupled with use by the International Building Code of the record of 2,500-year events for building design, suggests that it is appropriate to use the 2,500-year probabilistic maps for Carbon County analyses.

Honey and Hettinger (2004) have mapped landslide deposits covering about a quarter-section along the north side of Cottonwood Creek in Section 31, T14N:R92W and Section 6, T13N:R92W of the Peach Orchard 7.5-minute topographic quadrangle. These deposits are of limited extent and occur along the contact between the Main Body of the Wasatch Formation and overlying Tipton Tongue of the Green River Formation.

3.2 PALEONTOLOGIC RESOURCES

3.2.1 Paleontological Resource Preservation Act

The Paleontological Resources Preservation Act (PRPA 2009) was signed into law as part of the Omnibus Public Lands Management Act of 2009, Public Law 111-011 (123 Stat. 1173; 16 USC 470aaa) (OPLMA 2009). It states that these resources on federal land (except Indian land) shall be managed and protected "using scientific principles and expertise" and also requires the development of "appropriate plans for the inventory, monitoring, and scientific and educational use of these resources" in accordance with applicable agency laws, regulations, and policies. These plans emphasize interagency coordination and collaborative efforts where possible with non-federal partners, the scientific community, and the general public. In addition, programs to increase the public's awareness about the significance of paleontological resources are to be established.

The PRPA formally defines paleontological resources as "any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth," and as such include the fossilized remains of plants and animals as well as their traces.

3.2.2 Potential Fossil Yield Classification (PFYC) System

The PFYC system is described in BLM Instruction Memorandum [IM] No. 2008-009, *Potential Fossil Yield Classification (PFYC) System for Paleontological Resources on Public Lands* (BLM 2007d). The IM is summarized here and is included in its entirety in **Appendix D, Paleontological Resources Program Guidance**. The system is based on the premise that the probability of finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Under the system, geologic units are classified according to the relative abundance of fossils and their sensitivity to adverse impacts, with a higher class number indicating a higher potential.

The PFYC system provides baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification is an intermediate point in the analysis, used to assist in determining the need for further mitigation assessment or actions.

The descriptions for each class (provided below) serve as guidelines rather than as strict definitions. Note that the definition of *fossil* may be redefined in the Rules and Regulations Section of the PRPA, which is still in draft.

Class 1 – **Very Low**. Geologic units that are not likely to contain recognizable fossil remains.

- Units that are igneous or metamorphic, excluding reworked volcanic ash units.
- Units that are Precambrian in age or older.

The probability for impacting any fossils is negligible.

Class 2 – **Low**. Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant nonvertebrate fossils.

- Vertebrate or significant invertebrate or plant fossils not present or very rare.
- Units that are generally younger than 10,000 years before present.
- Recent eolian deposits.
- Sediments that exhibit significant physical and chemical changes (i.e., diagenetic alteration).

The probability for impacting fossils is low.

Class 3 – **Moderate** or **Unknown**. Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence; or sedimentary units of unknown fossil potential.

- Often marine in origin with sporadic known occurrences of vertebrate fossils.
- Vertebrate fossils and scientifically significant invertebrate or plant fossils known to occur intermittently; predictability known to be low.
- (or)
- Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.

Class 3a – Moderate Potential. Units are known to contain vertebrate fossils or scientifically significant nonvertebrate fossils, but these occurrences are widely scattered.

Class 3b – Unknown Potential. Units exhibit geologic features and preservational conditions that suggest significant fossils could be present, but little information about the paleontological resources of the unit or the area is known.

Class 4 – **High**. Geologic units containing a high occurrence of significant fossils.

Class 4a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two acres.

Class 4b – These are areas underlain by geologic units with high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances. Extensive soil or vegetative cover; bedrock exposures are limited or not expected to be impacted. Areas of exposed outcrop are smaller than two contiguous acres; outcrops form cliffs of sufficient height and slope so that impacts are minimized by topographic conditions; other characteristics are present that lower the vulnerability of both known and unidentified paleontological resources.

The probability for impacting significant paleontological resources is moderate to high, and is dependent on the proposed action.

Class 5 – **Very High**. Highly fossiliferous geologic units that consistently and predictably produce vertebrate fossils or scientifically significant invertebrate or plant fossils, and that are at risk of human-caused adverse impacts or natural degradation.

Class 5a – Unit is exposed with little or no soil or vegetative cover. Outcrop areas are extensive with exposed bedrock areas often larger than two contiguous acres.

Class 5b – These are areas underlain by geologic units with very high potential but have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation due to moderating circumstances.

The probability for impacting significant fossils is high.

3.2.3 Known Paleontological Resources in the CD-C Project Area

Known paleontological resources (frequently referred to here as *fossils* or *fossil resources*) within sedimentary deposits in the project area record the history of animal and plant life in Wyoming during the early part of the Cenozoic Era (Paleocene and Eocene Epochs) and the latest part of the Mesozoic (Cretaceous Period) Era. As described above, current mapping documents six geologic deposits exposed at the surface in the project area. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene to Pleistocene) age, (2) the middle Eocene Battle Spring Formation, (3) the middle and early Eocene Green River Formation, (4) the Wasatch Formation of early Eocene age, (5) the Fort Union Formation of Paleocene age, and (6) the Lance Formation of Latest Cretaceous age.

With the exception of the Holocene deposits that are probably too young to contain fossils, all sedimentary rock units exposed in the project area are known to produce or have the potential to produce scientifically significant fossil resources. Scientifically significant fossils have been recovered from the Wasatch (Morris 1954; Honey 1988; Roehler 1972, 1991a–b, 1992a–c, 1993; Roehler *et al.* 1988), Fort Union (Rigby 1980, Winterfeld 1982), and Lance Formations (Dorf 1942, Estes 1964, Clemens 1986, Clemens *et al*. 1979, Breithaupt 1982 and 1985, Weishample 1992, Archibald 1993, Lillegraven 2002, Honey 2003) within the project area or immediately adjacent areas.

Specifically, 15 fossil localities are known to occur within the project area in the Lance Formation and 17 fossil localities are known to occur within the Fort Union Formation. The Lance Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T18N:R20W), Doty Mountain (T17N:R91–92W), Peach Orchard Flat (T15N:R91W) and Blue Gap (T15N:R91W) 7.5-minute Quadrangles. The Fort Union Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T19N:R91W), Duck Lake (T16–17N:R91-91W), Mexican Flats (T16N:R92W) and Blue Gap (T15–16N:R91–92W) 7.5-minute Quadrangles. Localities from both the Lance and Fort Union Formations produce a wide variety of fossil remains, including those of mammals, reptiles, amphibians, and fish. Of great importance is the occurrence within the Fort Union Formation of some of the oldest known Paleocene-age fossil vertebrates in the world, which are considered to be of Puercan age (earlier Paleocene) and are very rare (Honey 2003).

Literature review and the field survey documented the occurrence of known scientifically significant fossils within the CD-C area in the following formations: (1) the middle Eocene Battle Spring Formation (PFYC 3b [unknown]), (2) the middle and early Eocene Green River Formation (PFYC 5, very high), (3) the Wasatch Formation of early Eocene age (PFYC 5, very high), (4) the Fort Union Formation of Paleocene age (PFYC 3a, moderate), and (5) the Lance Formation of Latest Cretaceous age (PFYC 5, very high).

3.2.4 Taphonomy and the Occurrence of Fossils

Taphonomy is the study of the origin and nature of accumulations of fossil materials or their traces. In general, vertebrate fossils are much rarer than invertebrate fossils, but there are sites where extraordinary accumulations of fossil vertebrates are found.

Knowledge of the geologic context of vertebrate fossils collected at a site is critically important in evaluating the reason fossils occur where they do. The geological context of a deposit contains information about whether the deposit formed under marine (ocean), lacustrine (lake), or fluvial (riverine) conditions. In the project area, five geological formations have high potential for yielding fossil vertebrates. From oldest to youngest, these are: (1) the Lance Formation (Upper Cretaceous), (2) the Fort Union Formation (Paleocene), (3) the Wasatch Formation (lower Eocene), (4) the Green River Formation (middle Eocene), and (5) the Battle Spring Formation (middle Eocene). None of these formations is of marine origin, and only the Green River Formation was deposited under largely lacustrine conditions. The Lance, Fort Union, Wasatch, and Battle Spring formations are dominantly of fluvial (river, stream, and associated floodplain) origin.

In lacustrine environments, fossil vertebrate remains might accumulate in shales deposited under open-water conditions or, closer to shore, in units containing coarser clastic material. Fluvial sediments (those deposited by streams) represent two basic environments: the channel and the floodplain. Channel deposits are generally dominated by sandstone and/or gravel conglomerate, whereas floodplain sediments consist chiefly of mudstones. Because they were subjected to periodic drying during intermittent deposition, rocks comprising floodplain deposits are commonly color-variegated. The thicknesses of the colored horizons reflect the relative maturity (relative time to form) of the ancient soils (Bown and Kraus 1980a and 1980b).

In fluvial rocks, the accumulation of vertebrate material may be either active or passive. Active accumulation involves the concentration of bones by running water. All fossil vertebrate concentrations formed by active accumulation are made up of remains that have been transported after death, although they need not have been transported very far.

Passive accumulation includes all mechanisms of concentrating fossil material in fluvial environments in which the remains of the organism are not transported to a large extent after death. Examples of passive accumulation include: (1) the slow buildup of bones in quicksand deposits, (2) the preservation of remains as a result of ash-falls, and (3) the gradual accumulation of the remains of dead animals in the upper (A) horizons of soils (paleosol accumulations). Because paleosols are ubiquitous in ancient fluvial sequences, and because floodplains with forming soils occupy more than 98 percent of the area of any basinal area of fluvial accumulation, the vast majority of vertebrate fossils accumulate as part of passive paleosol accumulations (Bown and Kraus, 1981b). Paleosols, like modern soils, form between times of major (depositional) events. The amount of vertebrate remains that accumulates during these events can be staggering. If only three bones/year accumulated on a soil surface 247 acres in area, as a paleosol that formed for 50,000 years, that soil might be expected to yield 150,000 individual bones.

Lance Formation

The presence of fossil localities of scientific significance in the Lance Formation is well established and has a long history (Breithaupt 1982). One of the earliest discoveries was the remains of a horned dinosaur (ceratopsian) discovered about 15 miles southeast of Point of Rocks near the old Black Butte Stage Station in 1872. These remains were identified as the new species *Agathaumus sylvestris* by Cope in 1872 and represent the first dinosaur remains found in strata now referred to as the Lance Formation.

Within the project area, the Upper Cretaceous Lance Formation consists of up to 2,900 feet of interbedded gray sandstone and sandy mudstone, carbonaceous shale, and coal. The Lance Formation is well-known for its dinosaurian remains (Breithaupt 1982); however, the only Lance fossil vertebrates found within the project area are some rare fish and crocodilian remains, as well as a few mammal teeth collected from anthills (J.G. Honey 2003). The provenance of these remains is uncertain, but they probably came from poorly developed paleosols.

Fort Union Formation

The Fort Union Formation is exposed within the project area as up to 3,400 feet of drab mudstone, sandy mudstone, sandstone, carbonaceous shales, and coal. Fossil vertebrates—especially mammals—are well-known from Fort Union rocks in and adjoining the study area (Rigby 1980; J.G. Honey 2003), the most noteworthy localities being Swain Quarry, in Section 3, T15 N:R 92 W, and another site in the basal part of the formation discovered by J.G. Honey, the paleontologist cited in the reference above. Swain Quarry yields principally mammal teeth from a sandstone, and both that site and the new site discovered by Honey are almost certainly gradual active accumulations of bones on point bars of meandering streams. Winterfeld (1982) has recorded the occurrences of fossil vertebrates in greenish to greenish-gray Fort Union mudstones. As these deposits are relatively thin and tabular in nature, it is quite likely that they represent the "A" horizons of relatively mature damp paleosols, and are therefore *passive accumulations*.

Wasatch Formation

The Ramsey Ranch Member, Main Body of the Wasatch Formation and the Niland and Cathedral Bluffs Tongues of the Wasatch comprise bedrock exposures of the Wasatch Formation within the project area.

Numerous fossil vertebrates, invertebrates, and trace fossils are known from the Main Body throughout southern Wyoming (Granger 1916; Gazin 1952, 1956, 1962; 1965; McGrew and Roehler 1960; West 1973), including deposits previously referred to as the Knight and Almy "formations" by Veatch (1907). These fossils include somewhat more primitive forms of rodents, carnivores, early horses, artiodactyls, and condylarths than those in the stratigraphically younger Cathedral Bluffs Member and range between early to middle early Eocene (early to late Wasatchian) in age.

Fossil vertebrates are locally abundant in the Wasatch Formation, including all the subunits that comprise the formation in the project area. Fossils are most abundant where they have weathered from immature through mature paleosols. However, about 10 miles north of Baggs, Wyoming, sandstones of the Cathedral Bluff Member that interfingers with the Tipton Shale have produced fossils of 11 mammalian species including primates, condylarths, tillodonts, dinocerates, and perissodactyls (Roehler 1988) as well as the fossils of mollusks, ostracodes, and burrows, worm trails, and an unidentified tubular impression. The mollusks include very abundant shells of the gastropods *Goniabasis* and *Viviparu,s* as well as freshwater unionid bivalves. These fossil-bearing sandstones represent deposition in a delta system prograding into Lake Gosuite. West of the project area, Wasatch vertebrates are described as coming from drab, carbonaceous mudstones containing the remains of terrestrial mollusks (Savage *et al.* 1972; Gazin, 1962; Savage and Waters, 1978; Williams and Covert, 1994). These deposits appear to be damp paleosols.

Green River Formation

The Laney Shale (including LaClede and Hartt Cabin beds), Godiva Rim, Wilkins Peak (lower part only) members and Tipton (including the Scheggs and Rife beds) and Luman tongues comprise bedrock exposures of the Green River Formation within the project area (Roehler 1991a, 1991b, 1992a, 1992b, 1992c, 1993).

Apparently, the only fossils known from the Godiva Rim Member are ostracodes. The Laney Shale is quite fossil-rich in places and is well-known for its fossil fish. Fossil gastropods, bivalves, and fish are common in the LaClede Bed. Small planorbid gastropod fossils of *Gyralus militaris* are extremely abundant and widespread in one particular layer (about a foot thick) that is recognized as a stratigraphic marker bed, the Gyralus Marker Bed. Impressions of plants and insects also occur in some shales of the LaClede Bed. Stromatolites—the remains of ancient reefs—also characterize the unit. Some of the stromatolies may be as much as 25 feet high and 10 feet wide. The Hartt Cabin Bed produces abundant fossil vertebrates, mostly fish, but also reptiles and mammals, along the eastern edge of the Washakie Basin at Willow Creek.

Plant, invertebrate, and vertebrate fossils have been reported from the Wilkins Peak Member elsewhere in Wyoming (Grande 1984, 1989; Olsen 1987, 1992). Roehler (1974) noted a fossil bird locality in the member south of Rock Springs at Scrivner Butte. Another fossil bird locality occurs a few miles away in the Four J Rim Quadrangle. This locality has yielded the dissociated skeletons, including skulls, of the wading bird *Presbyornis.* The number of individual birds preserved in the layer may number into the many thousands. Hundreds of fossil flamingo bones, apparently the remains of a large nesting colony, have been collected from a locality developed in rocks of the lower part of the member at a locality discovered near Oregon Buttes in gray-green lake claystone (McGrew and Feduccia 1973). The locality was originally described as occurring in the Cathedral Bluffs Member of the Wasatch Formation, but its location in lake sediments means that the locality actually occurs in the Wilkins Peak Member.

The Scheggs Bed preserves the fossil remains of ostracodes, gastropods, such as *Goniabasis tenera* and *Viviparus* sp., and the large unionid bivalve *Lampsilis*. Fish fossils also occur abundantly along outcrops of the Scheggs Bed (Roehler 1991a, 1991b, 1992a, 1992b, 1992c, 1993). One fossil mammal locality occurs in the Scheggs Bed and this locality, discovered in an ostracodal limestone along Parnel Creek a few miles north of Rock Springs, (T24N:R102W) produced the mold of a jaw of the early horse Hyracotherium, with incisors and molar impressions. Roehler (1992c) noted that fossil fish are locally abundant in the Rife Bed in the Sand Wash and Washakie basins.

Fossils of freshwater molluscs are abundant throughout the Luman Tongue and the assemblages of fossils are commonly characterized by the large prosobranch gastropods *Goniabasis tenera* and *Viviparus* sp. and by the large unionid bivalve, *Lampsilis* sp. Fish, ostracod, and trace fossils are also common in the unit.

Battle Spring Formation

The Battle Spring Formation was named by Pipiringos (1955) for up to 3,300 feet of arkosic sandstone that "… intertongues with … the Red Desert, Niland, and Cathedral Bluffs tongues of the Wasatch Formation, and the Lumen and Tipton tongues and Laney Shale Member of the Green River Formation" (Pipiringos 1961). Love and Christiansen (1985) mapped Battle Spring rocks as far south as I-80 west of Rawlins, and included in it several hundred feet of gray, green, gold, and red mudstones, thin arkosic ribbon sandstones, and carbonaceous shales. No fossil vertebrates have been reported from Battle Spring rocks within the project area; however, bone fragments, including one of a fossil bird, were found in red mudstones (paleosols) during a reconnaissance survey for this study.

3.3 SOILS

Soils in the CD-C project area vary widely, but are predominantly formed from residuum on bedrock-controlled uplands and alluvium in playas (BLM 1999). Residuum refers to unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place. Variable average annual precipitation patterns exist across the project area, with three different precipitation gradients that range from 7 to 9, 10 to 14, and 15 to 19 inches. The project area is dominated by the 10- to 14-inch precipitation zone with the northwest corner of the project area in the 7- to 9-inch precipitation zone and a small portion in the southeast area in the 15- to 19-inch precipitation zone (Texas Resource Consultants [TRC] 1981; Wells *et al.* [Wells] 1981).

Two Order 3 soil surveys were previously completed by the BLM in cooperation with the Soil Conservation Service [now known as the Natural Resources Conservation Service, NRCS] for most of the CD-C project area (TRC 1981; Wells et al. 1981). For areas not covered by the existing soil surveys, Order 3 field mapping was completed by KC Harvey Environmental, LLC during May 2007. During the field mapping, existing soil-mapping units from the TRC and Wells 1981 surveys were extended into the unmapped areas of the project area using aerial imagery. The proposed soil map unit boundaries in the unmapped areas were then verified in the field by sampling the soils to a depth of 60 inches with a Giddings probe (Giddings Machine Company, Colorado).

A total of 387 soil complexes, associations, taxadjuncts, and variant map units occur within the 1,070,086 acres that comprise the CD-C project area. A total of 286 soil series comprise the 387 map units.

The majority of the project area is used as rangeland for domestic livestock grazing, wildlife habitat, and recreation. A small portion of the area is used for production of native hay, both irrigated and dryland, and utilization of wood for fence posts and firewood (TRC 1981; Wells *et al.* 1981). Since the 1950s, development of the area's natural gas resources has become a major land use.

3.3.1 General Description of Major Soil Types

Soils in the project area were formed from erosion of bedrock exposed at the surface and from lacustrine, alluvium, loess, and eolian deposits (BLM 1999). The parent material in the project area is dominated by tertiary shales and sandstones and uplifted cretaceous sedimentary rock (Munn and Arneson 1998). Soils on the tertiary bedrock are poorly developed with little clay accumulation. Sandy soils occur on stabilized sand dunes and in areas with active dunes. Saline soils exist in playas, and sodic soils occur on alluvial fans derived from high-sodium parent materials. The project area contains soil orders of alfisols, inceptisols, mollisols, and aridisols. All soils within the project area have a frigid temperature regime. Soil texture is a mix of fine-loamy, coarse-loamy, and sandy materials. Slopes are generally level to undulating (zero–10 percent) and are separated by areas with steeper slopes (10–40 percent) to vertical slopes (rock outcrops).

3.3.2 Soil Limitations

To assess the potential limitations of the CD-C project area soils, five areas of concern were addressed: water erosion, wind erosion, runoff potential, local road construction limitations, and reclamation potential. These were evaluated using soils information from the two soil surveys completed by the BLM (TRC 1981; Wells *et al.* 1981). Results are summarized in **Table 3.3-1** and a discussion of each category is provided below.

Information from individual soil map units was used to evaluate the soil limitations. If multiple soil series existed within a single map unit, rankings were assigned based on the soil series that comprised the greatest acreage within the unit. To provide the most unbiased ranking, assignments were made using the relative size of the included soil series rather than the most limiting or the least limiting soil series within the map unit.

To ascertain the distribution of potential soil limitations for existing natural gas disturbances, the number of current wells drilled in each of the rating class areas for each limitation was determined.

Table 3.3-1. Potential soil limitations in the CD-C project area

Potential Limitation	Rating Class/Limiting Features	Acres	% Total Area	% of Disturbance in Each Class[2]
Water Erosion	Slight	748,850	69.9	72.8
	Moderate	230,713	21.5	21.5
	Severe	45,808	4.3	3.0
	Not Rated / Water	45,552	4.3	2.8
Wind Erosion	Slight	100,534	9.4	13.6
	Moderate	859,633	80.3	77.7
	Severe	65,204	6.1	5.9
	Not Rated / Water	45,552	4.3	2.8
Runoff Potential	Low	19,686	1.8	0.5
	Low To Moderate	21,416	2.0	0.9
	Moderate	362,499	33.8	6.6
	Low to High	67,473	6.3	35.5
	Moderate to High	237,355	25.0	29.6
	High	299,336	28.0	24.6
	Not Rated / Water	33,158	3.1	2.3
Road Construction	Moderate	680,344	63.5	63.8
	Moderate / Severe	703	0.1	0.0
	Severe	348,732	32.6	33.5
	Not Rated / Water	41,145	3.8	2.7
Rationale[1]	Shallow to Bedrock	55,597	5.2	3.2
	Low Strength Soils Present	902,656	84.4	87.3
	Shrink-Swell Soils Present	8,544	0.8	1.3
	Soils Too Sandy	52,110	4.9	5.4
	Wet Conditions	9,671	0.9	0.0
	No Rationale	40,934	3.8	2.7
Reclamation Potential	Good	221,785	20.7	13.7
	Fair	269,565	25.2	26.2
	Poor	537,228	50.2	57.4
	Not Rated / Water	40,934	3.8	2.7
Reclamation Rationale[1]	High Soil Salinity Levels	449,199	42.0	54.4
	Large Stones Present	4,678	0.4	0.4
	Soils Too Clayey	288,034	26.9	23.0
	Soils Too Sandy	57,433	5.4	5.5
	Wet Conditions	4,972	0.5	0.0

[1] *For the Road Construction Limitation and Reclamation Rationale, the limiting features should not sum to the total project acreage, as a single soil could be limited by several of the features listed.*

[2] *The percentage of disturbance in each class is estimated as the percentage of current wells located in each category.*

3.3.2.1 Water Erosion

To assess the potential for soil erosion caused by water, the soil erosion factor (K) obtained from data recorded by TRC and Wells in 1981 and soil slope data were used to rank the CD-C project area soils for susceptibility to erosion. Slope data were derived from the digital elevation model for the project area. The K indicates the susceptibility of a soil to sheet and rill erosion (Institute of Water Research 2002). It is one of the six factors used in the Revised Universal Soil Loss Equation to predict the average annual rate of soil loss by water erosion. The K is based on percentage of silt, sand, organic matter, soil structure, and hydraulic conductivity. The soil-surface horizon K was used to group the project area soils into water-erosion classes.

The values for K factors and slope ranges used to group the soil into slight, moderate, and severe water-erosion classes are provided in **Table 3.3-2**. The K value and percent slope data were queried to determine the surface area relative to the slight, moderate, and severe erosion classes. These data were plotted on **Map 3.3-1** to illustrate the potential for water erosion in the CD-C project area. Overall, the susceptibility to water erosion is slight, with 748,850 acres or 69.9 percent of the project area rated as having slight water-erosion potential (**Table 3.3-1**). Only 4.3 percent of the project area, or 45,808 acres, is rated as having a severe water-erosion potential. The large percentage of area classified as having slight water-erosion potential is controlled by the flat slopes that occur throughout the project area.

Table 3.3-2. Water erosion classes determined by Erosion Factor (K) and Slope in the CD-C project area

Erosion Factor (K)	Water Erosion Class		
	Slight	Moderate	Severe
	Slope (%)		
<0.2	<20	20 to 40	>40
0.2 to 0.32	<15	15 to 35	>35
>0.32	<10	10 to 20	>20

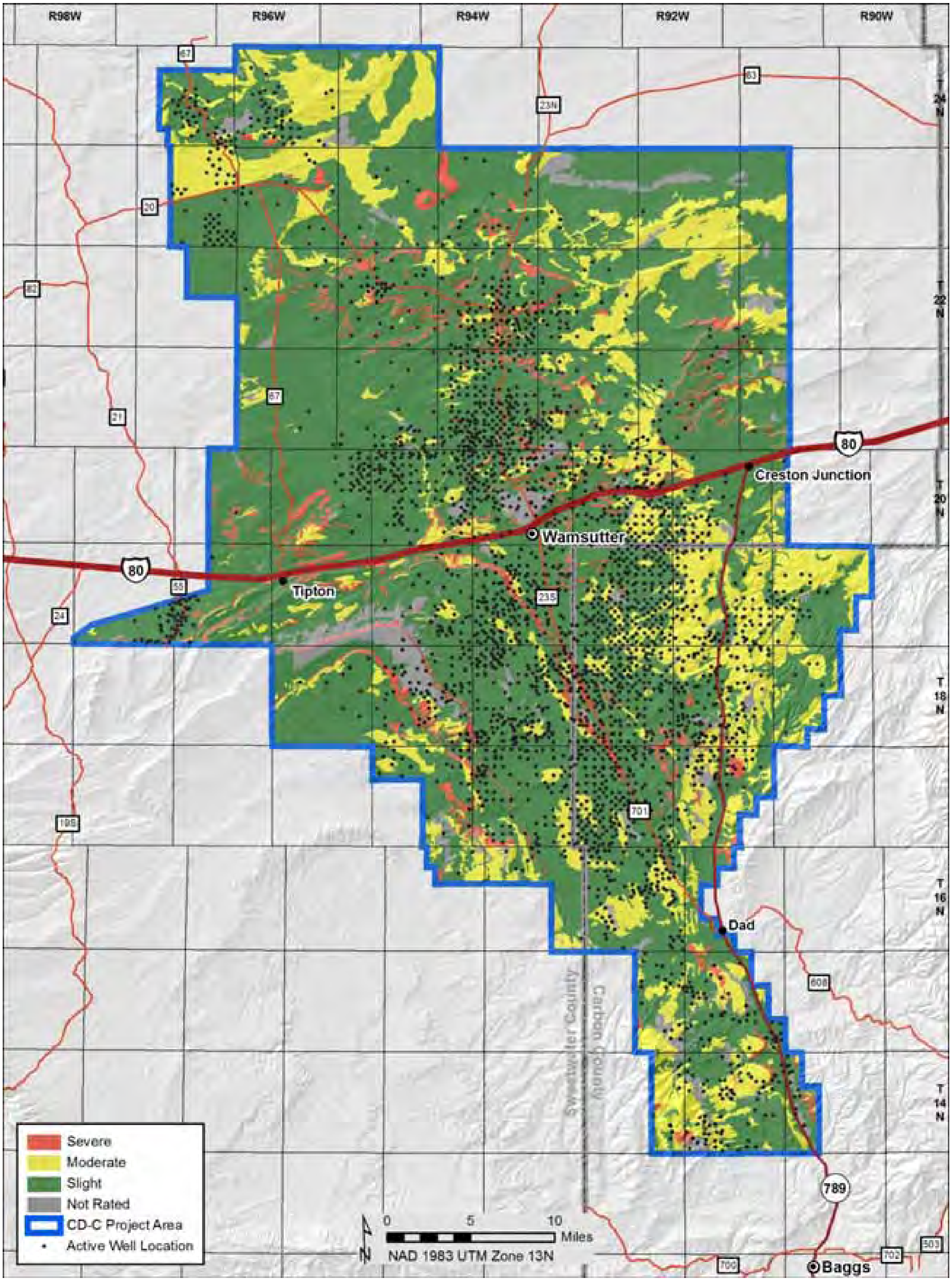
At present 72.8 percent of the total wells currently drilled within the CD-C project area are located within soils that have a slight risk for water erosion.

3.3.2.2 Wind Erosion

To assess the potential of soil erosion by wind, the wind-erodibility class was obtained from data recorded by Texas Resource Consultants (1981) and Wells *et al*. (1981). Wind-erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. Soils are grouped according to percent sand, silt, and clay; calcium carbonate content; presence of surficial coarse fragments; and surface-wetness conditions.

The potential for wind erosion in the CD-C project area is shown on **Map 3.3-2**. Soils within the 1 and 2 wind-erodibility groups are classified as a severe limitation for wind erosion; soils in the 3, 4, and 4L wind-erodibility groups are considered as a moderate limitation for wind erosion; and soils in the 5, 6, 7, and 8 wind-erodibility groups have a slight limitation for wind erosion (TRC 1981, Wells *et al.* 1981). A moderate limitation because of wind erosion exists for 80 percent of the total project area or 859,633 acres (**Table 3.3-1**). Only 9.4 percent or 100,534 acres and 6.1 percent or 65,204 acres, respectively, are rated to have slight and severe limitations to wind erosion, respectively.

At this time, 78 percent of the total wells currently drilled within the CD-C project area are located within soils that have a moderate limitation for wind erosion.



Map 3.3-1. Water-erosion potential for the CD-C project area

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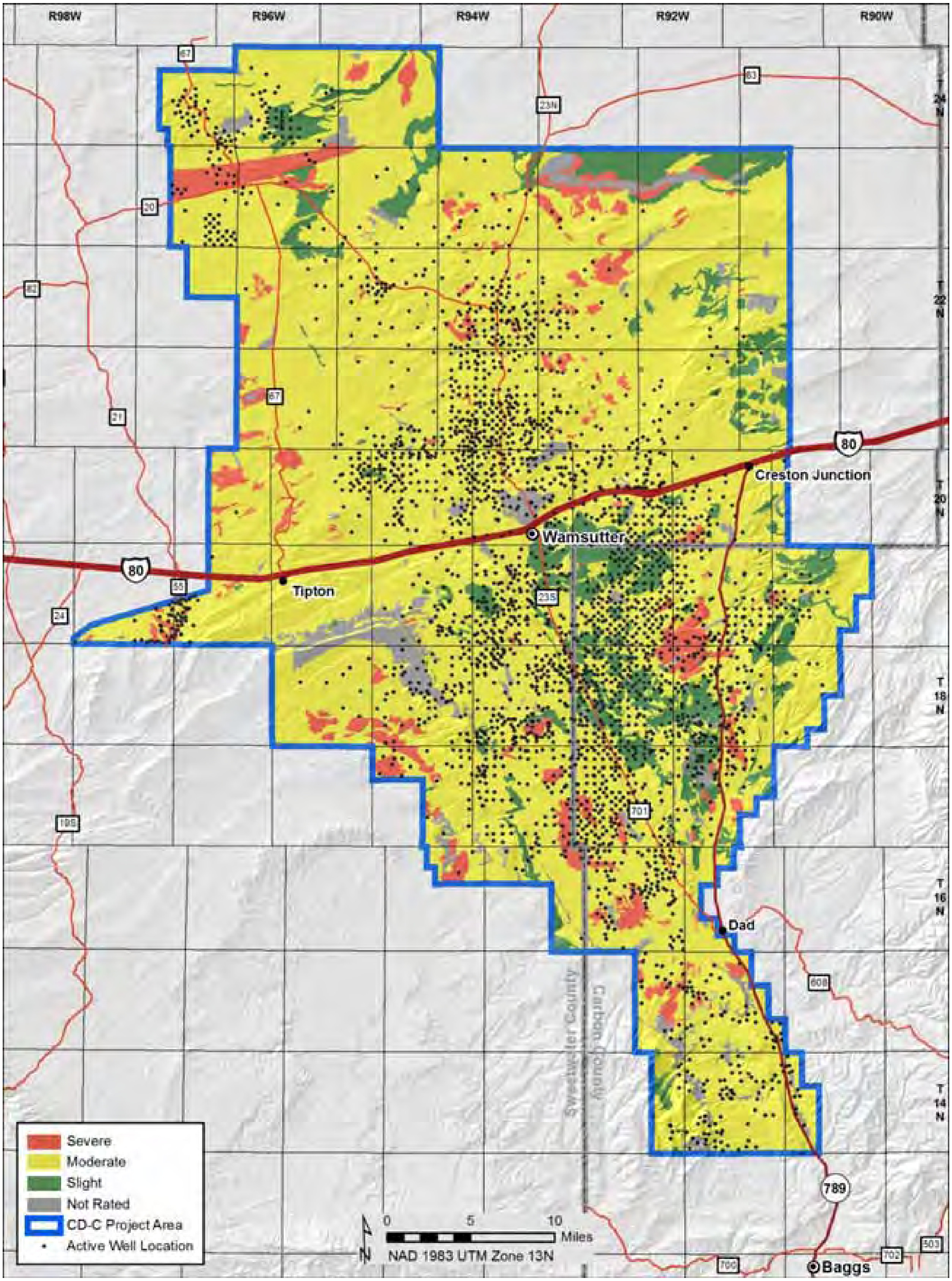


Map 3.3-2. Wind-erosion potential for the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.3.2.3 Runoff Potential

To assess the potential for surface runoff, the hydrologic soil group was obtained from Texas Resource Consultants (1981) and Wells *et al.* (1981). The hydrologic soil group classifies soils according to their runoff-producing characteristics, which include depth to the water table, infiltration rate, permeability after prolonged wetting, and depth to the lowest permeable layer. Also, site-specific factors relating to management practices are considered, such as compaction, crusting, organic matter, and vegetative cover. The hydrologic group rating only considers the potential for runoff when soils are thoroughly wet and does not consider the slope of the soil.

The potential for surface runoff in the CD-C project area is shown on **Map 3.3-3**. Soils within Hydrologic Soil Group A are considered to have a low runoff potential, Hydrologic Soil Group B soils have a moderate runoff potential, and Hydrologic Soil Groups C and D soils are considered to have a high runoff potential. Surface-runoff potential was predominantly moderate, composing 34 percent of the project area or 362,499 acres (**Table 3.3-1**). A rating of high runoff potential was given to 299,336 acres or 28 percent of the CD-C project area.

At this time, 36 percent of the total wells currently drilled within the CD-C project area are located within soils that have a moderate runoff potential.

3.3.2.4 Road Construction

To assess the degree of limitation to the construction of roads, unsurfaced road ratings were obtained from TRC (1981) and Wells *et al.* (1981). Road rankings were based on depth to bedrock, soil strength, shrink/swell potential, soil texture, large surface stones, slope, and surface wetness.

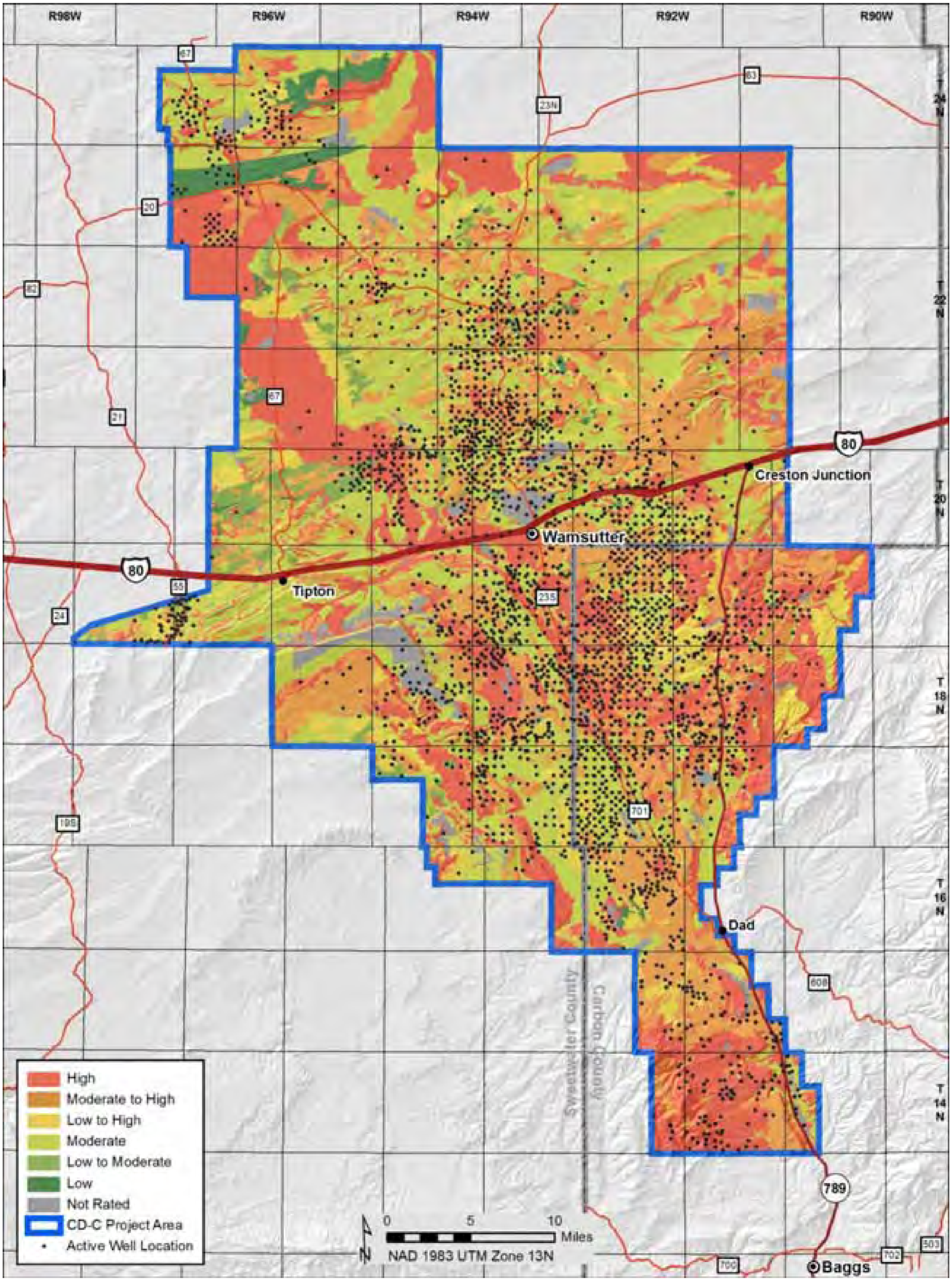
The potential limitation for the construction of roads in the CD-C project area is shown in **Map 3.3-4**. The CD-C project area is predominantly rated as having a moderate limitation for road construction, with 63.5 percent, or 680,344 acres, having this rating (**Table 3.3-1**). The limiting features to road construction are provided in Table 3.3-1. Soil strength, depth to bedrock, and sandy soil textures are the main limitations to construction in the CD-C project area.

At present, 64 percent of the total wells currently drilled within the CD-C project area are located within soils that have moderate limitations to road construction.

3.3.2.5 Reclamation Potential

Reclamation is the reconstruction of topographic, soil, and plant conditions following disturbance to allow the area to fully function as part of the ecosystem (Munshower 1994). The BLM’s long-term objective of final reclamation is to set the course for eventual ecosystem restoration, including the restoration of the natural vegetation community, hydrology, and wildlife habitats. In most cases, this means returning the land to a condition approximating or equal to that which existed prior to the disturbance. The Operator must achieve short-term stability, visual, hydrological, and productivity objectives of the surface-management agency and must take steps to ensure long-term objectives will be reached though natural processes (USDI and USDA 2006).

To determine reclamation potential of the CD-C project area soils, the topsoil rating presented in the soil surveys prepared by Texas Resource Consultants (1981) and Wells et al. (1981) was used as a direct correlation of the soil reclamation potential. Soils having good, fair, or poor topsoil ratings are classified on **Map 3.3-5** as having good, fair, and poor reclamation potential, respectively. The soil classifications defined in the soils survey are influenced by many factors such as rainfall, slope, and aspect in addition to the physical and chemical composition of the soil. The direct correlation used between topsoil rating and soil reclamation potential indirectly considers the factors that would be favorable or unfavorable for soil reclamation.



Map 3.3-3. Runoff potential in the CD-C project area

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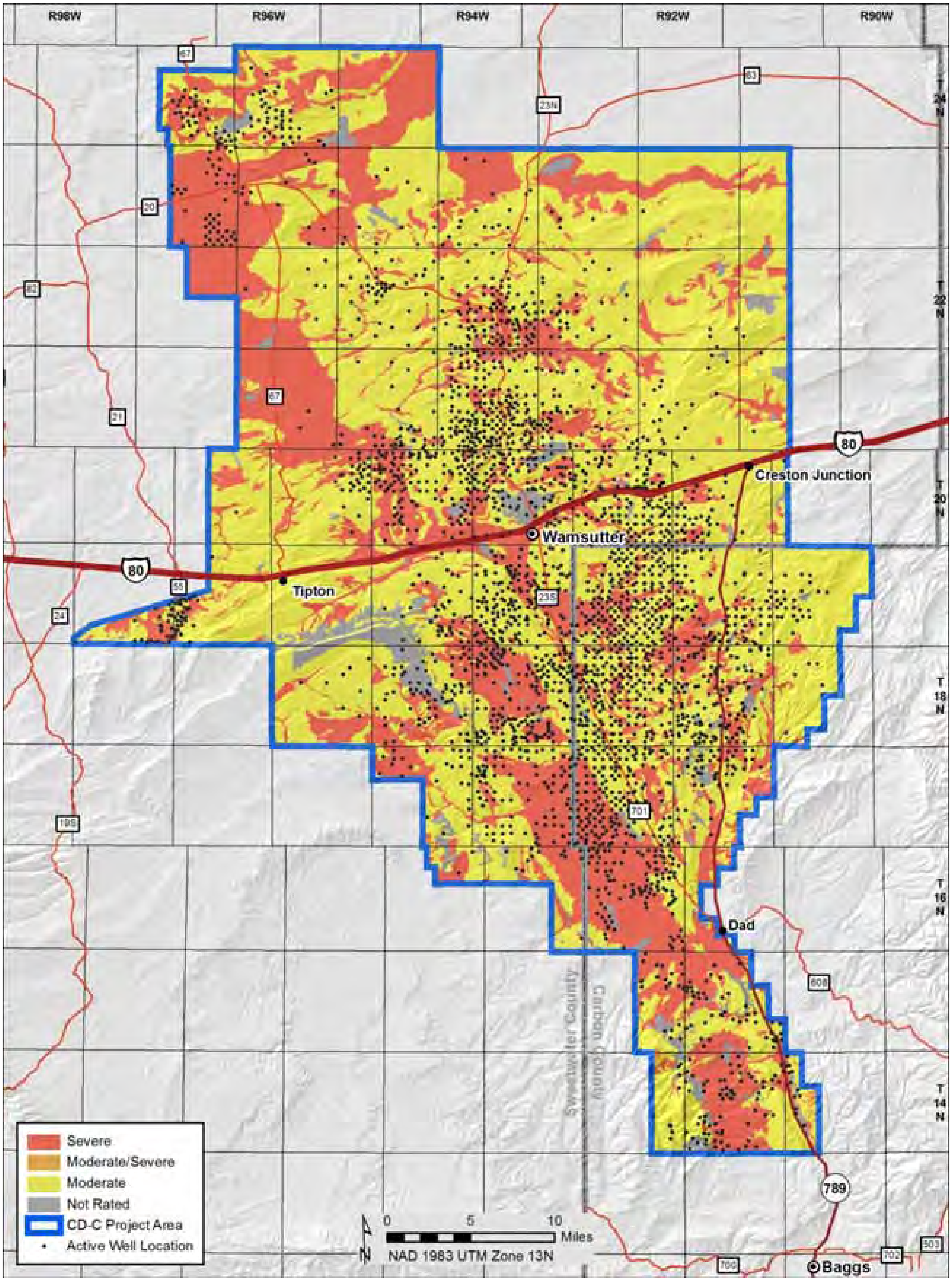

Map 3.3-4. Potential road construction limitations in the CD-C project area

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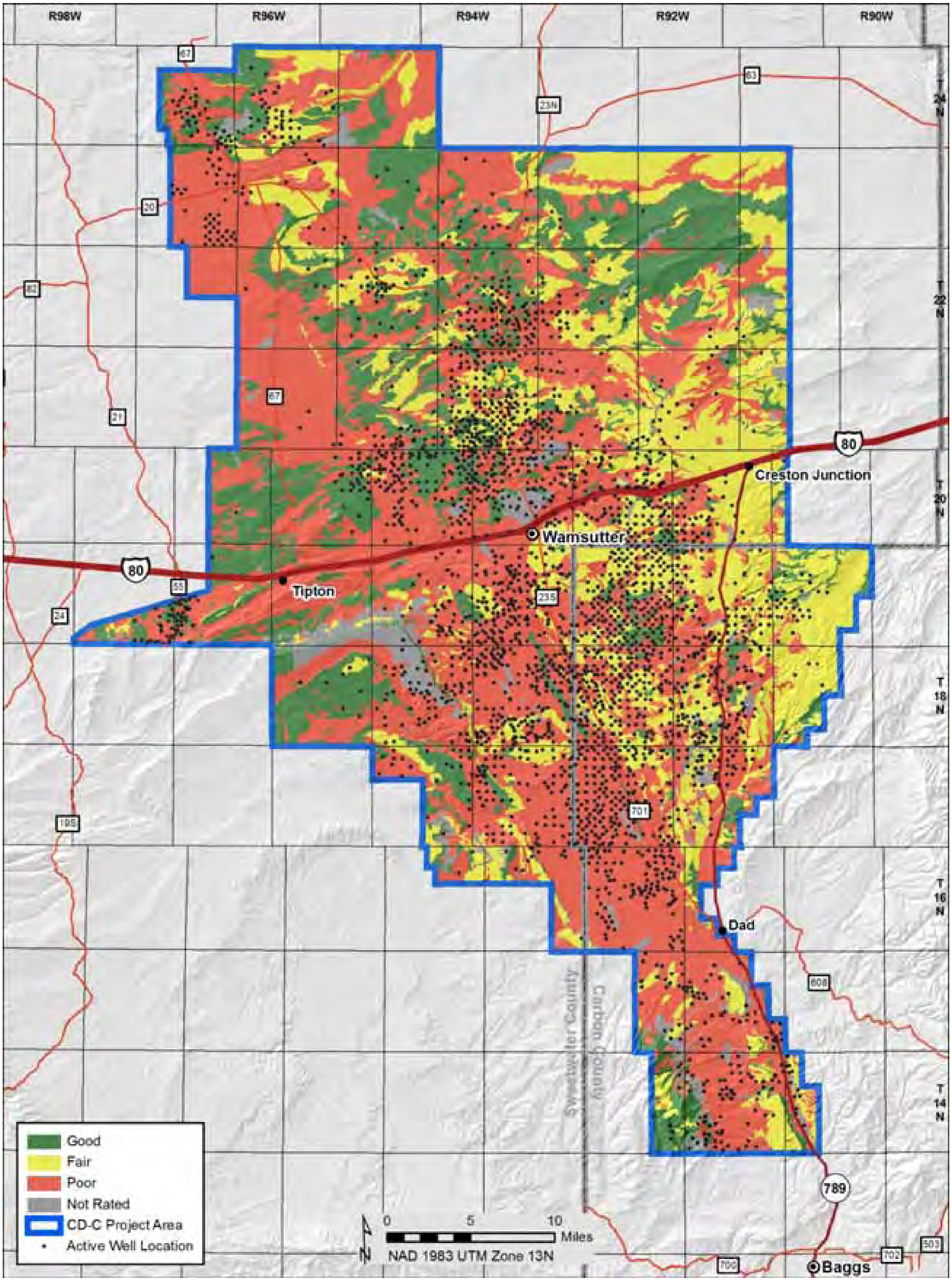

Map 3.3-5. Reclamation potential for soils in the CD-C project area

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The reclamation potential of the CD-C project area is primarily poor, with 537,228 acres or 50 percent of the total project acreage having this rating (Map 3.3-5, **Table 3.3-1**). Locations identified as "No Rating" on Map 3.3-5 generally consist of rock outcrops or rock surfaces that did not include a topsoil rating since topsoil is not present in these locations.

Rankings of fair and good were given to 25 percent or 269,565 acres, and 21 percent or 221,785 acres of the CD-C project area, respectively. The limiting features to reclamation are provided in **Table 3.3-1**. Saline/sodic soil conditions and either clayey or sandy soil textures are the main limitations to reclamation of the CD-C project area.

At this time, 57 percent of the total wells currently drilled within the CD-C project area are located within soils that have poor reclamation potential. For the currently drilled well locations with limitations to reclamation, the main limitation to reclamation is saline/sodic soil conditions.

3.3.3 Watershed-Based Land Health Assessment

In 2008 the RFO finished conducting Standards and Guidelines Assessments for all the watersheds within the field office. These are watershed-based land health assessments mandated by the Director of the BLM on a 10-year basis. From 1998 through 2000, the RFO conducted Standards and Guidelines Assessments on an allotment basis; however, in 200, in order to meet this 10-year timeframe, larger-scale watershed-based reports were undertaken. The Upper Colorado River and the Great Divide Basin were the first two watershed reports completed (2002 and 2003, respectively), and are due for reassessment over the next three years, at which time progress towards management objectives will be evaluated. Standard 1 – Watershed Health, states that "[w]ithin the potential of the ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff" (BLM 2001a). Standard 1 is considered met if upland soil cover generally exceeds 30 percent and obvious signs of soil erosion are not apparent, and if stream channels are stable and improving in morphology. Key watershed health-related issues identified by the Standards and Guidelines Assessment for the Upper Colorado River and Great Divide Basin include erosion from improved and unimproved roads, and short- and long-term erosion from oil and gas field development.

During the 2001 field season, project area watersheds within the Upper Colorado River Basin were assessed (BLM 2002). Barrel Springs Draw, a sub-watershed within the Muddy Creek watershed, and the Lower Sand Creek sub-watershed within the Little Snake River watershed, were determined to meet Standard 1. The Upper Muddy Creek and Lower Muddy Creek sub-watersheds within the Muddy Creek watershed did not meet Standard 1. Holler Draw and Chicken Springs Wash in the Upper Muddy Creek watershed (2,500 acres), and Little Robber and Cottonwood Creek in the Lower Muddy Creek watershed (6,000 acres) have large, active head-cuts caused by gradient readjustment processes; therefore, because the stream channels are not stable, these areas did not meet Standard 1.

During the 2002 field season, project area watersheds within the Great Divide Basin were assessed (BLM 2003). All sub-watersheds, including Battle Springs Flat, Buck Draw, Cyclone Draw, Latham Draw, Red Creek, Red Desert Basin, Red Wash Draw, Salt Sage Draw, and Upper Separation Creek were determined to meet Standard 1.

3.4 WATER RESOURCES

Water resources in the CD-C project area include both surface water and groundwater. A majority (approximately 70 percent) of the project area is located within the Great Divide Basin (hydrologic unit code [HUC] 14040200). Approximately 29 percent of the project area is within the White-Yampa Basin (HUC 140500) and 1 percent is within the Upper Green Basin (HUC 140401). Watershed basins within the project area are shown on **Map 3.4-1**. Surface water in the Great Divide Basin drains internally, with no surface hydrologic outlet. The Upper Green and White-Yampa watersheds are part of the Upper Colorado Basin (HUC 14).

Groundwater resources in the project area include unconfined (water table) and confined aquifers. The unconfined aquifers are generally shallow, blanket-type deposits of Quaternary or Tertiary age and are generally found within 400–600 feet of the ground surface. Alluvial deposits fall into this category. Confined aquifers are bound by relatively impermeable rocks and are generally in the deeper formations, such as the Mesaverde Group. Most of the geologic formations of pre-Oligocene age in the project area contain water under confined pressure (Welder and McGreevy 1966). Conventional oil and gas wells would be completed in the Almond Formation in the Mesaverde Group at depths between 8,000 and 12,000 feet. Coalbed natural gas (CBNG) development, if undertaken, would primarily target the Fort Union Formation with secondary reserves targeted in the Wasatch, Frontier, and Lance formations at depths between 550 and 7,700 feet.

3.4.1 Climate and Precipitation

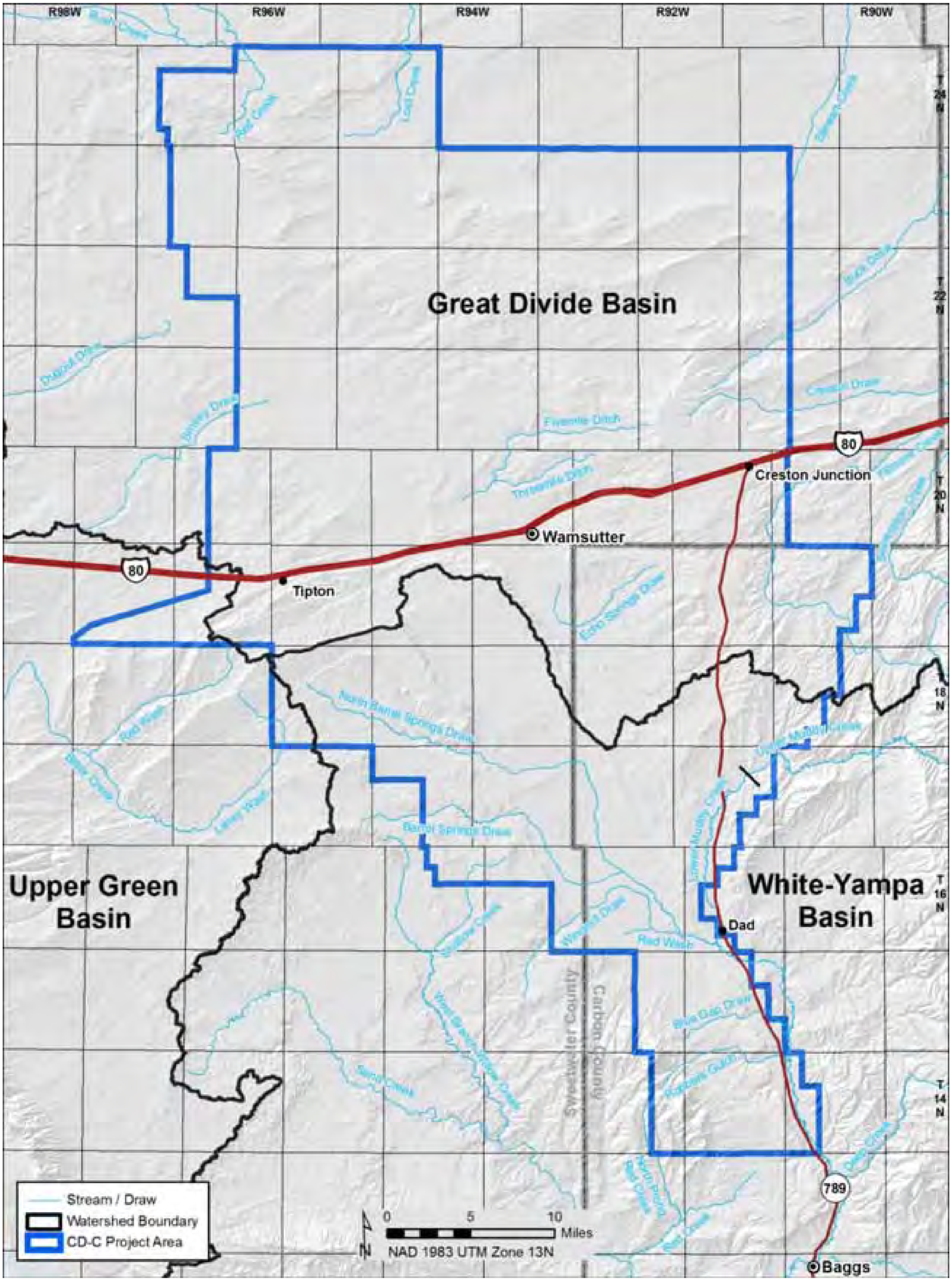
Climate and precipitation, as detailed in **Section 3.5** (**Air Quality**), greatly influence the character and condition of the surface and groundwater resources. The project area is located in a continental dry, cold-temperature-subarctic climate (Trewartha 1968). The climate is characterized by precipitation deficiency, where potential evaporation exceeds precipitation. Temperatures are generally cold, with fewer than eight months of the year having an average temperature greater than 50° F. Summer days are warm, summer nights are cool, and winters are cold. Strong and prolonged winds periodically sweep the project area throughout the year, being especially prevalent in winter.

These climatic conditions (low precipitation and high evaporation rates) result in the prevalence of surface water features in the project area with ephemeral or intermittent flows. The climatic conditions are reflected in the limited amount of shallow groundwater and the prevalence of confined aquifer systems. Recharge to the groundwater systems generally occurs at higher, distant elevations, with limited local recharge to the shallow aquifers.

3.4.2 Surface Water

There are three major drainage basins associated with the project area (**Map 3.4-1**). The Continental Divide runs east and west across the central portion of the project area. Drainages in the project area south of the Continental Divide flow into the Upper Green Basin or the White-Yampa Basin. Tributaries to Bitter Creek drain the portion of the project area within the Upper Green Basin. Bitter Creek flows to the Green River, which flows to the Colorado River, and ultimately to the Pacific Ocean. Tributaries to the Little Snake River drain the portion of the project area within the White-Yampa Basin. The Little Snake River flows to the Yampa River, which flows southwest to its confluence with the Green River in Colorado. Drainage north of the Continental Divide is contained in the Great Divide Basin. As mentioned above, the Great Divide Basin is internally drained, with no surface hydrologic outlet.

Just over 1 percent of the project area is within the Upper Green Basin. Tributaries to Bitter Creek (Red Wash and Laney Wash) begin in the project area and flow out of the area to the southwest (**Map 3.4-1**). Surface water hydrology data are limited for the portion of the project area within the Upper Green Basin due to the dry nature of the climate and resulting minimal stream-flow in the area.



Map 3.4-1. CD-C project area with watershed basins and streams

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Very small portions of the White-Yampa Basin within the project area are drained by Willow Creek/Shallow Creek (tributaries to Sand Creek) and the North Prong of Red Creek. The remainder of the White-Yampa Basin within the project area is drained by Muddy Creek and its tributaries. Muddy Creek is the dominant water feature within the project area and it flows into the perennial Little Snake River, immediately south of the project area (**Map 3.4-1**).

Most surface water flow within the Great Divide Basin is ephemeral (occurring only in response to localized rainfall or snowmelt) or intermittent (flowing water during certain times of the year, when groundwater provides water for stream flow). The only streams in the Great Divide Basin with perennial flow are the upper portion of Separation Creek, in the Atlantic Rim area, and Lost Soldier Creek, in the Green Mountain area. Lost Soldier Creek is not within the project area. A majority (approximately 85 percent) of the Great Divide Basin drainage area within the project area drains internally, not leaving the project area. Approximately 10 percent of the Great Divide Basin drainage area within the project area receives run-on from other areas in the basin (Bear Creek, Red Creek, Lost Creek, and Stewart Creek to the north, and Smiley Draw to the west). Surface water from the remaining 5 percent of the project area in the Great Divide Basin drains to the east off the project area by way of Creston Draw, Buck Draw, and Fillmore Creek, which are tributaries to Separation Creek. Major surface water features within the Great Divide Basin associated with the project area are shown on **Map 3.4-2**.

3.4.2.1 Surface Water Location and Quantity

Detailed information regarding surface water quantity within the project area is provided in **Appendix F, Water Resources Supplemental Data.** Historic flow data are available near the project area from one station on Muddy Creek (U.S. Geological Survey [USGS] Station 09259000) and one station on the Little Snake River (USGS Station 09257000). Current flow data are available from one station, monitored between 2004 and the present, on Muddy Creek (USGS Station 09258980). Historic flow data in the Great Divide Basin are available near the project area from two stations on Separation Creek (USGS Stations 09216525 and 09216527). Although all five of these stations are outside of the project area, they represent the nearest USGS flow monitoring stations.

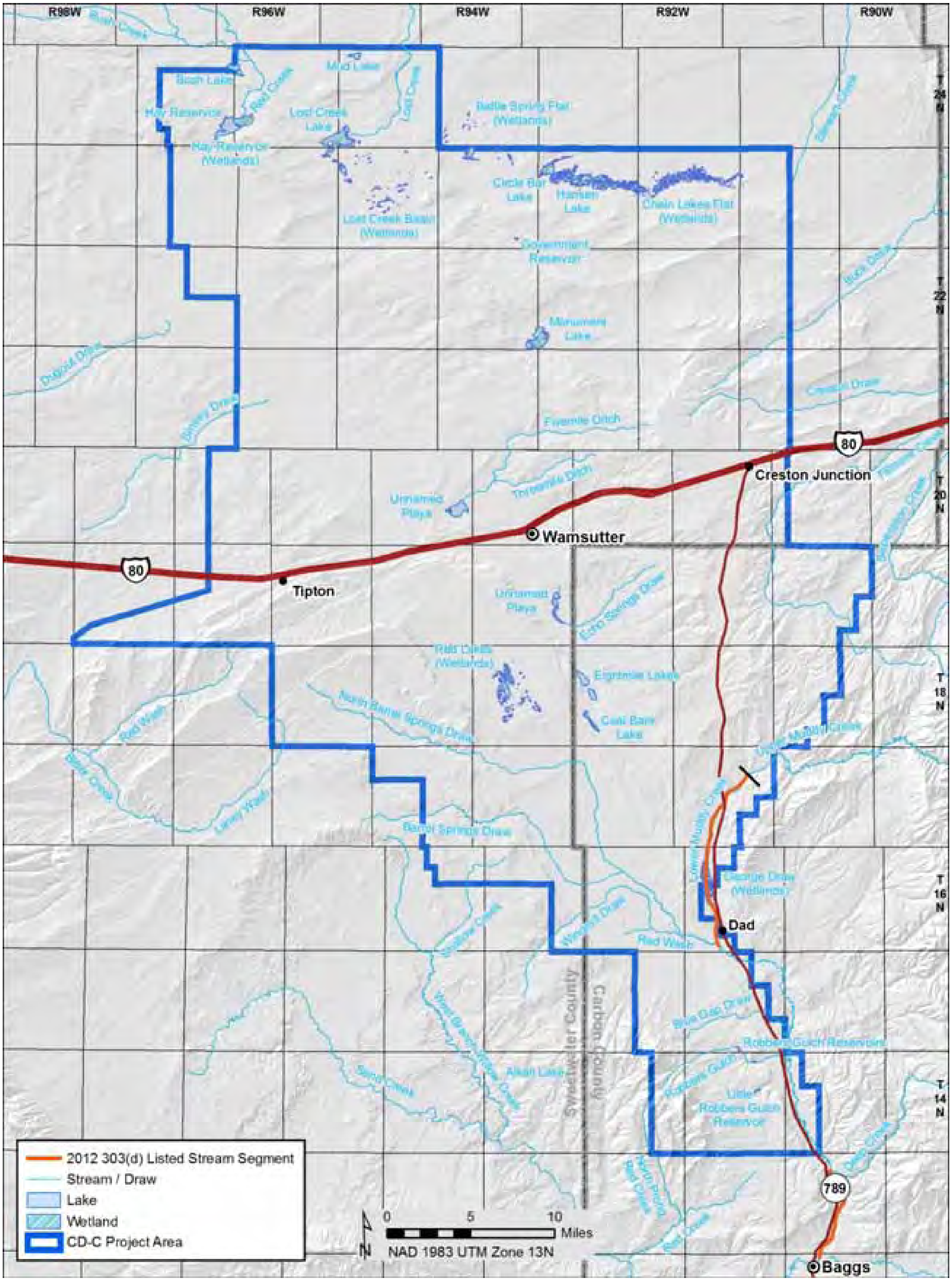
Upper Green Basin

A very small portion of the project area drains into the Upper Green Basin (**Map 3.4-1**). Less than one percent of the project area is drained by tributaries to Bitter Creek (HUC 14040105). Bitter Creek is a perennial stream that flows into the Green River approximately 50 miles west of the project area. Historical flow data (1975-1981) are available from one monitoring station on Bitter Creek (USGS Station 09216545). Flow data from this station varied widely, from zero to 333 cubic feet per second (cfs).

White-Yampa Basin

Approximately 29 percent of the project area is drained by the White-Yampa Basin (**Map 3.4-1**). Watersheds within the White-Yampa Basin that are associated with the project area include the Muddy Creek Sub-basin (HUC 14050004) and the Little Snake Sub-basin (HUC 14050003).

Muddy Creek begins in the Sierra Madre Range, east of the project area. Muddy Creek and its ephemeral tributaries, including Barrel Springs Draw (and its tributaries North Barrel Springs Draw and Windmill Draw), Blue Gap Draw, Robbers Gulch, and Red Wash, are included in this sub-basin. Muddy Creek flows west to Wyoming State Highway (WY) 789, where it enters the project area. It then flows south, meandering in and out of the project area, to its confluence with the Little Snake River near Baggs, Wyoming, approximately 6 miles south of the project area (**Map 3.4-1**). The Muddy Creek watershed encompasses approximately 1,200 square miles (mi^2) and ranges in elevation from about 6,300 to about 8,200 feet.



Map 3.4-2. CD-C project area surface water features

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Muddy Creek is a high-elevation, cold-desert stream. Streamflow varies with location along the drainage. Muddy Creek exhibits perennial flow for the majority of its length, and in some years flows intermittently because of irrigation water removal south of the George Dew/Red Wash wetlands complex. In years with high runoff amounts, Muddy Creek flows perennially throughout its length. Snowmelt (typically March to mid-June) produces significant runoff from higher elevations of the watershed, east of the project area. The intermittent stream flow that is present in some reaches below the George Dew/Red Wash wetlands complex is due to contributions from springs, seeps, and flowing wells. High-flow events can occur in response to precipitation events during the summer and fall months.

Flow in the tributaries to Muddy Creek is predominantly ephemeral, responding to localized snowmelt and rainfall events, but tributaries may also experience some intermittent flow due to contributions from springs and seeps. Tributary channels are generally dry and prone to flashy, periodic flood events from isolated thunderstorm systems from May to October.

Beatty (2005) divided Muddy Creek into two major segments: upper Muddy Creek and lower Muddy Creek (**Map 3.4-1**). The upper segment is identified as that portion of the watershed upstream of a large headcut stabilization structure that is located in Section 11, T17N: R92W. This structure is located just downstream of where Muddy Creek crosses the ARPA boundary and just upstream of where Muddy Creek crosses WY 789 (Map 3.4-1). The four primary tributaries mentioned above are within the lower segment, which extends from the large headcut stabilization structure to the Little Snake River confluence. Lower Muddy Creek is highly erosional and has abundant channel incisions (Beatty 2005). Channel substrates in the lower segment consist of very fine-grained sediments (sands, silts, and clays). A large wetland complex (George Dew/Red Wash) occurs on the reach of Muddy Creek that lies west of WY 789 (**Map 3.4-2**). This wetland area consists of impoundments, artificially constructed channels, vertical drop structures, headgate structures for water diversion, overflow spillways, and a braided stream-channel network.

The historical mean flow rates at two USGS Stations (09259000 and 09258980) on Muddy Creek near Baggs were 14.8 cubic feet per second (cfs) and 18.0 cfs, respectively. Calculated median flows at the same two stations were 2.8 cfs and 1.1 cfs (USGS 2011a). Median flows are generally more representative of the central tendency of the data because outliers (highest and lowest flow rates) can dramatically impact the average whereas the median is less affected. Because precipitation varies significantly from year to year, annual runoff values can vary significantly. Based on the 1,200 mi^2 drainage area and a 2004-2010 average annual runoff of 14,360 acre feet per year, the unit runoff for the Muddy Creek at USGS Station 09258980 is about 0.2 inch per year (USGS 2011a).

The Upper Muddy Creek Watershed/Grizzly Wildlife Habitat Management Area (Grizzly WHMA) is located primarily east of the CD-C project area (**Map 3.9**-5). The western-most portion of the Grizzly WHMA lies within the CD-C project area. The WHMA consists of 59,477 acres of public lands surface in a checkerboard pattern. The goal of the WHMA is to “manage habitat for the Colorado River fish species unique to the Muddy Creek watershed” (BLM 2008a). In the Grizzly WHMA, the WGFD has been working with the BLM, the grazing permittee, and the Little Snake River Conservation District (LSRCD) to implement similar measures. According to the Rawlins RMP, the area is open to oil and gas leasing with intensive management of surface-disturbing and disruptive activities (BLM 2008a).

Willow Creek/Shallow Creek (tributaries to Sand Creek) and the North Prong of Red Creek are drainages in the Little Snake Sub-basin that drain a small portion of the project area. Sand Creek and the North Prong of Red Creek flow into the Little Snake River approximately 8 miles from the southwest corner of the project area boundary (**Map 3.4-1**). Willow Creek/Shallow Creek and the North Prong of Red Creek are unclassified ephemeral drainages. No flow data are available for Willow Creek or the North Prong of Red Creek. The Little Snake River originates in the Sierra Madre Range and flows southwest into Colorado. The historical (1910–1923 and 1938–1971) mean flow rate at USGS Station 09259000 on the Little Snake River near Dixon was 514.3 cfs. Calculated median flow at the same station was 100.0 cfs

(USGS 2011a). Because precipitation varies significantly from year to year, annual runoff values can vary significantly. Based on the 988 mi^2 drainage area above USGS Station 0925700 and a 1911-1971 average annual runoff of 372,355 acre feet per year, the unit runoff for the Little Snake River at USGS Station 09257000 is about 7.1 inches per year (USGS 2011a).

Great Divide Basin

The northern 70 percent of the project area is within the Great Divide Basin, a closed basin that is bounded by the Continental Divide on all sides and has no surface hydrologic outlet (USGS 1976; Seaber et al. 1987). The Great Divide Basin is a relatively shallow depression with isolated buttes, pan-like depressions, and sparse vegetation. In general, streams within the Great Divide Basin are ephemeral, but can be intermittent in sections (Lowham et al. 1976). The only streams in the Great Divide Basin with perennial flow are the upper portion of Separation Creek, in the Atlantic Rim area and Lost Soldier Creek, in the Green Mountain area. Numerous ephemeral streams flow toward the center of the Basin and terminate in natural or artificially constructed impoundments or disappear due to losses to diversions, evaporation, and/or infiltration (seepage). There are some spring-fed systems such as the Battle Springs Flat and unique alkaline wetland systems around Chain Lakes. Since a majority of the project area is within the Great Divide basin and since it is a closed basin, a majority of the surface water flow originating in the CD-C project area terminates within the project boundary.

The Chain Lakes wetlands are located in the north central portion of the CD-C project area (**Map 3.4-2**). They are managed cooperatively by the WGFD and BLM as the Chain Lakes WHMA. The Chain Lakes WHMA consists of 30,560 acres of public lands in a checkerboard pattern. This area is one of the lowest topographic regions (6,500 feet in elevation) within the Great Divide Basin, resulting in numerous shallow lakes that are alkaline due to the lack of external water outlets. The annual precipitation of less than 7 inches, high evaporative loss rates, and surface salt crusting also contribute to shaping this community. The lakes and adjacent moist soils support a variety of plant and animal species adapted to this environment. The goal of the Chain Lakes WHMA is to "*manage the unique, fragile, and rare alkaline desert lake system and wildlife habitat values associated with the lake system*" (BLM 2008a). According to the approved Rawlins Resource Management Plan (RMP), the area is open to oil and gas leasing with intensive management of surface disturbing and disruptive activities (BLM 2008a).

While a majority of the surface water flow originating in the project area terminates within the project boundary, the majority of surface water leaving the project area in the Great Divide Basin flows into Separation Creek via Fillmore Creek and Creston Draw. Separation Creek flows adjacent to and east of the CD-C project area to Separation Lake. Separation Creek is, for most of its length, an ephemeral stream. It exhibits perennial flow in its upper reaches. Average flows documented at the two stations near Riner are 1.3 to 1.8 cfs. Estimated annual runoff volume for downstream reaches of Separation Creek is 2,500 acre-feet (Larson and Zimmerman 1981). Fillmore Creek is an ephemeral stream (WDEQ 2001) that flows only in response to snowmelt or rainstorms, with snowmelt as the biggest contributor. Springs provide minor flow in the upstream reaches.

Several other small ephemeral streams flow out of the project area but also have no outlets from the Great Divide Basin.

Reservoirs, Lakes, and Ponds

According to the Wyoming State Engineer's Office (SEO) database, there are 286 reservoirs with valid water rights within the project area (SEO 2011). Approximately 96 percent (274) of these water bodies have an appropriated use of stock. Major reservoirs within the CD-C project area are shown on **Map 3.4-2**. A complete list of valid surface-water rights associated with reservoirs, lakes, and ponds is included in **Appendix F, Water Resources Supplemental Data.**

Wetlands

Wetlands are aquatic features defined as "*those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas*" (33 CFR 328.3(b)). The prolonged presence of water creates conditions that favor the growth of specially adapted plants and promote the development of characteristic wetland (hydric) soils (EPA 2007). Vegetation in wetland environments is highly productive and diverse and provides habitat for many wildlife species. These systems as a whole play important roles in controlling floodwaters, recharging groundwater, and filtering pollutants (Niering 1985).

The U.S. Army Corps of Engineers (USACE) administers a regulatory program under Section 404 of the Clean Water Act (CWA), which requires a permit for the discharge of dredged or fill materials into Waters of the U.S. (WoUS), including jurisdictional wetlands. This regulatory program requires that an inventory of all WoUS, including wetlands, be performed; permits be acquired prior to dredging or filling jurisdictional wetlands; and impacts to jurisdictional wetlands and Other Waters of the U.S. (OWUS) be adequately mitigated.

Formal wetland delineations have not been confirmed by the USACE for the project area. A preliminary evaluation of potential wetlands within the project area was completed using National Wetland Inventory (NWI) mapping. According to the NWI mapping, prominent natural wetland systems are found near internally drained sub basins in the northern portion of the project area within the Great Divide Basin (Hay Reservoir area, Lost Creek Basin, Battle Springs Flat, and Chain Lakes Flat) and artificially constructed/enhanced wetlands occur along Muddy Creek (George Dew/Red Wash wetland complex) in the southern portion of the project area (**Map 3.4-2**). There are also a large number of small wetlands linked to natural or artificially constructed impoundments throughout the project area. The vegetation types associated with riparian/wetlands habitats are discussed in **Section 3.6.2.9**.

3.4.2.2 Surface Water Use

As of February 2011, the SEO had a total of 383 permitted surface water rights on record within and 1 mile adjacent to the project area (SEO 2011). Stock use was associated with 334 of the surface water rights. Surface water rights were also associated with irrigation (39), wetlands and fisheries (30), miscellaneous (13), reservoir supply (12), industrial/oil (10), domestic (7), temporary use (4), flow through non-consumptive (2), wildlife (2), flood control (1), recreation (1), and unspecified (1). The total for permitted uses exceeds the number of permitted surface water rights due to the fact that many of the surface water rights were permitted for multiple uses. A complete list of valid surface-water rights is included in **Appendix F.**

WDEQ classifies Wyoming surface water resources according to the water body's use designation. More detailed information regarding surface-water use classifications are presented in **Appendix F**.

Ten lakes and reservoirs within the project area are classified for use by WDEQ (**Map 3.4-2**). None of the lakes or reservoirs in the project area are classified for *outstanding value* (Class 1). The highest classification on lakes and reservoirs within the project area is *drinking water* (Class 2AB). One reservoir (Little Robbers Gulch Reservoir) is within this classification. The highest classification for five of the lakes/reservoirs is *fish consumption* (Class 3A). The highest use classification for the remaining four water bodies is *other aquatic life* (Class 3B).

Seventeen streams and springs within the project area and two near the project area are classified by the WDEQ. None of the streams in or near the project area are classified for *outstanding use* (Class 1). The Little Snake River, located near the project area, is classified for use as *drinking wate*r (2AB). The highest classification for two streams within or near the project area is *non-game fish* (2C). The highest classification for 14 of the 19 streams/springs is *other aquatic life* (Class 3B). The highest classification for the remaining two streams is for *non-aquatic life use* (Class 4B/C).

3.4.2.3 Surface Water Quality

In the arid high plains of southwestern Wyoming, surface-water quality, like stream flow, is variable both spatially and temporally. Perennial stream water is generally of better quality than that of the ephemeral and intermittent streams. The quality of runoff is largely dependent upon the amount of salts, sediments, and organic materials that accumulate in dry stream channels between periods of runoff. Factors that can govern the amount of buildup of these materials are a basin's physical characteristics, land uses, and season of the year. More detailed information regarding water quality is presented in **Appendix F**.

According to **Section 3.3 Soils**, the project area contains many types of topsoil that are saline or sodic. These soils, when eroded as a result of runoff events, can make salt available for dissolution into surface waters. Approximately 70 percent of the entire project area was rated as having slight water erosion potential, approximately 22 percent had moderate water erosion potential, and just over 4 percent had severe water erosion potential (the remaining 4 percent was not rated). Nearly 73 percent of existing project area disturbance is located on lands with slight water erosion potential, nearly 22 percent on lands with moderate water erosion potential, and 3 percent on lands with severe water erosion potential (the remaining 3 percent was not rated) (**Section 3.3.2 Soil Limitations**).

Various federal and state agencies (e.g., USGS, BLM, EPA, and WDEQ) have monitored surface-water quality in and around the project area. Surface water samples have been analyzed for physical and chemical properties, salinity, and major ions. From this pool of existing water quality data, representative surface-water quality data were selected for inclusion in this EIS based on selecting sites on significant surface water courses and the availability of multiple samples from a particular site. Surface water quality data were evaluated from ten water-quality monitoring stations. Detailed information regarding surface-water quality within the project area is provided in **Appendix F**.

Surface water quality information in the Upper Green and White-Yampa sub-basin is available near the project area from two stations on the Little Snake River (USGS Stations 09257000 and 09259050), four stations on Muddy Creek (USGS stations 09258900, 09258050, 09258980, and 09259000), one station on Lower Barrel Springs Draw (USGS Station 09216310), and one station on Bitter Creek (USGS Station 09216545). Six of the seven sampling stations in the Upper Green and White-Yampa sub-basin are outside of the project area but indicate water quality of streams leaving the project area. Historic surface-water quality data in the Great Divide Basin are available for Fillmore Creek (USGS Station 09219240), the Chain Lakes (Station 481), and Separation Creek (USGS Station 09216527). The first two sampling stations listed are within the project area. Separation Creek is adjacent to and east of the project area.

Baseline Water Quality Data

Baseline surface-water quality data at selected sites associated with the project area are presented in **Table 3.4-1**.

Table 3.4-1. Surface-water quality at selected sites associated with the CD-C project area

	Number of Samples[2]	Ph, Standard Units	Conductance, µmhos/cm (Mean)	Conductance, µmhos/cm (Min)	Conductance, µmhos/cm (Max)	TDS (Mean)	TDS (Minimum)	TDS (Maximum)	Suspended Solids[3] (Mean)	Suspended solids[3] (Minimum)	Suspended Solids[3] (Maximum)	Turbidity, NTU (Mean)	Calcium (Mean)	Magnesium (Mean)	Potassium (Mean)	Sodium (Mean)	Bicarbonate (Mean)	Sulfate (Mean)	Chloride (Mean)	Iron, µmhos/cm g/L (Mean)	Hardness ($CaCO_3$) (Mean)	Dissolved Oxygen (Mean)
Little Snake River (09257000)	107	8.1	259$_{(34)}$	82	460	158$_{(9)}$	46	260	154$_{(101)}$	4	1,180	13	30	8	2	11	159	25	3	74	111	9
Little Snake River (09259050)	100	8.1	366$_{(90)}$	87	855	243$_{(17)}$	87	540	228$_{(25)}$	6	852	167	34	12	2	26	190	54	2	164	151	10
Muddy Creek [1] (09258050)	19	8.2	879$_{(15)}$	570	1,170	1,460	395	897	256$_{(12)}$	12	1,370	56	95	39	4	43	nm	270	10	1,460	399	9.2
Muddy Creek (09258900)	3	8.6	1,350$_{(2)}$	600	2,100	913$_{(2)}$	396	1,430	6,198$_{(2)}$	195	12,200	1,260	54	44	7	200	373	380	65	105	315	11
Muddy Creek (09259000)	41	8.2	966$_{(35)}$	529	1,790	346$_{(1)}$	346	346	3,191$_{(41)}$	7	22,500	nm	42	40	9	286	308	320	32	nm	270	10
Muddy Creek [1] (09258980)	76	8.3	1,763$_{(76)}$	448	3,990	1,229$_{(65)}$	267	2,810	324$_{(62)}$	13	2,530	55	82	53	5	257	nm	516	115	30	422	10
Lower Barrel Springs Draw (09216310)	7	8.4	533$_{(4)}$	340	1,000	619$_{(1)}$	619	619	nm	nm	nm	17	28	2	5	205	500	100	12	nm	80	5.2
Bitter Creek (09216545)	155	8.4	1,755$_{(149)}$	280	4,500	1,289$_{(78)}$	295	2,740	1,843$_{(105)}$	22	21,900	305	40	27	3	348	369	590	39	103	211	9.7
Upper Fillmore Creek (09219240)	1	7.7	700$_{(1)}$	700	700	495$_{(1)}$	495	495	141$_{(1)}$	141	141	984	32	68	7	22	68	320	12	210	nm	5
Separation Creek (09216527)	45	8.2	1,089$_{(39)}$	220	2,390	200$_{(1)}$	200	200	490$_{(1)}$	490	490	131	74	69	6	80	277	385	13	76	467	8.2
Chain Lakes, Hansen Lake (481)	15	9.1	4,502$_{(7)}$	1,800	11,350	4,465$_{(8)}$	1,304	11,289	423	15	956	nm	13	8	13	1,604	1,400	1,139	342	17,090	67	6.4

[1] Daily mean values analyzed through February 14, 2012.
[2] Total number of grab samples analyzed; not every parameter was analyzed in every sample.
[3] Total concentration; except as noted here, all reported values represent dissolved concentrations.

NTU = Nephelometric Turbidity Units.

nm = Not measured.
(34) - Number of samples analyzed for that parameter.
All units are mg/L except as noted.

Source: WRDS 2007, USGS 2012

Surface water quality information in the Muddy Creek watershed was examined for this EIS at Muddy Creek (USGS Stations 09258050, 09258980, 09259000, and 09259050 stations) and Lower Barrel Springs Draw (USGS Station 09216310). The water quality was variable both spatially and temporally. Muddy Creek water quality was characterized by moderate conductance and total dissolved solids (TDS) concentrations. The predominant ions were sodium, sulfate, and bicarbonate. Lower Barrel Springs Draw had moderate conductance and TDS values.

Water quality in the Little Snake River was characterized (based on analysis at USGS Stations 09257000 and 09259050) by low conductance and TDS concentrations. The water type was calcium bicarbonate.

Water quality in the Bitter Creek watershed (based on analysis at USGS Station 09216545) was variable. Conductance and TDS values for Bitter Creek tended to be higher than those levels seen at the other stations.

Water quality in the Great Divide Basin was examined at three stations. Upper Fillmore Creek (USGS Station 09219240) had low conductance and TDS levels. Separation Creek (USGS Station 09216527) had variable conductance. TDS concentrations in Separation Creek were low. The Chain Lakes/Hansen Lake (WDEQ 481) had high conductance and high TDS levels.

Surface waters associated with the project area had moderately to highly basic pH (7.7 to 9.1). Dissolved oxygen concentrations were moderate (5.2 to 11). Hardness values varied between soft in the Chain Lakes (67 mg/L $CaCO_3$) to hard in Separation Creek (467 mg/L $CaCO_3$). Alkalinity (as expressed as bicarbonate) varied from 68 mg/L in upper Fillmore Creek to 1,400 mg/L in Chain Lakes.

Suspended solids concentrations were typically high in Muddy Creek and Bitter Creek. Suspended sediment concentrations, like TDS concentrations, were greater in the ephemeral and intermittent streams than the perennial Little Snake River. The mean suspended solid concentrations in the Great Divide Basin ranged between 141 mg/L (Upper Fillmore Creek) and 490 mg/L (Separation Creek).

Turbidity values were consistent with the suspended solids concentrations. Muddy Creek and Bitter Creek had turbidity of up to 1,260 and 305 nephelometric turbidity units (NTUs). The Little Snake River showed turbidity of up to 167 NTUs. Lower Barrel Springs Draw and Upper Fillmore Creek showed turbidity less than 100 NTUs. Turbidity at Separation Creek was 131 NTUs.

The ionic composition of the various surface water bodies associated with the project area was variable. Major ion characterization of each surface water sample was compared. Bicarbonate was the dominant anion (negatively charged ion) in the Little Snake River, Lower Barrel Springs Draw, and the Chain Lakes. Sulfate was the dominant anion in Muddy Creek, Bitter Creek, Upper Fillmore Creek, and Separation Creek. Chloride was not dominant in any of the samples. Calcium was the dominant cation (positively charged ion) in the Little Snake River. Sodium was the dominant cation in Muddy Creek, Lower Barrel Springs, Bitter Creek, the Chain Lakes, and Separation Creek. Magnesium was high in Upper Fillmore Creek.

Irrigation suitability of the streams as a function of sodium-adsorption ratio and salinity was examined for each stream sample. The Little Snake River, Muddy Creek, Lower Barrel Springs Draw, and Upper Fillmore Creek are in the C1-S2 category. C1-S2-categorized water can be used for all crops and soils where salt toxicity is concerned; however, the sodium may cause clay particles in irrigated soils to swell and disperse and thereby reduce the soil infiltration rate. Bitter Creek and Separation Creek are in the C2-S1 category. C2-S1 water should be used with caution on moderately salt tolerant crops and should not be used on salt sensitive crops. Water from the Chain Lakes is categorized as C3-S2 water, indicating that crop production would suffer greatly if it were used for irrigation.

Based on average values, Muddy Creek was moderately suitable as an irrigation-water supply where flows are available. The George Dew/Red Wash wetland complex is the primary location where Muddy Creek is used for irrigation (the wetland complex is formed by spreader dikes along Muddy Creek) (**Maps**

3.4-2 and **3.9-5**). This area is primarily used for cattle and there is a diversion for small-scale bottomland irrigation along Muddy Creek.

Salinity has become a major concern within the Colorado River drainage basin. The 1972 Clean Water Act required the establishment of numeric criteria for salinity for the Colorado River and in 1973, seven Colorado River basin states created the Colorado River Basin Salinity Control Forum. The Forum developed water quality standards for salinity including numeric criteria and a basin-wide plan of implementation. The plan consists of a number of control measures to be implemented by State and Federal agencies. In 1974, Congress enacted the Colorado River Basin Salinity Control Act. The Act was amended in 1984 to require the Secretary of Interior to develop a comprehensive program to minimize contributions from lands administered by the BLM.

Selenium, like mercury and other metals, bioaccumulates in organisms at each trophic level. Aquatic life is exposed to selenium primarily through diet. Unlike mercury or PCBs, concentrations of selenium do not increase significantly in animals at each level of the food chain going from prey to predator (EPA 2011b). The core regulatory guidelines for aquatic selenium pollution in the United States are the Aquatic Life Water Quality Criteria (Aquatic Life Criteria) derived by the U.S. Environmental Protection Agency (EPA) pursuant to the Clean Water Act (CWA) of 1977. The current aquatic life chronic criterion for selenium set by the EPA and WDEQ is 5 µg/L (EPA 2011b and WDEQ 2001).

3.4.2.4 Water Bodies with Impairments or Threats

The WDEQ evaluates streams periodically to determine what streams are threatened or impaired relative to the use classification. The current threatened and impaired streams are listed in Wyoming's 2012 305(b) Water Quality Assessment Report (WDEQ 2012). According to the assessment report, a portion of Muddy Creek (west of WY 789) is listed as threatened. No other surface water bodies in the project area are listed as threatened or impaired, although one other segment of Muddy Creek outside of the project area is listed as impaired due to exceedances of chloride and selenium criteria.

According to WDEQ (2012), "*Unstable stream channels and loss of riparian function have been identified as problems in much of the Muddy Creek Sub-basin*," in reference to Muddy Creek. The LSRCD, working through a Coordinated Resource Management (CRM) process with the BLM, landowners, grazing permittees, WGFD, and other stakeholders, addressed these water quality and riparian habitat problems. As part of the CRM process, LSRCD managed several Section 319 watershed improvement projects in the upper Muddy Creek drainage. Implementation measures included upland water development, cross fencing, and vegetation and grazing management. While the CRM process is no longer formally in place, the beneficial effects are still being realized.

Within the project area, several projects have been designed for Muddy Creek to address physical (riparian condition and bank stability) degradation of the stream channel, which threatens its aquatic life support. Upstream of the project area reclamation measures included planting a variety of woody riparian vegetation to help stabilize streambanks, removal of a culvert on Muddy Creek, and restoration of 0.75 mile of Muddy Creek in the upper watershed. According to WDEQ, results of this project showed considerable improvement to stream stability, aquatic habitat and riparian health, especially in the upper Muddy Creek tributaries (WDEQ 2012).

Habitat degradation has been identified by the BLM and LSRCD as a serious water-quality concern on Muddy Creek from Red Wash (in the project area) downstream to the Little Snake River. According to WDEQ (2012), habitat degradation is likely caused by season-long riparian grazing that is exacerbated by accelerated erosion associated with oil and gas activities. WDEQ (2012) also states, "… *projected increases in CBM [CBNG] development may lead to increased surface disturbance and increased erosion and sediment loading.*" Several grazing management BMPs are being implemented in much of this lower watershed including changes in length, timing and duration of grazing, and cross-fencing. The Upper Muddy Creek Watershed/Grizzly WHMA is located in the north central portion of the CD-C project area. This WHMA was established with the goal to "manage habitat for the Colorado River fish species unique to the Muddy Creek watershed" (BLM 2008a). In the Grizzly WHMA, the WGFD has been working with the BLM, the grazing permittee, and the LSRCD to implement similar measures.

3.4.2.5 Salinity Issues in the Colorado River Basin

The southern 30 percent of the project area is located in the Colorado River Basin; as such, point-source discharge permits are regulated by the State of Wyoming in accordance with its adoption and incorporation into the Water Quality Rules and Regulations of the Colorado River Basin Salinity Control Forum (CRBSCF), which was established in 1973 (CRBSCF 2008). The CRBSCF is composed of representatives from each of the seven Basin states appointed by the governors of the respective states. The CRBSCF was created for interstate cooperation and to provide the states with the information necessary to comply with Section 303(a) and (b) of the Clean Water Act. In 1975, CRBSCF proposed, the states adopted, and the EPA approved water quality standards which included numeric criteria and a plan of implementation to control salinity increases in the Colorado River. The plan was designed to maintain the flow-weighted average annual salinity concentrations at or below the 1972 levels, while the Basin states continued to develop their compact-apportioned water supply (CRBSCF 2008).

According to the CRBSCF, the focus for the implementation of salinity standards in the National Pollutant Discharge Elimination System (NPDES) permit program policy "*shall be a no-salt return policy whenever practicable*." The NPDES Program policy (revised in 2002) states that the permitting authority may permit the discharge of salt from new industrial sources upon a satisfactory demonstration by the permittee that salt loading to the Colorado River from the new construction is less than one ton per day or 366 tons per year, or the proposed discharge from the new construction is of sufficient quality in terms of TDS concentrations that the maximum TDS concentration is 500 mg/L for discharges into the Colorado River and its tributaries upstream of Lees Ferry, Arizona (CRBSCF 2008). In general, the salinity concentrations have decreased at the monitoring stations since the program was implemented (CRBSCF 2008).

As one of the seven member states of the CRBSCF, Wyoming regulates point discharge sources of salinity in the Wyoming portion of the Colorado River Basin through its Wyoming Pollutant Discharge Elimination System (WYPDES) permit program. The program is administered by the WDEQ/Water Quality Division (WQD) (WDEQ 1982).

3.4.3 Groundwater

The project area occurs in the Colorado Plateau and Wyoming Basin groundwater regions described by Heath (1984) and the Upper Colorado River Basin groundwater region described by Freethey (1987). More specifically, the project area is located over the Great Divide and Washakie structural basins in eastern Sweetwater and southwestern Carbon counties. The northern half of the project area is occupied by the Great Divide Basin and the southern half of the area is occupied by the Washakie Basin, with the Wamsutter Arch separating the two structural basins. Relatively recent studies by the USGS (Mason and Miller 2005; Bartos *et al.* 2006;) cataloged the groundwater resources within Sweetwater and Carbon counties, which include the Great Divide and Washakie structural basins. Groundwater resources include deep and shallow, confined and unconfined aquifers. Groundwater occurrence and flow in the project area are controlled largely by the geologic structure and precipitation in the area. Most of the saturated geologic units in the project area are heterogeneous, consisting of aquifers, semi-confining units, and confining layers.

3.4.3.1 Groundwater Location and Quantity

Welder and McGreevy (1966) reported that the geologic formations capable of producing the greatest quantities of water in the project area include the following: Quaternary alluvium; Tertiary deposits in the Wasatch and Fort Union Formations; Cretaceous units, including the Mesaverde Group and the Frontier and Cloverly Formations; the Sundance-Nugget Sandstone of the Jurassic age; and the Tensleep and

Madison Formations of the Paleozoic Era (**Figure 3.1-1, Section 3.1.2**). General aquifer characteristics are provided in **Appendix F**. Fisk (1967) estimated that the amount of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft. within the Washakie Structural Basin. The available data are not adequate for estimating the quantities of groundwater stored within the individual hydrogeologic units or the aquifer systems in the Green River Watershed Basin, which includes the Great Divide and the Washakie structural basins, but estimates of producible water volumes are available for the Tertiary formation beneath the Greater Green River Basin (Cleary *et al.* 2010).

Quaternary aquifers in the Great Divide and Washakie basins are comprised of alluvial deposits along floodplains and isolated wind-blown and lake sediments. The Quaternary aquifers in the vicinity of the project area occur in alluvial deposits along Muddy Creek (Washakie Basin), in the Red Desert Flats area and around lakes (Great Divide Basin), and in wind-blown segments in the northwest and southeast of the project area. Groundwater flow within the sandy Quaternary aquifers is typically downward toward permeable underlying formations (Collentine *et al.* 1981). Intermittent drainages also often contain groundwater in the associated unconsolidated valley fills. Incised drainages serve as capture areas for wind-blown sand in reaches perpendicular to the prevailing winds. The sand-choked drainages favor rapid infiltration of rainfall and snowmelt, leading to contact springs and seeps where groundwater, perched in sandy surface deposits, escapes along contacts with less permeable bedrock. Thicknesses of Quaternary sediments range from zero to 70 feet. Well yields are typically less than 20 gallons per minute (gpm) (Welder and McGreevy 1966).

“Minor” Tertiary aquifers in the project area occur in the Laney Member of the Green River Formation (mostly in the Washakie Structural Basin). “Major” Tertiary aquifers in the project area include the Wasatch, Battle Springs, and Fort Union (Washakie and Great Divide basins). Using nomenclature of Collentine et al. (1981), “minor” and “major” aquifers are characterized based on their relative water-bearing potential. Aquifers near the surface are recharged from direct downward percolation of precipitation and snowmelt and from seepage losses from streams. Deep aquifers are also recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. Thicknesses of Tertiary deposits vary from zero to more than 4,000 feet. Wasatch Formation wells yield up to 50 gpm. The Laney Member of the Green River Formation and the Battle Springs and Fort Union formations can yield hundreds of gpm to wells (Mason and Miller 2005; Bartos *et al.* 2006). There are six wells that are designated as municipal use and supply a public water system completed in Tertiary age aquifers (all in the Wasatch Formation) within the project area. These six wells are associated with water supply for the Town of Wamsutter. Using estimates of the volume of producible groundwater from Cleary *et al.* (2010), the volume of groundwater in the top 1,000 feet of the Tertiary formation under the project area is approximately 9.67 million ac-ft. Fisk (1967) estimated that the amount of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft. within the Washakie Structural Basin.

Upper Cretaceous aquifers include “minor” aquifers in the Lance and Fox Hills formations. “Major” aquifers of this period include the formations within the Mesaverde Group (Almond Formation, Ericson Formation, Rock Springs Formation, and Blair Formation in descending order), the Baxter Shale, and the Frontier Formation. The Mesaverde Group contains “major” aquifer units (the Almond Formation, Pine Ridge Sandstone, Allen Ridge Formation, and Haystack Mountains Formation), and is referred to as the Mesaverde Aquifer (Mason and Miller 2005; Bartos *et al.* 2006) in the Washakie and Great Divide basins. Due to water-quality variability, it is considered a groundwater source only near outcrop areas. Units within the Mesaverde Group yield natural gas to conventional gas wells in the area. In the Atlantic Rim area to the east, coal seams within the Almond Formation are the target of CBNG development. In areas where they occur, Upper Cretaceous strata range from a few hundred feet to 5,000 feet thick. Well yields from the “minor” aquifers are typically less than 25 gpm. Well yields of up to several hundred gpm are reported for the “major” aquifers (Welder and McGreevy 1966).

The Lower Cretaceous aquifers generally are deeply buried in the center of the Great Divide and Washakie basins, though these formations outcrop near the eastern edge of the project area. The lower Cretaceous strata consist of shale layers that act as regional aquitards or leaky confining layers (Mowry and Thermopolis shales). The Cloverly Formation is a “major” aquifer. Yields to wells range from 45 to 240 gpm (Mason and Miller 2005; Bartos *et al.* 2006). There are no wells that are designated as a domestic use or as a municipal use and supply a public water system completed in Lower Cretaceous aquifers within the project area.

The low-permeability Morrison Formation separates the Sundance-Nugget Aquifer of the Jurassic age from the Upper Cretaceous aquifers. The Jurassic-age Sundance-Nugget aquifer is comprised of permeable sandstone with minor quantities of shale, siltstone, and limestone (Collentine *et al.* 1981). The flow characteristics of the Sundance-Nugget aquifer are not well-defined. These aquifer units range from about 200 to 450 feet thick. Well yields are less than 35 gpm in the Sundance aquifer and up to 200 gpm in the Nugget aquifer (Mason and Miller 2005; Bartos *et al.* 2006). There are no wells that are designated as a domestic use or as a municipal use and supply a public water system completed in Sundance or Nugget aquifers within the project area.

According to Collentine *et al.* (1981), two “important water-bearing intervals” occur in Paleozoic-Era rocks within the project area. The Pennsylvanian age Tensleep Formation consists of fine- to medium-grained sandstone between confining layers of the Chugwater Formation (Triassic) and the Amsden Formation (Pennsylvanian) (Collentine *et al.* 1981). The Madison aquifer is comprised of limestone and dolomite bordered on the top by the fine-grained Amsden Formation and on the bottom by Cambrian rocks. Early Paleozoic rocks are notably absent from far southeast Wyoming and extremely thin on the west flank of the Sierra Madre uplift east of the project area. The zero isopach line for these Paleozoic units lies across and north of the Sierra Madre uplift indicating either non-deposition or erosion and complete removal of these units across the ancestral uplift prior to deposition of Mesozoic and Cenozoic age rocks. The truncated edge of Cambrian and Mississippian rocks lies east of the project area according to Blackstone (1963). Wells completed in the vicinity of the project area within both of these Paleozoic age aquifers, where present and of significant thickness, have demonstrated yields up to 400 gpm. There are no wells that are designated as a domestic use or as a municipal use and supply a public water system completed in Tensleep or Madison aquifers within the project area.

3.4.3.2 Groundwater Use

The SEO water rights database indicates that there are 1,081 groundwater wells permitted within or 1 mile adjacent to the project area (SEO 2011). Permitted well uses include stock (294), miscellaneous (218), domestic (80), industrial (18), municipal (6), irrigation (5), and test wells (1). The total for permitted uses exceeds the number of well permits due to the fact that many of the wells are permitted for multiple uses. A complete list of valid groundwater rights is included in **Appendix F**.

Other than designated land uses described above, little information is available on groundwater use specific to the Great Divide and Washakie structural basins. In 1981, total groundwater use in the Great Divide and Washakie basins was estimated by Collentine *et al.* (1981) at between 20,000 and 24,000 acre-feet per year, approximately 30 percent of the total water use. More recent estimates of groundwater use are available on a county-wide basis. In 2000, Sweetwater County groundwater use was estimated at 57,000 acre-feet per year, approximately 30 percent of the overall water used (Mason and Miller 2005). In 2000, Carbon County groundwater use was estimated at 7,000 acre-feet per year, less than 2 percent of the overall water used (Bartos *et al.* 2006).

3.4.3.3 Groundwater Recharge and Discharge

Recharge to aquifers in the project area occurs by infiltration of precipitation on outcrop areas, infiltration of snowmelt runoff from the mountains, and seepage from streams and lakes.

Four major groundwater-recharge areas are identified in the Great Divide and Washakie structural basins. Three of these areas are outside of the project area near Rock Springs in Sweetwater County and the Atlantic Rim area in Carbon County. The fourth recharge area is the topographic high area around Creston Junction (**Map 3.4-1**). Piezometric levels in hydrogeologic units are higher in these four major recharge areas than other parts of the basin, probably because the higher altitude of these features results in slightly higher annual precipitation. Welder and McGreevy (1966) reported that most streams in the Washakie basin are "losing" streams, contributing to local groundwater recharge in the basin. The same is likely true for streams in the Great Divide Basin. Fisk (1967) estimated that the combined annual recharge for the Great Divide and Washakie structural basins was at 11,300 ac-ft. Section 4.9.3.1, Special Status Species, Proposed Action, includes a discussion of potential annual depletions to the Colorado River System.

Aquifers in the Great Divide and Washakie structural basins are reported to be in direct hydraulic connection across the Wamsutter Arch. Recharge is reported to be at least 15 cfs in both basins. Due to the large groundwater storage capacity and the low recharge rate, estimates indicate that it would take more than 50,000 years to refill the fresh-water aquifers of the basins with groundwater if all of the groundwater was removed (Mason and Miller 2005; Bartos *et al.* 2006).

In general, groundwater discharge from the aquifers throughout the project area occurs through seepage to streams and springs, discharge to wells, evaporation, and underground flow (Mason and Miller 2005; Bartos *et al.* 2006). According to Mason and Miller (2005), groundwater from the Mesaverde formation discharges to the Little Snake River, downstream of the confluence with Muddy Creek. Much of the deeper groundwater in the basins is artesian (i.e., having a static water level which rises to an elevation above the saturated zone). This results because the major recharge areas in the basins are exposed at higher elevations, putting the confined groundwater under hydraulic pressure. Water in a confined aquifer that is under hydraulic pressure will rise above the top of the aquifer when the overlying confining bed is pierced or broken, resulting in discharge from the confined aquifer (Mason and Miller 2005). The source of some of the water within the Chain Lakes surface water features in the Great Divide Basin is thought to be artesian groundwater that flows at the surface (WGFD 2008).

3.4.3.4 Groundwater Flow Direction

As discussed in Section 3.4.3.1, formations capable of producing the greatest quantity of water in the project area include the Quaternary alluvium, Tertiary deposits in the Wasatch and Fort Union Formations, Cretaceous units, including the Mesaverde Group and the Frontier and Cloverly Formations, the Sundance-Nugget Sandstone of the Jurassic age, and the Tensleep and Madison Formations of the Paleozoic Era. More detailed information regarding potentiometric surfaces of project area aquifers and groundwater flow are presented in **Appendix F**.

The Quaternary aquifers consist of unconsolidated sand and gravel formations, mainly of alluvial origin, interbedded with lake and wind-blown sediments. The Quaternary alluvium is highly permeable, absorbing rainfall and stream flow, transmitting it downward to underlying formations.

The groundwater flow direction in the Tertiary-aged Wasatch aquifer is from areas of recharge toward the basin center. In the Great Divide Structural Basin, Wasatch aquifer groundwater flows from the northwest, northeast, southwest, and southeast. In the Washakie Structural Basin, groundwater generally flows from west to east in the southern part of the Washakie Structural Basin. In the northern portion of the Washakie Basin groundwater motion is largely static. Some groundwater flows westward from the Washakie Structural Basin along Bitter Creek and southward along Muddy Creek.

Groundwater flow direction for the Upper Cretaceous-aged aquifer within the Mesaverde Group is undefined in the northern part of the Great Divide Structural Basin. Groundwater within the aquifers of the Mesaverde Group is reported to flow from the Great Divide Basin toward the east, southeast, southwest, and west. In the Washakie Structural Basin, groundwater is reported to flow to the west and south (Mason and Miller 2005; Bartos *et al.* 2006).

Available potentiometric data are sporadic and could not be used to delineate flow patterns in the Sundance-Nugget aquifer. Potentiometric heads are highest in the uplift areas to the east, west, north, and northeast (Collentine *et al.* 1981).

The groundwater flow direction for the Paleozoic-aged Tensleep aquifer is generally from the recharge areas along the northern and eastern flanks of the Great Divide Basin. Additional recharge into the Washakie Basin may occur to the south and east of the Rock Springs uplift. Tensleep aquifer groundwater flow is from the recharge areas toward the basin centers (Collentine et al. 1981). The groundwater flow direction for the Paleozoic-aged Madison aquifer is generally west, away from the outcrops (sources of recharge) towards the Great Divide and Washakie basin centers (Bartos *et al.* 2006).

3.4.3.5 Groundwater Quality

For the most part, comparisons between groundwater quality within the different structural features in the project area are difficult given the large variation in water quality within the features. In general, the quality of the groundwater underlying the Great Divide and Washakie basins is largely related to the depth of the aquifer, the type of strata in the saturated zone, the recharge rate and volume at the area sampled, and the residence time of the groundwater in the aquifer. Typically, quality of groundwater within a given hydrogeologic unit usually deteriorates with depth.

Water-quality samples collected from wells and springs within Quaternary and Tertiary hydrogeologic units that were being used to supply water for livestock and wildlife were typically of good water quality (i.e. fresh water, see below). Wells that do not produce usable water are usually abandoned, and springs that do not produce usable water typically are not developed. In addition, where hydrogeologic units are deeply buried, they usually are not tapped for a water supply when a shallower supply is available. For these reasons the groundwater quality samples from the Quaternary and Tertiary hydrogeologic units are most likely biased toward better water quality and do not represent a random sampling of the units. Although the possible bias of these data does not allow for a complete characterization of the water quality of these hydrogeologic units as a whole, it probably allows for a more accurate characterization of the units in areas where they are shallow enough to be economically used.

Most of the groundwater-quality samples used to characterize Mesozoic and Paleozoic hydrogeologic units came from the USGS Produced Waters Database (USGS 2011b). Although these samples were collected only where oil and gas production has taken place, they probably have less bias in representing ambient groundwater quality within hydrogeologic units developed as a result of this project than samples used to characterize Quaternary and Tertiary hydrogeologic units.

Baseline groundwater-quality data (TDS and selenium) at selected aquifers associated with the project area are presented in **Table 3.4-2**. More detailed data regarding groundwater quality are presented in **Appendix F**.

TDS concentrations in ground-water samples are classified according to the USGS salinity classification (Heath 1983) as follows: fresh, 0-1,000 mg/L; slightly saline, 1,000-3,000 mg/L; moderately saline, 3,000-10,000 mg/L; very saline, 10,000-35,000 mg/L; and briny, more than 35,000 mg/L.

TDS values for 18 samples collected in Quaternary aquifers in Sweetwater County ranged from fresh to very saline with the median value within the slightly saline range. In Carbon County, 32 samples collected from Quaternary aquifers varied from fresh to moderately saline with the median value within fresh range.

Table 3.4-2. Groundwater quality parameters for selected aquifers associated with the CD-C project area

	From Mason and Miller (2005)					From Bartos *et al.* 2006						Produced Water		
	Sweetwater Co. Quaternary Aquifer	**Sweetwater Co. Wasatch Aquifer**	**Sweetwater Co. Mesaverde Aquifer**	**Sweetwater Co. Nugget Aquifer**	**Sweetwater Co. Madison Aquifer**	**Carbon Co. Quaternary Aquifer**	**Carbon Co. Wasatch Aquifer**	**Carbon Co. Mesaverde Aquifer**	**Carbon Co. Nugget Aquifer**	**Carbon Co. Madison Aquifer**	**Sweetwater Co. Wasatch/Ft. Union Aquifer Produced Water**	**Sweetwater Co. Mesaverde Aquifer Produced Water**	**Sweetwater Co. Nugget Aquifer Produced Water**	**Madison Aquifer (USGS 2011b)**
# of Samples	18	80	30	--	17	32	11	130	15	11	--	221	28	2
Parameter														
TDS (Median) (mg/L)	1,200	1,000	1,000	--	11,100	500	2,000	5,000	4,500	3,000	13,900	12,000	10,000	30,300
TDS (Min) (mg/L)	500	150	200	3,000	3,820	30	700	250	1,500	150	1,050	2,800	5,000	6,094
TDS (Max) (mg/L)	20,000	8,000	20,000	35,000	76,800	8,000	5,000	40,000	50,000	12,000	153,000	65,000	40,000	54,545
Selenium (Median) (µg/L)	32.9[1]	0.7[2]	nm[7]	<1[3]	nm	3.9[4]	0.6[5]	0.6[6]	nm	1.4[3]	nm	nm	nm	nm
Selenium (Min) (µg/L)	3.8[1]	0.3[2]	nm	<1[3]	nm	<0.5[4]	0.4[5]	<0.3[6]	nm	1.4[3]	nm	nm	nm	nm
Selenium (Max) (µg/L)	133[1]	1.6[2]	nm	<1[3]	nm	4.5[4]	<0.7[5]	0.8[6]	nm	1.4[3]	nm	nm	nm	nm

[1] *Based on 7 Samples*
[2] *Based on 8 Samples*
[3] *Based on 1 Sample*
[4] *Based on 3 Samples*
[5] *Based on 4 Samples*
[6] *Based on 6 Samples*
[7] *Not Measured.*

TDS concentrations from 80 samples collected from the Wasatch aquifer (Tertiary age) in Sweetwater County ranged from fresh to moderately saline, with a median value within the fresh/slightly saline range. TDS values for 11 samples collected in Carbon County ranged from fresh to moderately saline, with a median value within the slightly saline range. TDS values from samples collected in Sweetwater County of water produced by oil and gas extraction from the Wasatch/Fort Union formations ranged from slightly saline to briny. TDS values of produced water from the Wasatch aquifer above 60,000 mg/L occurred at depths greater than about 2,500 feet below ground surface (Mason and Miller 2005).

TDS concentrations in 30 samples collected in Sweetwater County from the aquifers of the Mesaverde group ranged from fresh to very saline, with a median value within the fresh/slightly saline range. TDS from 130 samples collected in Carbon County from the aquifers of the Mesaverde Group ranged from fresh to briny. TDS in 221 samples of water from oil and gas production in the Mesaverde ranged from slightly saline to briny with a median value within the very saline range.

TDS concentrations from samples collected from the Nugget aquifer in Sweetwater County ranged from slightly/moderately saline to very saline/briny. TDS values for 15 samples collected in Carbon County ranged from slightly saline to briny, with a median value within the moderately saline range. TDS values from 28 samples collected in Sweetwater County of water produced by oil and gas extraction from the Nugget formation ranged from moderately saline to briny.

TDS concentrations from 17 samples collected from the Madison aquifer in Sweetwater County ranged from moderately saline to briny, with a median value within the very saline range. TDS values for 11 samples collected in Carbon County ranged from fresh to very saline, with a median value within the slightly/moderately saline range. TDS values from samples collected in Sweetwater County of water produced by oil and gas extraction from the Madison Formation ranged from moderately saline to briny.

In general, TDS concentrations typically increase with the depth below ground surface. TDS values are usually higher when the aquifer is interbedded with lake or marine deposits that contain evaporate minerals.

Selenium values obtained from samples of selected aquifers are included in **Table 3.4-2**. In comparison to the number of samples analyzed for TDS, selenium sampling results are sparse but they do provide some idea of the potential for encountering excessive selenium in produced water. EPA's current chronic criterion for selenium is 5 μg/L (EPA 2011a). WDEQ/LQD's groundwater fish/aquatic life use suitability limit for selenium is also 5 μg/L (WDEQ/LQD 2005). Both the EPA's chronic criterion and WDEQ-WQD's suitability limits for selenium were exceeded in Quaternary aquifer water samples.

Confining beds typically restrict the movement of groundwater between aquifers, hence, movement of potential contaminants between aquifers. Although there is some downward movement of the water from the shallow surficial units, most of the groundwater movement, if any, is upward from the deeper confined aquifers to the shallower unconfined aquifers. Water in a confined aquifer is under hydraulic pressure and will rise above the top of the aquifer when the overlying confining bed is pierced or broken (Mason and Miller 2005). There is potential for groundwater quality degradation due to the piercing of confining layers and vertical and horizontal migration and mixing of waters of variable qualities between the layers. Improperly completed wells, especially poor casing or cementing, could produce such a result. There are no data suggesting this is currently a problem in the CD-C project area.

3.4.3.6 Springs and Flowing Wells

As described above, water in a confined aquifer is under hydraulic pressure and will rise above the top of the aquifer when the overlying confining bed is broken (spring) or pierced (well). When the hydraulic pressure is great enough, the water from a well completed in a confined aquifer can reach the surface, resulting in a flowing well. Springs and flowing wells are important local water sources for livestock, wildlife, and wild horses. It is unclear how many springs and flowing wells are located within the project area. The SEO records identify two named springs among the 1,081 groundwater rights within 1 mile of the project area (SEO 2011). The SEO records indicate that 118 of the 1,081 groundwater rights are flowing wells (SEO 2011). Of the 1,081 groundwater rights, 325 lack the information to determine if the groundwater permit is for a spring or flowing well.

According to previous studies, springs in the area intercept the ground surface in three geologic units. South of Interstate 80 (I-80), springs occur in the Green River Formation. North of I-80, springs occur in the Wasatch and Battle Springs formations (Mason and Miller 2005; Bartos *et al.* 2006).

Historic water-quality data were located for 16 water samples collected from springs or flowing wells (WRDS 2007, USGS 2007). Water quality for these samples is variable. Conductance levels range from 769 to 16,215 µmhos/cm. TDS levels ranged from 479 to 12,755 mg/L. Detailed information related to springs and flowing wells can be found in **Appendix F**. Based on a February 2011 search of SEO water rights information, none of the 16 springs evaluated for water quality are covered by valid water rights.

3.4.3.7 The Safe Drinking Water Act as it Relates to Groundwater

The Safe Drinking Water Act (SDWA) is the main federal law that regulates drinking water quality, including drinking water from groundwater sources. Under the SDWA, the EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. Two aspects of the SDWA that are relevant to an assessment of the groundwater quality related to the CD-C project are the underground injection control (UIC) program and the sole source aquifer (SSA) protection program. The UIC program ensures that injection wells meet appropriate performance criteria for protecting underground sources of drinking water (USDW). As defined in 40 CFR 144.3, an USDW aquifer supplies any public water system or contains a sufficient quantity of groundwater to supply a public water system; currently supplies drinking water for human consumption or contains fewer than 10,000 mg/l total dissolved solids and is not an exempted aquifer (i.e. exempt from SDWA regulation). The EPA defines an SSA as an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. While there are no EPA designated SSAs associated with the CD-C project area, there are aquifers in the area that qualify as an USDW.

Quaternary age aquifers within the CD-C project area likely do not qualify as USDWs since there are no wells designated for domestic or municipal use and supply a public water system. Further, the yields from these aquifers are not likely sufficient to sustain a public water system. Tertiary age aquifers within the CD-C project area qualify as USDWs based on the presence of Wamsutter municipal wells and on the suitability of the groundwater quality. Wyoming State Engineer records indicate that one domestic well is completed in the Upper Cretaceous Lance Formation aquifer within the project area.

There are no wells that are designated for municipal use or supply a public water system completed in Upper Cretaceous aquifers within the project area. Upper Cretaceous age aquifers within the CD-C project area qualify as USDWs based on suitability of water quality, on the presence of a sufficient quantity of groundwater to supply a public water system, and the one domestic well completed in the Lance Formation aquifer. Due to the depth of the Upper Cretaceous aquifers in the CD-C area (2,000 to 12,000 feet depending on location [Mason and Miller 2005]) and the low population density of the area, these aquifers are not likely to be the target for large numbers of domestic or public water system wells.

Lower Cretaceous and Jurassic age aquifers within the CD-C project area could qualify as USDW based on suitability of water quality and based on the presence of a sufficient quantity of groundwater to supply a public water system but, due to the depths of the aquifers in the CD-C area (2,000 to 12,000 feet depending on location [Mason and Miller 2005]), Lower Cretaceous and Jurassic age aquifers are not likely to be the target for domestic or public water system wells. Pennsylvanian age and older aquifers within the CD-C project area could qualify as USDW based on the presence of a sufficient quantity of groundwater to supply a public water system but, due to the depths of these aquifers in the CD-C area (4,800 to 18,000 feet depending on location [Mason and Miller 2005]) and the low population density of the area, they are not likely to be the target for domestic or public water system wells.

3.4.4 Injection Wells

As discussed above, subsurface water-disposal methods are administered by the EPA under the UIC program (40 CFR 144). The UIC program ensures that injection wells meet appropriate performance criteria for protecting USDWs. There are five classes of injection wells permitted under the UIC program based on similarity in the fluids injected, activities, construction, injection depth, design, and operating techniques. Class II and Class V injection wells would likely be used to dispose of produced water resulting from the CD-C project. Class II injection well permits are issued by the WOGCC for injection of fluids associated with oil and natural gas production (EPA 2011b),and are issued by the WOGCC under a 1989 Memorandum of Agreement (MOA) between the EPA and the WOGCC. Class V injection wells are permitted through WDEQ-WQD and cover wells not included in Classes I-IV. Most Class V wells (facilities) inject non-hazardous fluids into or above USDWs and are typically shallow, onsite disposal systems (stormwater drainage wells, cesspools, and septic tanks) but also include more complex wells that are deeper and often used for commercial or industrial facilities (EPA 2011b).

According to WOGCC information there are 18 permitted Class II injection wells within the CD-C project area that are capable of operation (WOGCC 2011a). The target injection formations for these wells are Big Red (1), Ericson (1), Fort Union (1), Fort Union/Lance (1), Fox Hills (1), Lewis (1), Mesaverde/Lance (1), Almond (2), Mesaverde (2), and Lance (7). According to WOGCC information there are no permitted Class V injection wells within the project area but there are seven Class V wells adjacent to the project area (WOGCC 2011a). All seven wells are the deeper injection type and target the Haystack Mountain (1), Deep Creek (3), and Mesaverde Coal (3) formations.

3.5 AIR QUALITY

Regional air quality is influenced by a combination of factors including climate, meteorology, the magnitude and spatial distribution of local and regional air pollution sources, and the chemical properties of emitted pollutants. Within the lower atmosphere, regional and local scale air masses interact with regional topography to influence atmospheric dispersion and transport of pollutants. The following sections summarize the climatic conditions and existing air quality within the project area and surrounding region.

3.5.1 Regional Climate

The CD-C project area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, windy conditions with limited rainfall and long, cold winters. The nearest meteorological measurements were collected at Wamsutter, Wyoming (1897-2011), located near the center of the project area at an elevation of 6,800 feet above mean sea level; (WRCC 2012).

The annual average total precipitation at Wamsutter is 7.1 inches, with annual totals for the period of record ranging from 3.8 inches (1979) to 13.6 inches (1983). Precipitation is greatest from spring to summer, tapering off during the fall and winter months. An average of 27.4 inches of snow falls during the year (annual high 78.0 inches in 2010), with the majority of the snow distributed evenly between November and April.

The region has cool temperatures, with an average range (in degrees Fahrenheit [˚F]) between 7.1˚F and 28.6˚F in January to between 48.9˚F and 84.5˚F in July. Extreme temperatures have ranged from -40˚F (2011) to 105˚F (1897). The frost-free period generally occurs from May to September. **Table 3.5-1** shows the mean monthly temperature ranges and total precipitation amounts.

Table 3.5-1. Mean Monthly Temperature Ranges and Total Precipitation Amounts

Month	Average Temperature Range (˚F)	Total Precipitation (inches)
January	7.1 – 28.6	0.27
February	10.6 – 33.1	0.29
March	18.4 – 41.8	0.40
April	26.5 – 54.1	0.75
May	34.5 – 65.0	1.07
June	42.4 – 76.5	0.81
July	48.9 – 84.5	0.75
August	46.8 – 82.1	0.81
September	38.5 – 72.5	0.73
October	28.5 – 59.0	0.58
November	17.2 – 41.9	0.36
December	8.5 – 29.9	0.28
ANNUAL	41.5 (mean)	7.11 (mean)

Source: WRCC 2012

The CD-C project area is subject to strong and gusty winds, often accompanied by snow during the winter months, producing blizzard conditions and drifting snow. The closest comprehensive wind measurements were collected in the project area at the WDEQ meteorological monitoring station located approximately 2 miles northwest of Wamsutter. To describe the wind flow pattern for the region a wind rose for the Wamsutter site, for years 2008 through 2010, is presented in **Figure 3.5-1**. **Tables 3.5-2 and 3.5-3** provide the wind speed and wind direction distributions in tabular format. From this information, it is evident that the winds originate from the west to southwest nearly 36 percent of the time and from the south to southeast over 37 percent of the time.

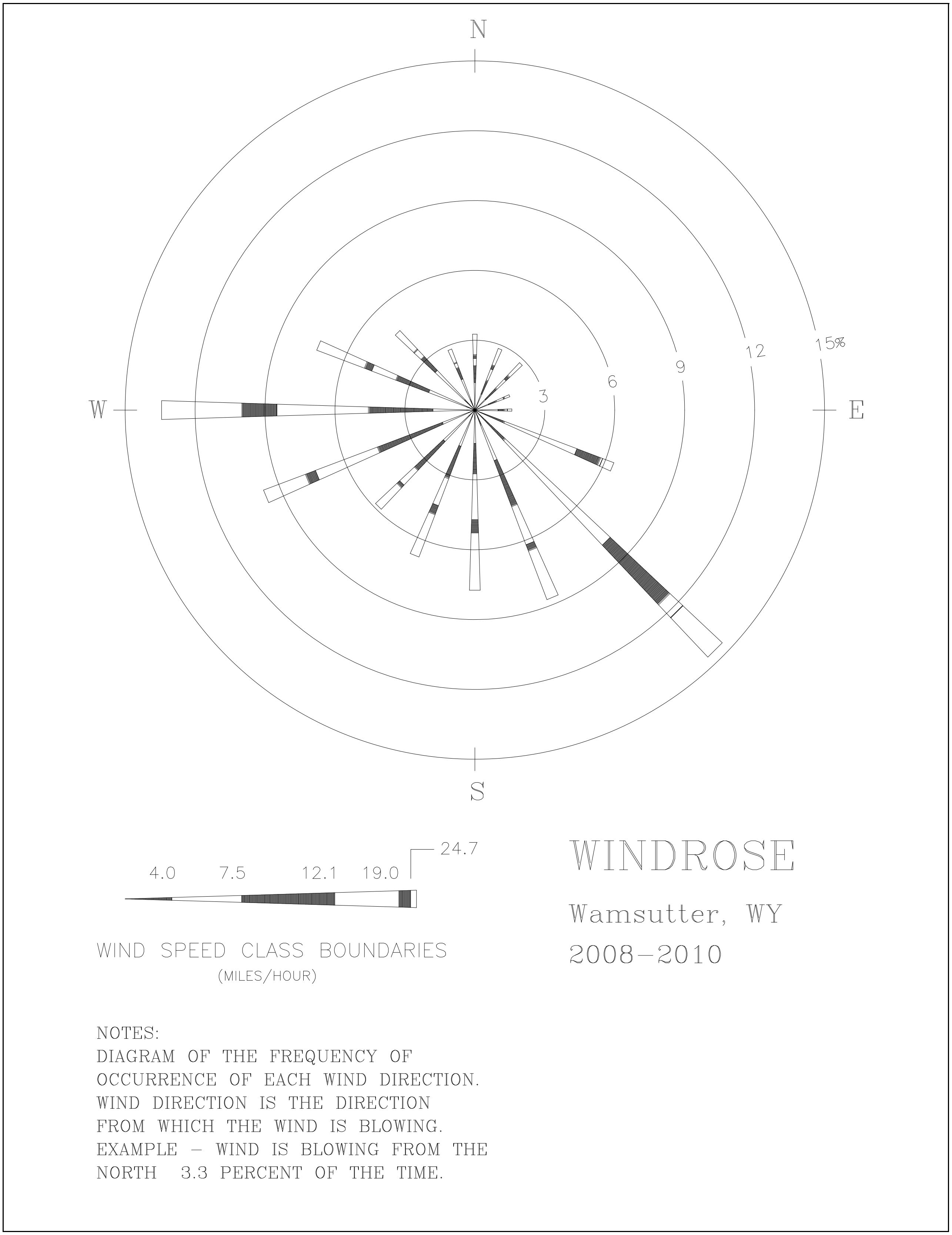


Figure 3.5-1. Wamsutter, WY meteorological data wind rose

The frequency and strength of winds greatly affect the transport and dispersion of air pollutants. The annual mean wind speed is 11.4 miles per hour (mph), and the relatively high average wind speed indicates good dispersion and mixing of any potential pollutant emissions.

Table 3.5-2. Wind Speed Distribution, Wamsutter, Wyoming, 2008–2010[1]

Wind Speed (mph)	Frequency (%)
0 – 4.0	8.3
4.0 – 7.5	25.0
7.5 – 12.1	22.6
12.1 – 19.0	16.9
19.0 – 24.7	4.5
Greater than 24.7	2.3

[1]*Source: WDEQ-AQD 2012.*

Table 3.5-3. Wind Direction Frequency Distribution, Wamsutter, Wyoming, 2008–2010

Wind Direction	Frequency (%)
N	3.3
NNE	2.8
NE	2.8
ENE	1.6
E	1.6
ESE	6.4
SE	14.6
SSE	8.7
S	7.7
SSW	6.8
SW	5.9
WSW	9.7
W	13.4
WNW	7.3
NW	4.7
NNW	2.8

Source: WDEQ-AQD 2012.

3.5.2 Overview of Regulatory Environment

The WDEQ-AQD is the primary air quality regulatory agency responsible for estimating impacts once detailed industrial development plans have been made, and those development plans are subject to applicable air quality laws, regulations, standards, control measures, and management practices. Unlike the conceptual 'reasonable, but conservative' engineering designs used in NEPA analyses, any WDEQ-AQD air quality preconstruction permitting demonstrations required would be based on very site-specific, detailed engineering values, which would be assessed in the permit application review. Any proposed facility which meets the requirements set forth under Wyoming Air Quality Standards and Regulations (WAQSR) Chapter 6 is subject to the WDEQ-AQD permitting and compliance processes.

Federal air quality regulations adopted and enforced by WDEQ-AQD limit incremental emission increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. Incremental increases in PSD Class I areas are strictly limited, while increases allowed in Class II areas are less strict. Under the PSD program, Class I areas are protected by Federal Land Managers (FLMs) through management of air quality related values ((AQRVs) such as visibility, aquatic ecosystems, flora, fauna, and others.

The 1977 Clean Air Act amendments established visibility as an AQRV for FLMs to consider. The 1990 Clean Air Act amendments contain a goal of improving visibility within PSD Class I areas. The Regional Haze Rule finalized in 1999 requires states, in coordination with federal agencies and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment.

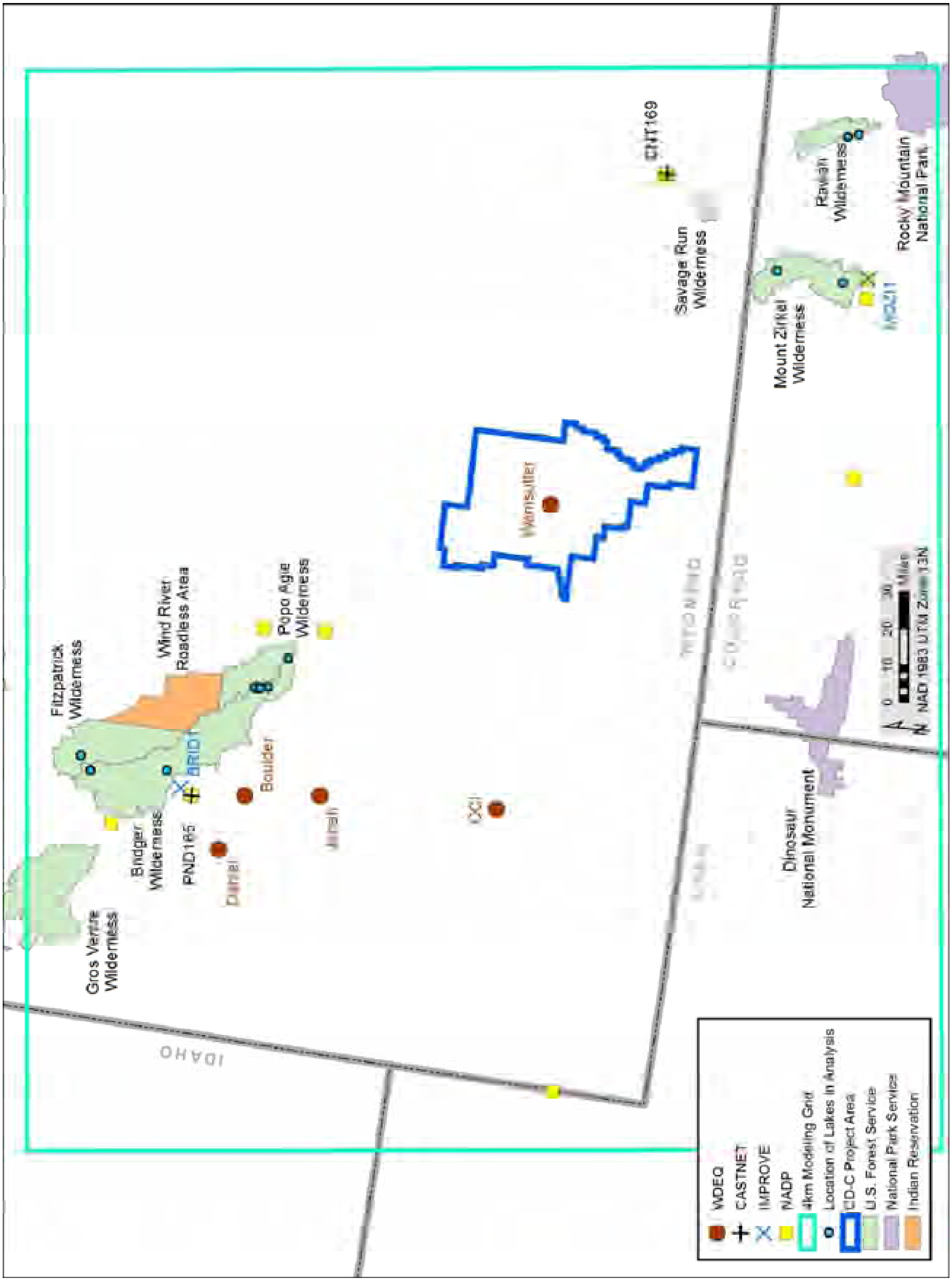
Regulations and standards which limit permissible levels of air pollutant concentrations and air emissions and are relevant to the CD-C project air impact analysis include:

- NAAQS (40 CFR Part 50) , WAAQS (WAQSR Chapter 2), CAAQS (5 CCR 1001-14);
- Prevention of Significant Deterioration (40 CFR Part 51.166);
- New Source Performance Standards (NSPS) (40 CFR Part 60);
- Non-Road Engine Tier Standards (40 CFR Part 89); and
- Wyoming 2010 Oil and Gas Permitting Guidance (supplement to WAQSR Chapter 6, Section 2)

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

3.5.2.1 Ambient Air Quality Standards

The Clean Air Act requires the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered to endanger public health and the environment. The NAAQS prescribe limits on ambient levels of these pollutants in order to protect public health, including the health of sensitive groups. The EPA has developed NAAQS for six criteria pollutants: NO_2, CO, SO_2, PM_{10}, $PM_{2.5,}$ ozone, and lead. Lead emissions from CD-C project sources are negligible and therefore the lead NAAQS is not addressed in this analysis. States typically adopt the NAAQS but may also develop state-specific ambient air quality standards for certain pollutants. The NAAQS and the state ambient air quality standards for Wyoming (WAAQS) and Colorado (CAAQS) are summarized in **Table 3.5-4.** The CAAQS are included in this table due to the proximity of the CD-C project area to Colorado (See **Map 3.5-1**). PSD Class I and Class II increments are also included in Table 3.5-7 and a discussion of PSD increments is provided in **Section 3.5.2.3**. The ambient air quality standards are shown in units of parts per million (ppm), parts per billion (ppb), and micrograms per cubic meter ($\mu g/m^3$) for purposes of providing the standards as written in the corresponding regulation, and for comparison with the pollutant concentration units as provided by the air quality models used for impact analysis (**Section 4.5**).



Map 3.5-1. Air quality monitoring stations within the CD-C study area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Table 3.5-4. Ambient air quality standards and PSD increments (µg m^3)

Pollutant	Averaging Time	NAAQS			CAAQS			WAAQS		
		(ppm)	(ppb)	(µg/m^3)	(ppm)	(ppb)	(µg/m^3)	(ppm)	(ppb)	(µg/m^3)
CO	1-hour[1]	35	35,000	40,000	35	35,000	40,000	35	35,000	40 (mg/m^3)
	8-hour[1]	9	9,000	10,000	9	9,000	10,000	9	9,000	10 (mg/m^3)
NO_2	1-hour[2]	0.1	100	188	0.1	100	188	--	--	--
	Annual[3]	0.053	53	100	0.053	53	100	0.053	53	100
Ozone	8-hour[4]	0.075	75	147	0.075	75	147	0.08	80	157
PM_{10}	24-hour[1]	NA	NA	150	NA	NA	150	NA	NA	150
	Annual[3]	NA	NA	--[5]	NA	NA	--	NA	NA	50
$PM_{2.5}$	24-hour[6]	NA	NA	35	NA	NA	35	NA	NA	35
	Annual[3]	NA	NA	15	NA	NA	15	NA	NA	15
SO_2	1-hour[7]	0.075	75	196	0.075	75	196	--	--	--
	3-hour[1]	0.5	500	1,300	0.267	267	700	0.5	500	1,300
	24-hour[1]	--[5]	--	--	--	--	--	0.10	100	260
	Annual[3]	--[5]	--	--	--	--	--	0.02	23	60

*Note: **Bold** indicates the standard as written the corresponding regulation. Other values are conversions.*

[1] *Not to be exceeded more than once per year.*

[2] *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.*

[3] *Annual arithmetic mean.*

[4] *An area is in compliance with the standard if the fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.*

[5] *The NAAQS for this averaging time for this pollutant has been revoked by EPA.*

[6] *An area is in compliance with the standard if the highest 24-hour $PM_{2.5}$ concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.*

[7] *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.*

An area that is shown to exceed the NAAQS for a given pollutant may be designated as a non-attainment area for that pollutant. In March 2009, the Governor of Wyoming recommended to the EPA that Sublette County and parts of northeastern Lincoln and northwestern Sweetwater Counties be designated non-attainment for ozone due to exceedances of the 2008 75 parts per billion ozone NAAQS. The CD-C project area is located in eastern Sweetwater and western Carbon counties, outside of the proposed non-attainment area. In April 2012, Sublette County and parts of Lincoln and Sweetwater were designated by the EPA as nonattainment areas under the 2008 ozone standard <http://www.epa.gov/groundlevelozone/-designations/2008standards/final/region8f.htm>.

3.5.2.2 Hazardous Air Pollutants

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

For the CD-C analysis, short-term (1-hour) HAP concentrations are compared to acute Reference Exposure Levels (RELs) (EPA, 2011) shown in **Table 3.5-5**. RELs are defined as concentrations at or below which no adverse health effects are expected. No RELs are available for ethyl benzene and n-hexane; instead, the available “Immediately Dangerous to Life or Health” values divided by 10 (IDLH/10) are used. These IDLH values were determined by the National Institute for Occupational

Safety and Health and were obtained from EPA's Air Toxics Database (EPA, 2011). These values are approximately comparable to mild effects levels for 1-hour exposures.

Long-term exposure to HAPs are compared to Reference Concentrations for Chronic Inhalation (RfCs). An RfC is defined by the 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, 2010). Annual modeled HAP concentrations for all HAPs emitted were compared directly to the non-carcinogenic RfCs shown in **Table 3.5-6**..

Long-term exposures to emissions of suspected carcinogens (benzene, ethyl benzene and formaldehyde) are also evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime.

Table 3.5-5. Acute RELs (1-hour exposure)

HAP	REL ($\mu g/m^3$)
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 3.5-6. Non-Carcinogenic HAP RfCs (annual average)[1]

HAP	Non-CarcinogenicRfC[1] ($\mu g/m^3$)
Benzene	30
Toluene	5000
Ethyl Benzene	1,000
Xylenes	100
n-Hexane	700
Formaldehyde	9.8

[1] *EPA Air Toxics Database, Table 1 (EPA, 2010).*

3.5.2.3 Prevention of Significant Deterioration

The PSD Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. All areas of the country are assigned a classification which describes the degree of degradation to the existing air quality that is allowed to occur within the area under the PSD permitting rules. PSD Class I areas are areas of special national or regional natural, scenic, recreational, or historic value, and very little degradation in air quality is allowed by strictly limiting industrial growth. PSD Class II areas allow for reasonable industrial/economic expansion. Certain national parks and wilderness areas are designated as PSD Class I, and air quality in these areas is protected by allowing only slight incremental increases in pollutant concentrations. Five PSD Class I areas are located within the CD-C study area as shown on **Map 3.5-1**: the Bridger, Fitzpatrick, Mount Zirkel, Savage Run, and Rawah Wilderness Areas. In a PSD increment analysis, impacts from proposed emissions sources are compared with the allowable limits on increases in pollutant concentrations, which are called Class I PSD increments; these increments are shown in **Table 3.5-7**. Dinosaur National Monument is a federal PSD Class II area given Class I protection for SO_2 by the Colorado Department of Public Health and Environment (CDPHE). The remainder of the impact study area is classified as PSD Class II, where less stringent limits on increases in pollutant concentrations apply. The Popo Agie

Wilderness Area and the Wind River Roadless Area are considered sensitive areas and are subject to the PSD Class II Increments shown in Table 3.5-7.

Table 3.5-7. PSD increments (μg/m^3)

Pollutant	Averaging Time	PSD Class I Increment	PSD Class II Increment
NO_2	1-hour	None	None
	Annual	2.5	25
PM_{10}	24-hour	8	30
	Annual	4	17
$PM_{2.5}$	24-hour	2	9
	Annual	1	4
SO_2	1-hour	None	None
	3-hour	25	512
	24-hour	5	91
	Annual	2	20

Note: The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.

Comparisons of CD-C project impacts to the PSD Class I and II increments are for informational purposes only and are intended to evaluate a threshold of concern. They do not represent a regulatory PSD Increment Consumption Analysis, which would be completed as necessary during the New Source Review permitting process by the State of Wyoming.

In addition to the PSD increments, Class I areas are protected by FLMs through management of AQRVs such as visibility, aquatic ecosystems, flora, and fauna. Evaluations of impacts to AQRVs would also be performed during the New Source Review permitting process under the direction of the WDEQ-AQD in consultation with the FLMs.

AQRVs that were identified as a concern for the CD-C project included visibility, atmospheric deposition, and potential sensitive lake acidification. A discussion of the applicable background data and analysis thresholds is provided below.

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 The Federal Land Managers' Air Quality Related Values Work Group (FLAG) Report (FLAG 2010), with the results reported in percent change in light extinction and change in deciviews (dv). A 5-percent change in light extinction (approximately equal to 0.5 dv) is the threshold recommended in FLAG (2010) and is considered to contribute to regional haze visibility impairment. A 10-percent change in light extinction (approximately equal to 1.0 dv) is considered to represent a noticeable change in visibility when compared to background conditions.

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

Atmospheric Deposition and Lake Chemistry

The effects of atmospheric deposition of nitrogen and sulfur compounds on terrestrial and aquatic ecosystems are well documented and have shown to cause leaching of nutrients from soils, acidification of surface waters, injury to high-elevation vegetation, and changes in nutrient cycling and species composition. FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition in 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 (NPS) and the Fish and Wildlife Service (USFWS). 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).

In addition to the screening level analysis, project-specific and cumulative modeled results are compared to critical load thresholds established for the Rocky Mountain region to assess total deposition impacts. The BLM has compiled currently available research data on critical load values for Class I areas in the vicinity of the CD-C project area. Critical load thresholds published by Fox et al. (Fox 1989) established pollutant loadings for total nitrogen of 3–5 kg/ha/yr) and for total sulfur of 5 kg/ha/yr for Bob Marshall Wilderness Area in Montana and Bridger Wilderness Area in Wyoming. However, the 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) suggested that critical load values above 3 kg/ha/yr may result in moderate impacts. Research conducted by Jill Baron (Baron 2006) using hindcasting of diatom communities suggests 1.5 kg/ha/yr as a critical loading value for wet nitrogen deposition for high-elevation lakes in Rocky Mountain National Park, Colorado. Recent research conducted by Saros et. al. (2010) using fossil diatom assemblages suggest that a critical load value of 1.4 kg/ha/yr for wet nitrogen is applicable to the eastern Sierra Nevada and Greater Yellowstone ecosystems. For the CD-C project, both project-specific and cumulative nitrogen and sulfur deposition impacts are compared to the following critical load values: 1.5 kg/ha/yr as a surrogate for total nitrogen deposition and 3 kg/ha/yr for total sulfur deposition for the Class I and sensitive Class II areas evaluated.

Analyses to assess the change in water chemistry associated with atmospheric deposition are performed following the procedures developed by the USFS Rocky Mountain Region (USFS 2000). The analysis assesses the change in the acid neutralizing capacity (ANC) of the 12 sensitive lakes (**Table 3.5-6**) within the CD-C study area (**Map 3.5-1**). Predicted changes in ANC are compared with the applicable threshold for each identified lake: 10-percent change in ANC for lakes with background ANC values greater than 25 microequivalents per liter [µeq/L], and less than a 1-µeq/L change in ANC for lakes with background ANC values equal to or less than 25 µeq/L.

3.5.2.4 New Source Performance Standards

Under Section 111 of the Clean Air Act, the EPA has promulgated technology-based emissions standards which apply to specific categories of stationary sources. These standards are referred to as New Source Performance Standards (NSPS; 40 CFR Part 60). The NSPS potentially applicable to the CD-C project include the following subparts of 40 CFR Part 60:

- Subpart A – General Provisions;
- Subpart Kb – Standards of Performance for Volatile Organic Storage Vessels;
- Subpart JJJJ – Standards of Performance for Stationary Spark-Ignition Internal Combustion Engines; and
- Subpart KKKK – Standards of Performance for Stationary Combustion Turbines.

Subpart A – General Provisions

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

Subpart Kb – Volatile Organic Liquid Storage Vessels

Subpart Kb applies to storage vessels with a capacity greater than or equal to 75 cubic meters (m^3) that are used to store volatile organic liquids for which construction, reconstruction, or modification is commenced after July 23, 1984. This subpart potentially would be applicable to storage tanks for natural gas liquids.

Subpart JJJJ – Spark Ignition Internal Combustion Engines

Subpart KKKK establishes emission standards and compliance schedules for the control of emissions from stationary combustion turbines that commenced construction, modification or reconstruction after February 18, 2005. Stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 gigajoules (10 MMBtu) per hour, based on the higher heating value of the fuel proposed as part of the CD-C project, would be subject to this NSPS.

Subpart KKKK – Stationary Combustion Turbines

Subpart KKKK establishes emission standards and compliance schedules for the control of emissions from stationary combustion turbines that commenced construction, modification or reconstruction after February 18, 2005. Stationary combustion turbines with a heat input at peak load equal to or greater than 10.7 gigajoules (10 MMBtu) per hour, based on the higher heating value of the fuel proposed as part of the CD-C project would be subject to this NSPS.

3.5.2.5 Non-Road Engine Tier Standards

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

3.5.2.6 Wyoming 2010 Oil and Gas Permitting Guidance (Wyoming BACT)

The CD-C project area lies entirely within eastern Sweetwater County and western Carbon County in Wyoming; this area is part of the State of Wyoming's Concentrated Development Area (CDA; **Map 3.5-3**), and is therefore subject to CDA restrictions on emissions set forth in the WDEQ-AQD's March 2010 "Oil and Gas Production Facilities Chapter 6, Section 2 Permitting Guidance" (WDEQ-AQD, 2010). The Guidance states, "….all new or modified sources or facilities which may generate regulated air emissions shall be permitted prior to start-up or modification and Best Available Control Technology (BACT) shall be applied to reduce or eliminate emissions". The Guidance establishes presumptive BACT requirements for emissions from the following source categories for new facilities:

- Tank Flashing[8] (see Glossary). Pad facilities: 98-percent control upon startup; single-well facilities: 98-percent control of all new/modified tank emissions ≥ 8 tpy (tons per year) VOC within 60 days of startup/modification.
- Dehydration Units. Upon first date of production (FDOP), glycol flash separators and still vent condensers must be installed/operating on all dehydrators; 98-percent control must be installed/operational on dehydrators within 30 days of FDOP if total potential uncontrolled dehydrator VOC emissions are ≥8 tpy; combustion units used to achieve 98-percent control may be removed upon approval after 1 year if total potential VOC emissions from dehydrators are <8 tpy.
- Pneumatic Pumps. Pad facilities: VOC and HAP emissions associated with the discharge streams of all natural gas-operated pneumatic pumps controlled by at least 98 percent or the pump discharge streams routed into a closed-loop system such as sales line, collection line, fuel supply; single-well facilities with combustion units installed for the control of flash or dehydration unit emissions: VOC and HAP emissions associated with the discharge streams from natural gas-operated pneumatic pumps controlled by at least 98 percent by routing the pump discharge streams into the combustion unit or the discharge streams routed into a closed loop system.
- Pneumatic Controllers. Install low- or no-bleed controllers at all new facilities.
- Well Completions. Green completions are required in the Jonah, Pinedale and Anticline development fields (JPAD) area and concentrated development areas (**Map 3.5-2**).
- Produced Water Tanks. Pad facilities-upon FDOP, 98-percent control of all produced water tank emissions. No water produced into open-top tanks; single-well facilities within 60 days of FDOP, 98-percent control of all produced water tank emissions at sites where flashing emissions must be controlled. No water produced into open-top tanks.
- Blow-down/Venting. Best Management Practices and information-gathering requirements incorporated into permits for new and modified facilities.
- Other sources. For uncontrolled sources emitting ≥8 tpy VOC or ≥5 tpy total HAPs that do not have presumptive BACT requirements, a BACT analysis must be filed with the permit application for the associated facility.

[8] Flashing losses occur when a liquid with entrained gases goes from a higher pressure to a lower pressure. As the pressure on the liquid drops, some of the compounds dissolved in the liquid are released, or “flashed” as gas.

Map 3.5-2. The concentrated development area (from WDEQ-AQD, 2010)

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.5.2.7 Greenhouse Gases (GHGs)

Greenhouse gases (GHGs) present in the earth's atmosphere trap outgoing longwave radiation and warm the earth's atmosphere. Higher concentrations of GHGs in the atmosphere result in more heat being absorbed and cause higher global temperatures. Some GHGs, such as water vapor, occur naturally in the atmosphere, and some such as carbon dioxide (CO_2) and methane (CH_4) occur naturally and are also emitted by human activities. The global atmospheric concentration of CO_2 has increased by about 36 percent over the last 250 years, and far exceeds pre-industrial values determined from ice cores spanning many thousands of years (IPCC, 2007). The anthropogenic GHGs of primary concern are: CO_2, CH_4, NO_2 and fluorinated gases. Ice core records extending back over thousands of years indicate that worldwide emissions of these anthropogenic GHGs have increased dramatically during the industrial era with an increase of 70 percent between 1970 and 2004 alone (IPCC, 2007).

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme and the World Meteorological Organization in 1988 to provide a clear scientific view on the current state of knowledge about climate change and its potential environmental and socioeconomic impacts. The main activity of the IPCC is to provide at regular intervals Assessment Reports of the state of knowledge on climate change. The latest report is "Climate Change 2007," the IPCC Fourth Assessment Report (AR4). (IPCC 2007). In AR4, the IPCC concluded that warming of the climate system is unequivocal and most of the observed increase in global average temperatures since the mid 20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The IPCC further concluded that, "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century."

The impacts of climate change are expected to vary by region, and there is significant uncertainty regarding the effects of climate change on any particular region. In particular, it is unknown how climate change will affect the CD-C project area or its surrounding environment. However, AR4 identified specific risks for North America as a whole, and these are shown below:

- Warming in western mountains is projected to cause decreased snowpack, more winter flooding and reduced summer flows, exacerbating competition for over-allocated water resources.
- In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20 percent, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources.
- Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity, and duration of heat waves during the course of the century, with potential for adverse health impacts.
- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

The GHGs projected to be emitted by the CD-C Project Alternatives are CO_2, CH_4 and $NO_{2.}$ The atmospheric lifetimes for CO_2, CH_4 and NO_2 are on the order of years (IPCC, 2007). Emissions of GHGs from any particular source become well-mixed throughout the global atmosphere. GHG emissions from all sources contribute to the global atmospheric burden of GHGs, and it is not possible to attribute a particular climate impact in any given region to GHG emissions from a particular source. It is possible to state only that GHG emissions produced by the Proposed Action and action alternatives would add to the global burden of GHGs and may therefore contribute to climate change impacts to the Affected Environment produced by world-wide emissions; these impacts may include those shown above.

In 2007, the U.S. Supreme Court ruled in *Massachusetts v. EPA* that EPA has the authority to regulate greenhouse gases such as CH_4 and CO_2 as air pollutants under the Clean Air Act. The ruling did not, however, require the EPA to create any emission control standards or ambient air quality standards for GHGs. At present there are no ambient air quality standards for GHGs, and there are no emissions limits on GHGs that would apply to the sources developed under the Proposed Action and the action alternatives. There are, however, applicable reporting requirements under the EPA's Greenhouse Gas Reporting Program. These GHG emission reporting requirements, finalized in 2010 under 40 CFR Part 98, will require the Operators to develop and report annual methane and CO_2 emissions from equipment leaks and venting, and emissions of CO_2, CH_4, and N_2O from flaring, onshore production stationary and portable combustion emissions, and combustion emissions from stationary equipment. At present, there are no rules related to GHG emissions or impacts that would affect development of the Proposed Action or the action alternatives besides these GHG reporting requirements.

3.5.3 Air Pollutant Concentrations

The U.S. EPA and the states set limits on permissible concentrations of air pollutants. The National Ambient Air Quality Standards (NAAQS), Wyoming Ambient Air Quality Standards (WAAQS), and Colorado Ambient Air Quality Standards (CAAQS) are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access.

Monitoring of air pollutant concentrations has been conducted within both the CD-C project area and the study area, shown in **Map 3.5-1**. Map 3.5-1 presents the locations of ambient air monitoring sites within the study area. These monitoring sites are part of several monitoring networks overseen by state and federal agencies, including: WDEQ (State of Wyoming), Clean Air Status and Trends Network (CASTNET), Interagency Monitoring of Protected Visual Environments (IMPROVE), and National Acid Deposition Program (NADP) National Trends Network (NTN).

The study area shown in **Map 3.5-1** encompasses five Prevention of Significant Deterioration (PSD) Class I areas and three sensitive Class II areas. The five Class I areas located within the CD-C study area are the Bridger, Fitzpatrick, Mount Zirkel, Savage Run, and Rawah Wilderness Areas, and the three sensitive Class II areas are the Popo Agie Wilderness Area, Dinosaur National Monument, and Wind River Roadless Area.

Air pollutants monitored at these sites include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). Background concentrations of these pollutants define ambient air concentrations in the region and establish existing compliance with ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants as identified by WDEQ-AQD (WDEQ-AQD, 2011) are shown in **Table 3.5-8**.

Table 3.5-8. Background ambient air quality concentrations (μg/m^3)

Pollutant	Averaging Period	Measured Background Concentration
CO[1]	1-hour 8-hour	1,026 798
NO_2[2]	1-hour Annual	75 9.1
O_3[3]	8-hour	126.1
PM_{10}[4]	24-hour Annual	56 13.5
$PM_{2.5}$[5]	24-hour Annual	9.2 4.2
SO_2[6]	1-hour 3-hour 24-hour Annual	19.7 11.5 4.2 3.8

[1] Data collected during 2008 at Murphy Ridge, Wyoming; concentrations are maximum values.

[2] Data collected at Wamsutter, Wyoming: 1-hour concentration is the three year average (2008-2010) of daily maximum 98th percentile 1-hour concentrations, annual value is for 2010.

[3] Data collected at Wamsutter, Wyoming: 8-hour concentration is the three year average (2008-2010) of the fourth-highest daily maximum 8-hour concentrations.

[4] Data collected at Wamsutter, Wyoming during 2010, 24-hour value is maximum concentration.

[5] Data collected at Cheyenne, Wyoming: 24-hour value is the three year average (2008-2010) of daily maximum 98th percentile 24-hour concentrations, annual value is three year average of annual means (2008-2010).

[6] Data collected at Wamsutter, Wyoming: 1-hour value is the three year average (2007-2009) of daily maximum 98th percentile 1-hour concentrations, 3-hour, 24-hour and annual concentrations were collected during 2009, 3-hour and 24-hour data are maximum values.

3.5.4 Air Quality Related Values

An AQRV is a resource "that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource (FLAG 2010). The (AQRVs) visibility, atmospheric deposition, and the change in water chemistry associated with atmospheric deposition at acid-sensitive lakes have been identified as a concern at several Class I and sensitive Class II areas within the study area.

Visibility conditions can be measured as standard visual range (SVR), the farthest distance at which an observer can just see a black object viewed against the horizon sky; the larger the SVR, the cleaner the air. Visibility for the region is considered to be very good. Continuous visibility-related optical background data have been collected in the PSD Class I Mount Zirkel and Bridger Wilderness Areas, as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The average SVR at the both the Mount Zirkel and Bridger Wilderness Areas is over 200 kilometers (Visibility Information Exchange Web System [VIEWS] 2012).

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and it is reported as the mass of material deposited on an area per year (kg/ha-yr). Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). The chemical components of wet deposition include sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4); the chemical components of dry deposition include SO_4, SO_2, NO_3, NH_4, and nitric acid (HNO_3).

The National Acid Deposition Program (NADP) and the National Trends Network (NTN) station monitors wet atmospheric deposition and the Clean Air Status and Trends Network (CASTNET) station monitors dry atmospheric deposition at sites near Centennial/Brooklyn Lake, and Pinedale which are approximately 65 miles east-southeast, and 95 miles northwest, respectively, of the project area. The total annual deposition (wet and dry) reported as total nitrogen and total sulfur deposition for year 2009 at shown in **Table 3.5-9**.

Table 3.5-9. Background nitrogen and sulfur deposition values (kg/ha-yr)

Site Location	Nitrogen Deposition			Sulfur Deposition			Year of Monitoring
	Wet	Dry	Total	Wet	Dry	Total	
Centennial	2.60	0.53	3.13	1.51	0.17	1.68	2009
Pinedale	1.00	0.34	1.34	0.47	0.14	0.61	2009

EPA (2012b).

Table 3.5-10 presents a list of 12 lakes within the study area that have been identified as acid sensitive. Analyses for potential changes to lake acidity from atmospheric deposition are based on the ANC for the lake. The most recent lake chemistry background ANC data are also shown in **Table 3.5-9**. The ANC values shown are the 10th percentile lowest ANC values which were calculated for each lake following procedures provided from the USFS. The years of monitoring data that were currently available, and the number of samples used in the calculation of the 10th percentile lowest ANC values, are provided.

Of the 12 lakes listed in Table 3.5-10, two lakes (Lazy Boy and Upper Frozen) are considered by the USFS as extremely sensitive to atmospheric deposition since the background ANC values are less than 25 microequivalents per liter (µeq/l).

Table 3.5-10. Background ANC values for acid-sensitive lakes

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	10th Percentile Lowest ANC Value (µeq/l)	Number of Samples	Monitoring Period
Bridger	Black Joe	42º44'22"	109º10'16"	69.7	78	1984-2009
Bridger	Deep	42º43'10"	109º10'15"	60.4	75	1984-2009
Bridger	Hobbs	43º02'08"	109º40'20"	70.1	85	1984-2009
Bridger	Lazy Boy	43º19'57"	109º43'47"	12.4	5	1997-2009
Bridger	Upper Frozen	42º41'13"	109º09'39"	7.4	12	1997-2009
Fitzpatrick	Ross	43º22'41"	109º39'30"	54.1	60	1988-2009
Mount Zirkel	Lake Elbert	40º38'3"	106º42'25"	53.6	67	1985-2007
Mount Zirkel	Seven Lakes	40º53'45"	106º40'55"	40.5	24	1985-2007
Mount Zirkel	Summit Lake	40º32'43"	106º40'55"	48.0	108	1985-2007
Popo Agie	Lower Saddlebag	42º37'24"	108º59'38"	55.6	59	1989-2009
Rawah	Island	40º37'38"	105º56'28"	71.4	21	1996-2009
Rawah	Rawah Lake #4	40º40'16"	105º57'28"	41.6	26	1996-2009

Source: USFS (2010).

■ BIOLOGICAL ENVIRONMENT

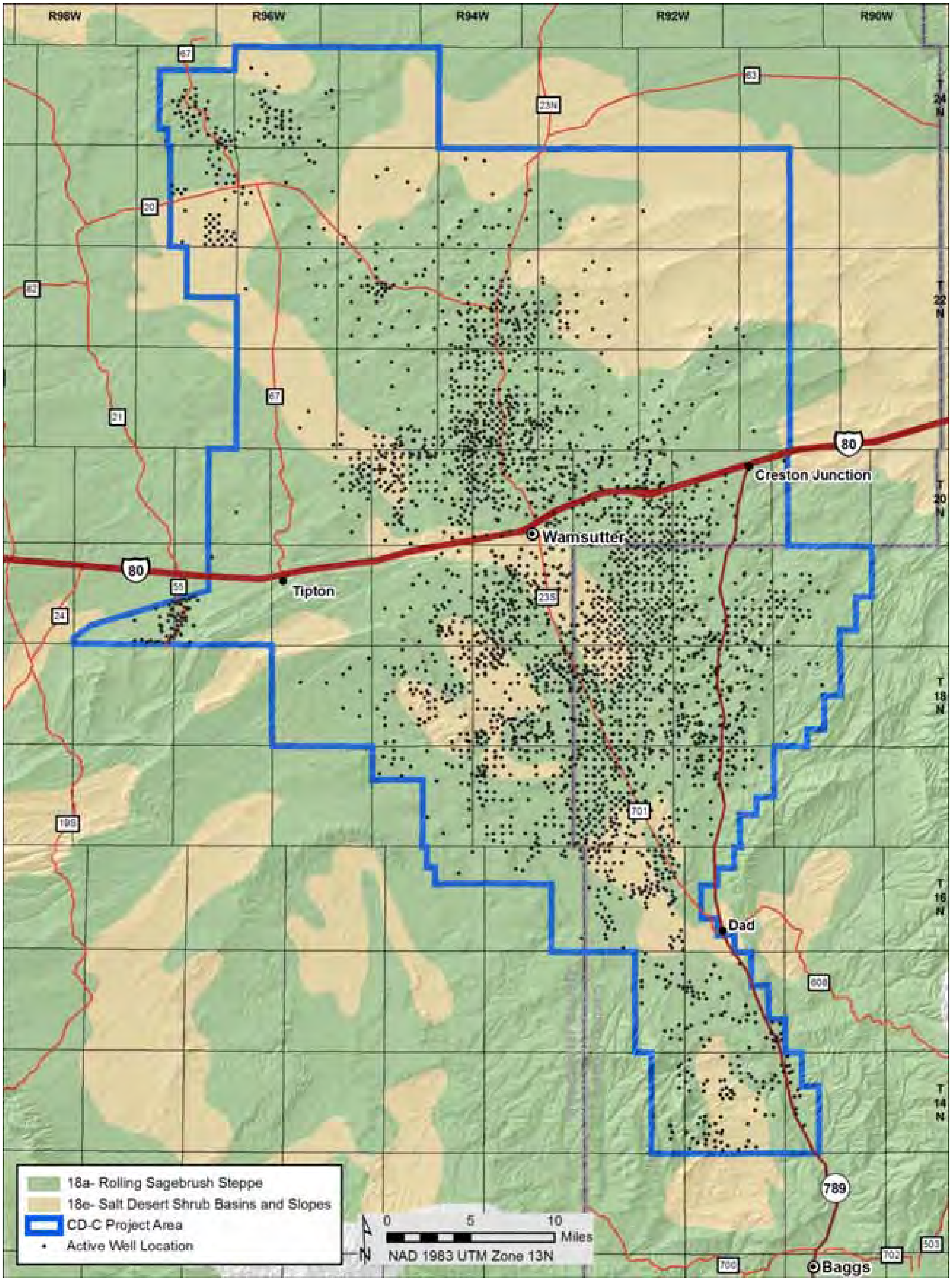
3.6 VEGETATION AND BIOLOGICAL SOIL CRUSTS

3.6.1 Introduction

The CD-C project area is located within the Omernik Level III "Wyoming Basin" Ecoregion 18 (Omernik 1987). This ecoregion is described as a broad intermontane basin dominated by arid grasslands and shrublands and interrupted by high hills and low mountains. Ecoregion 18 is further divided into seven smaller Level IV Ecoregions (18a through 18g) to provide a better description of local diversity within the Wyoming Basin (Chapman *et al*. 2004). Two of these Level IV Ecoregions are present within the project area: 18a (Rolling Sagebrush Steppe) and 18e (Salt Desert Shrub Basins). The approximate boundaries of these two ecoregions within the project area are shown in **Map 3.6-1**.

Ecoregion 18a is described as a semiarid, vast region of rolling plains, alluvial and outwash fans, hills, cuestas (a ridge with a gentle slope on one side and a cliff on the other), mesas, and terraces. Average annual precipitation in this ecoregion ranges from 10–12 inches depending upon elevation and proximity to mountains. The dominant vegetation in this ecoregion is sagebrush (*Artemisia* spp.), often associated with various wheatgrasses (*Agropyron* spp.) or fescue (*Festuca* spp.). Elevation, aridity, slope, aspect, snow accumulation, prevailing winds, and other factors all affect the species composition, morphology, and density of sagebrush communities in the ecoregion. Ecotones between sagebrush steppe and adjacent mountain ecoregions may appear at elevations as high as 9,800 feet (Omernik 1987). The ecoregion is also interspersed with desert shrublands, dunes, and barren area in more arid regions (e.g., Red Desert); and with mixed-grass prairie at the eastern limit of the ecoregion (Knight 1994). Streams originating in the center of the basin are usually incised with a low gradient with fine gravel substrates derived from shales. Small streams are ephemeral or weakly intermittent with sand or platy shale substrates (EPA 2003, 2004).

The Salt Desert Shrub (18e) ecoregion includes disjunct playas and isolated sand dunes. The plains, terraces, and rolling alluvial fans of Ecoregion 18e have soils that tend to be more alkaline and less permeable than soils in the Rolling Sagebrush Steppe (18a). Vegetation is a sparse cover of xeric-adapted species such as shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), and Gardner's saltbush (*Atriplex gardneri*). Areas with stabilized sand dunes are dominated by alkali cordgrass (*Spartina gracilis*), Indian ricegrass (*Achnatherum hymenoides*), blow-out grass (*Redfieldia flexuosa*), alkali wildrye (*Leymus simplex*), and needle-and-thread (*Hesperostipa comata*). This arid region is sensitive to grazing pressure, which may promote the spread of invasive weeds such as Russian thistle (*Salsola kali*), cheatgrass (*Bromus tectorum*), and halogeton (*Halogeton glomeratus*). Land use is primarily rangeland and wildlife habitat (Omernik 1987). Streams are incised and flow into playa areas which are usually seasonal and have high levels of soluble salts (e.g., Chain Lakes area). Substrate is commonly fine-textured material or platy shale gravels (EPA 2003, 2004).



Map 3.6-1. General location of Level IV Ecoregions within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.6.2 Primary Cover Types

Native plants in the project area are predominantly drought-tolerant low shrub, grass, and flowering forb species that are generally distributed according to the biological, chemical, and physical properties of the parent soils of the area, as well as elevation, slope, aspect, and water availability.[9]

Fourteen primary cover types were identified and classified in the project area using the digitized data that were field-verified throughout the 2007 growing season. Ten of the 14 cover types are vegetation cover types and the remaining four are non-vegetated (bare ground, water, rock or talus slopes, and playas). **Table 3.6-1** shows the GIS-derived acreage of each vegetation and non-vegetated cover type. The distribution of the various cover types on the project area is shown on **Map 3.6-2**.

Table 3.6-1. Primary cover types within the project area

Primary Cover Type	Acres	Percent of Total Project Surface Area
Wyoming Big Sagebrush	417,572.7	39.00
Greasewood flats and fans	246,272.7	23.00
Saltbush flats and fans	172,698.7	16.10
Mixed desert shrub	142,062.6	13.30
Mountain Big Sagebrush	54,605.9	5.10
Basin Big Sagebrush	7,157.1	0.70
Basin grassland	5,122.2	0.50
Bare ground	4,117.5	0.40
Water	2,128.5	0.20
Rock or talus slope	1,033.9	0.10
Riparian/wet meadow	1,003.7	0.10
Juniper woodland	536.0	0.05
Vegetated sand dunes	275.5	0.03
Playa	124.3	0.01

Extended drought conditions throughout southwestern and south-central Wyoming have adversely impacted many native shrub communities and several drought-related die-backs and die-offs are evident throughout the project area. The greatest mortality appears to occur in *Artemisia* species and subspecies that are more adapted to mesic sites, e.g., basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) (ATT) and mountain big sagebrush (*A.t.* spp. *vaseyana var. vaseyana* and *var. pauciflora*). The majority of shrub mortality appears to be localized within and along the many draws (e.g., Barrel Springs Draw, Red Wash Draw) and ephemeral drainages within the project area that, in a normal precipitation year, retain enough moisture through the summer months to support the water requirements of these taxa. The more xeric-adapted Wyoming big sagebrush (*A.t. wyomingensis*) (ATW) subspecies and Gardner's saltbush (*Atriplex gardneri*) communities have been least affected. However, many ATW plants exhibit individual stem death which is common for this subspecies under severe moisture stress (Fisser 1987). With the exception of the 2007 growing season, seed production of ATW and Gardner's saltbush has been minimal over the past six to seven years as a result of drought stress. Plant mortality is also evident in several greasewood (*Sarcobatus vermiculatus*) and shadscale stands in the southern portion of the project area (e.g., south of I-80).

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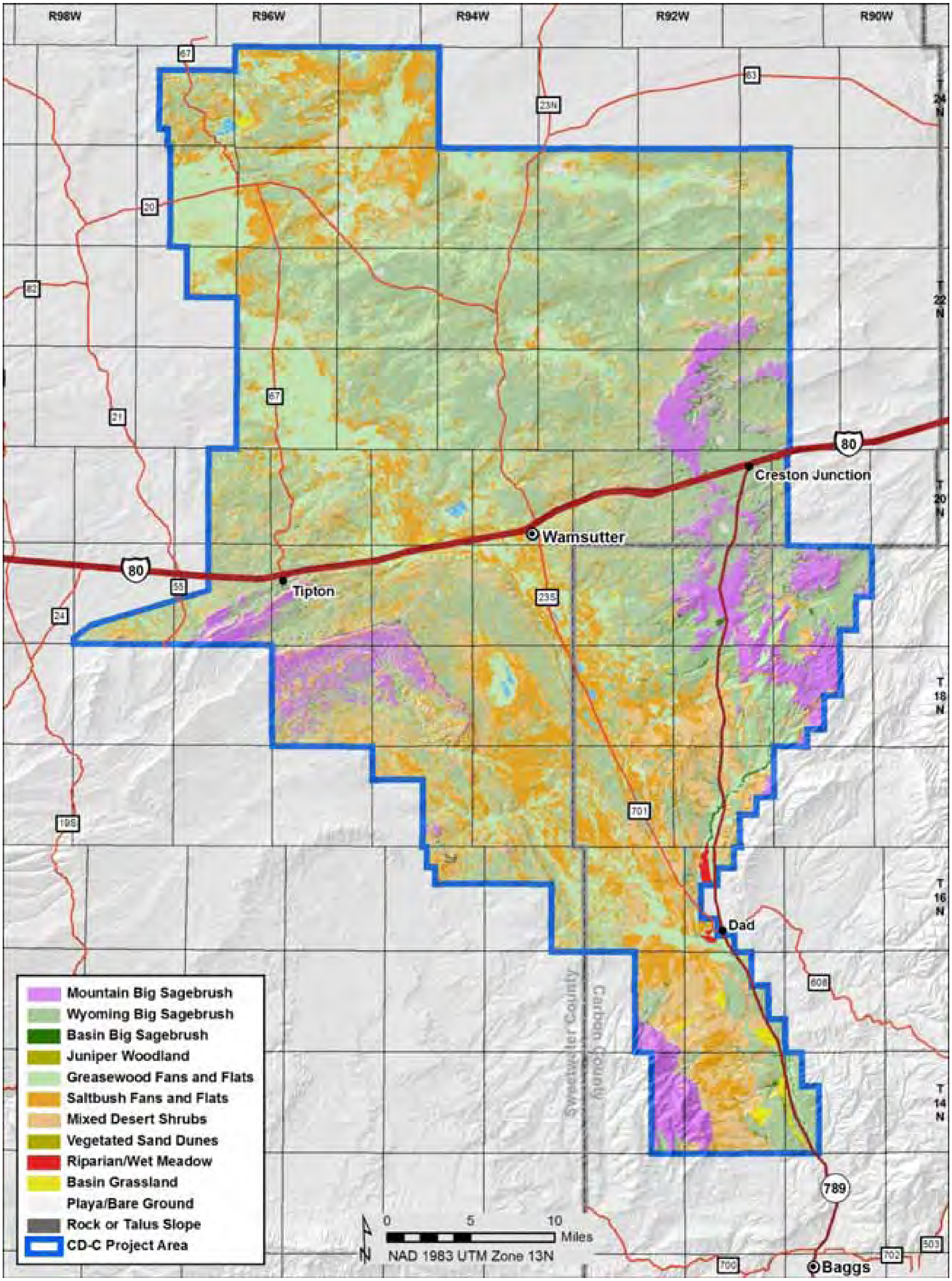
[9] The baseline data for the primary vegetation cover types were provided by Aero-graphics, Inc. (Salt Lake City, UT). The sub-meter aerial photographs were acquired with a fixed-wing aircraft flying at an altitude of 12,000 feet above ground level during the week of June 19–23, 2006. The aerially-acquired data were digitized and ortho-rectified by Aero-graphics. The final digitized data were processed by Hayden-Wing Associates LLC using ArcGIS® Version 9.1.



Map 3.6-2. Major land cover types within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.6.2.1 Mountain Big Sagebrush Cover Type and Subtype Inclusions

In the past, studies have identified *Artemisia tridentata* spp. *vaseyana* as mountain big sagebrush. However, recent investigations (Goodrich *et al*. 1999, Tart and Winward 1996) recognize two varieties of this subspecies, *vaseyana* and *pauciflora*. Numerous field investigations by Hayden-Wing Associates LLC (HWA) throughout Wyoming have found these two varieties are morphologically similar in growth form and are usually intermixed in the same habitat. Therefore, in the project area, these two varieties have been mapped as one type and will be hereafter referred to as mountain big sagebrush (ATVP). ATVP occupies approximately 54,606 acres within the project area, or about 5.1 percent of the project's total land surface area (**Table 3.6-1**).

Throughout the Intermountain West, ATVP is found at elevations from 3,500–9,800 feet and occurs from foothills to subalpine zones. Annual precipitation ranges from 12–30 inches. Soils on which mountain big sagebrush grows range from slightly acid to slightly alkaline and are generally well-drained. Soil moisture is usually favorable throughout the growing season. A large number of grass, forb, and shrub species grow in association with this shrub and usually produce an abundance of forage. Open stands with good, diverse understory are essential to sage-grouse, and such sites can be used in treatment projects to maintain sufficient shrub density and cover for sage-grouse. It is essential that desirable understory species and woody species associated with mountain big sagebrush be retained or reestablished as part of the reclamation effort.

The lower-elevation range of ATVP on the project area is about 6,500–6,800 feet. ATVP plant density (stems per unit area) increases and plant form becomes more robust at about 6,900 feet. These attributes are more noticeable on the leeward side of north/south-oriented ridgelines and hogbacks where topographic features are favorable for extensive snow deposition and retention. The more robust stands appear to be closely associated with the higher elevations along the west rim of the Continental Divide which bisects the project area near Wamsutter, and in the Flat Top Mountain complex in the southern portion of the project area.

The southern and southwestern portions of the project area include the Flat Top Mountain complex (Flat Top Mountain, East Flat Top Mountain, North Flat Top Mountain, and West Flat Top Mountain) and Robbers Gulch areas, where higher elevations and a greater moisture regime provide suitable habitats for ATVP and mountain mixed-shrub communities. North Flat Top Mountain in the NW ¼ Section 2, T14N, R93W is the highest topographic feature in the project area with an altitude of 7,822 feet. It is at these greater elevations with deeper soils that ATVP can grow to over 40 inches tall and become so dense that it is difficult to walk through the stand.

Common grass species associated with the ATVP cover type include:

- Bluebunch wheatgrass (*Pseudoroegneria spicata*)
- Bottlebrush squirreltail (*Elymus elymoides*)
- Green needlegrass (*Nassella viridula*)
- Idaho fescue *(Festuca idahoensis)*
- Little bluegrass (*Poa secunda*)
- Mutton bluegrass (*Poa fendleriana*)
- Needle-and-thread (*Hesperostipa comata*)
- Oniongrass (Melica bulbosa)
- Prairie junegrass (*Koeleria cristata*)
- Spike fescue (*Leucopa kingii*)
- Thickspike wheatgrass (*Elymus macrourus*)

Common understory shrubs may include green (Douglas) rabbitbrush (*Chrysothamnus viscidiflorus*), gray (rubber) rabbitbrush (*Ericameria nauseosa*), and snowberry (*Symphoricarpus oreophilus*), with lesser densities of antelope bitterbrush (*Purshia tridentata*) and serviceberry (*Amelanchier alnifolia*). The increased average annual precipitation at these ATVP sites provides suitable habitat for a diverse and abundant forb component. Frequently observed forb species include the following:

- Arrowleaf balsamroot (*Balsamorhiza sagittata*)
- Beardtongue (*Penstemon* spp.)
- Bluebells (*Mertensia* spp.)
- False dandelion (*Agoseris glauca*)
- Geranium *(Geranium richardsonii)*
- Groundsel (*Senicio* spp.)
- Indian paintbrush (*Castilleja* spp.)
- Phlox *(Phlox multiflora)*
- Sego lily *(Calochortus nuttallianum)*
- Silky lupine (*Lupinus sericeus*)
- Sulphur buckwheat (*Eriogonum umbellatum*)
- Wild onion (*Allium* spp.)

The mixed mountain-shrub cover type is similar to the mountain big sagebrush described above, with the distinction that mountain-shrub species must comprise 5 percent or more of the canopy cover to be classified as a mixed mountain-shrub cover type. Mixed mountain-shrubs occur in the Flattop Mountain complex, especially on the north and east aspects, but ATVP is the dominant shrub species at all these locations.

Chemical treatment of late successional, dense stands of ATVP in the project area has been conducted by the RFO to reduce sagebrush density and increase herbaceous production. Thinning of ATVP with low rates of the herbicide tebuthiuron has been demonstrated to enhance herbaceous plant production, community structure, ecosystem functioning, and biodiversity (Olson and Whitson 2002). The concept of sagebrush “thinning” was developed at the University of Wyoming and has been shown to have broad applications in rangeland environments, including restoration projects.

Wildfires and prescribed fires both occur in the ATVP cover type. Mountain big sagebrush is highly susceptible to injury from fire, and plants are readily killed in all seasons, even by light-severity fires (Blaisdell 1953, Blaisdell *et al*. 1982, Neuenschwander 1980). Without rest or post-burn grazing management, sagebrush cover may return to pre-treatment levels. Lesica *et al*. (2007) examined 38 sites in southwestern Montana and found that average post-fire time to full recovery for mountain big sagebrush was about 32 years. Monitoring of prescribed burns of ATVP with rest or deferment after burning in Carbon County indicates sagebrush recovery may take up to 50 years to reach pre-burn levels (Warren 2004).

3.6.2.2 Wyoming Big Sagebrush Cover Type and Subtype Inclusions

Wyoming big sagebrush (ATW) is the dominant vegetation cover type in the project area and occupies approximately 417,572 acres or about 39 percent of the project’s total land surface area (**Table 3.6-1**). The ATW subspecies can be found throughout the Intermountain West on xeric sites, foothills, valleys, and mesas between 2,500 and 7,000 feet. Annual precipitation varies from 7–15 inches. Soils on which ATW occur are usually well-drained, gravelly to stony, and may have low water-holding capacity. Soils are shallow, usually less than about 18 inches deep. Fewer herbaceous species are associated with Wyoming big sagebrush than with ATT or ATVP. Native bunchgrasses are often important understory species in ATW communities.

ATW occurs in almost an infinite number of communities and associations. Since the plants are almost totally dependent upon moisture received through infiltration and percolation of snow or rain water, their size and productivity responds as a direct result to moisture availability as influenced by soil, chemical, or other site criteria. The ATW communities with vigorous and productive plants are often located in depressions/swales protected from wind. These sites have a relatively deep and porous soil. Open, wind-blown sites normally have a thin, A Horizon topsoil layer. The plants are sparse, small in stature, and exhibit limited productivity. Fisser (1972) identified three recognizable ATW sub-community classifications based on obvious plant heights:

1. Arid – average height about 10–12 inches;
2. Intermediate – average height about 12–18 inches; and
3. Mesic – average height about 18–24 inches.

Healthy and vigorous ATW plants located in ideal growing sites can attain a height of 40 inches.

An estimate of the elevation range for ATW in the project area indicates it is the dominant sagebrush subspecies below an elevation of about 6,500 feet. This elevation is about the same as the lower-elevation limit of ATVP. Therefore, it becomes apparent that in most cases, the transition zone between these two taxa is not well-defined and may occur over a distance of several miles depending mainly on parent-soil characteristics, snow-deposition patterns, slope, and aspect.

The most common grasses associated with the ATW cover type include the following:

- Bottlebrush squirreltail
- Indian ricegrass *(Achnatherum hymenoides)*
- Little bluegrass
- Needle-and-thread
- Thickspike wheatgrass
- Western wheatgrass (*Pascopyrum smithii*)
- Threadleaf sedge (*Carex filifolia*)

Other shrubs often associated with this cover type are typically as follows:

- Broom snakeweed *(Gutierrezia sarothrae)*
- Cotton horsebrush (*Tetradymia canescens*)
- Gray rabbitbrush
- Green rabbitbrush
- Shadscale
- Spiny hopsage (*Grayia spinosa*)
- Plains prickly-pear cactus (*Polyacantha opuntia*)
- Winterfat *(Krascheninnikovia lanata)*

Forbs are less common than in other sagebrush communities due to the more arid environment. However, the most frequently observed species include the following:

- Beardtongue (*Penstemon* spp.)
- Goldenweed (*Happlopappus* ssp.)
- Hood’s phlox (*Phlox hoodii*)
- Hollyleaf clover *(Trifolium gymnocarpum)*
- Hooker’s sandwort (*Arenaria hookeri*)
- Locoweeds (*Oxytropis* spp.)
- Long-leaf phlox (*Phlox longiloba*)
- Low buckwheat *(Erigonum ovalifolium)*
- Spring parsley (*Cymopterus acaulis*)
- Wild onion (*Allium* spp.)

An *Artemisia* taxon closely related to ATW (Winward 1991a) was identified north of the Chain Lake Flats area. This currently undescribed taxon is tentatively known as Gosiute big sagebrush and is thought to be a hybrid between ATW and ATV var. *pauciflora* (Winward 1999). The distribution of this hybrid *Artemisia* is believed to be closely associated with the shoreline soils of the ancient paleolake Gosiute in Wyoming (Winward 1999). A map of the approximate shoreline of Lake Gosiute during the Eocene (Dyni 1996) indicates the eastern extent of its shoreline was approximately near Creston Junction and extended northwest into Sweetwater County, crossing the Chain Lakes area. At its maximum extent, Lake Gosiute covered about 15,000 mi^2 (Dyni 1996). Gosiute big sagebrush has many unique characteristics that are described more fully by Bennett (2004).

On gravelly to rocky, shallow sites, both bluebunch wheatgrass and black sagebrush (*A. nova*) are found in addition to a greater density of cushion plants. This subtype inclusion may be observed at certain locations along Red Creek Road in the northern portion of the project area. The black sagebrush present is the light form of the genus. Other sub-type inclusions in the ATW cover type include small, open areas dominated by bud sagebrush (*Picrothamnus desertorum*) such as that found on the plateau area north of Lost Creek Basin. The most diverse ATW sub-type inclusions observed are associated with the many small, stabilized sand dunes that occur in the western and northern portions of the project area. These dunes are associated with similar dunes found in the Sand Hills, Ferris Mountains, and the Killpecker Sand Dune areas. When the dune is oriented perpendicular to the westerly winter wind, it is not uncommon to observe arid-adapted species such as ATW, spiny hopsage, and prickly-pear cactus on the western aspect of the dune slope and mesic forms such as basin big sagebrush and greasewood on the leeward side where snow deposition provides greater water availability. The dune sites with the greatest vegetation diversity occur near the south shore of the several small lakes in the Chain Lakes area where it is not uncommon to observe budsage, ATW, Wood's rose, shadscale, spiny hopsage, fringed sage (*A. filifolia*), greasewood, and green rabbitbrush growing together, intermixed with grasses and forbs in a very small area.

The value of ATW as an important winter browse species cannot be overemphasized. Mule deer preference for sagebrush species as winter forage is well-documented (Sheehy and Winward 1981, Wambolt 2004). Nelson *et al*. (1994) found that ATW in the winter diets of mule deer in the Baggs Habitat Unit comprised approximately 74 percent of the total diet. DeBolt (2000) found ATW made up more than 70 percent of mule deer diets on winter ranges west of WY 789. ATW is also an important food item for greater sage-grouse (*Centrocercus urophasianus*) and taller stands have been shown to serve as severe winter relief (SWR) habitat for these birds during winters of record-breaking snowfall such as occurred during the winter of 2000–01 (HWA 2004) and 2010–11 (WRCC 2012).

The sagebrush "thinning" concept discussed in the mountain big sagebrush sub-section (**3.6.2.1**) has also been employed by the RFO to reduce ATW density and increase herbaceous production in the Tipton and Flattop areas of the CD-C project area.

Wildfire is not common in the ATW cover type due to the low quantity of fine fuels in the shrub's interspaces that can support and carry a fire. However, in extreme weather conditions (e.g., low humidity, high temperatures, and strong winds) such as was common during the 2000 fire season, fire was observed to carry rapidly through a sparse ATW stand west of Medicine Bow, Wyoming (Bennett 2004).

Following fire or other major disturbance, herbaceous species will dominate the treatment site and recovery to 20 percent canopy cover may take more than 40 years (Young and Evans 1989, Winward 1991b). Site reestablishment is by seed bank, seed production from remnant plants, and seeds from adjacent plants outside of the burn area. Discontinuity of fuels in ATW communities usually results in mosaic burn patterns, leaving remnant plants for seed (Bushey 1987). Overall fire return intervals in ATW appear to have ranged from 10–240 years or more (Winward 1991b, Bunting *et al*. 1987, Young and Evans 1989). Reviewers for the Rapid Assessment Reference Condition Model component of the LANDFIRE project (www.landfire.gov) disagreed about average fire-return intervals in the ATW vegetation group, but agreed the mean fire intervals of 90–140 years were probably realistic (Schmidt *et al*. 2002).

3.6.2.3 Basin Big Sagebrush Cover Type

Basin big sagebrush (ATT) occupies approximately 7,157 acres within the project area or about 0.7 percent of the project's total land surface area (**Table 3.6-1**). ATT typically occurs on the deeper, well-drained soils usually found along ephemeral and intermittent drainages, floodplains, and leeward slopes where water availability is greater than on adjacent uplands. It is often co-dominant with greasewood at certain sites and may occur as small inclusions in the ATW and ATVP cover types. Bennett (2004) found that heights of ATT are a good measure of site suitability. More arid sites produce plants that average about 23 inches in height, intermediate sites about 29 inches and mesic sites greater than 62 inches. At ideal sites such as found along the Muddy Creek drainage, ATT often grows to 10 feet in height, and plants attaining 13 feet in height have been recorded along the Green River in Sublette County (Bennett 2004). Palatability of ATT is generally considered lower than ATW (Rosentreter 2005). This phenomenon was observed by the Rawlins BLM staff during the harsh winter of 1983–84 in the Muddy Creek area. They found that mule deer use of ATW was severe compared to marginal use of ATT, even though animals were starving and winter mortality reached 50 percent in some Herd Units (Warren 2004).

Common understory species in the ATT cover type include the following:

- Aster
- Basin wildrye (*Leymus cinereus*)
- Bluebell
- Buttercup
- False dandelion
- Golden currant (*Ribes aureum*)
- Gray rabbitbrush
- Green rabbitbrush
- Kentucky bluegrass (*Poa pratensis*)
- Little bluegrass
- Locoweed
- Lupine
- Louisiana sagewort (*A. ludovicianna*)
- Povertyweed (*Iva axillaris*)
- Snowberry
- Thickspike wheatgrass
- Violet
- Wild onion
- Wood's rose (*Rosa woodsii*)

Wildfires and prescribed burns both occur in this cover type. Where other species are uncommon or without post-burn grazing management, sagebrush cover may return to pre-treatment levels in 15–20 years. However, monitoring of prescribed burns with rest or deferment after treatment indicate ATT recovery may take up to 50 years to attain pre-treatment levels.

The recent prolonged drought in south-central Wyoming has had a severe effect on ATT. The majority of the sagebrush die-backs and die-offs observed at present in the project area occur in ATT and ATVP stands, both of which depend on perennial mesic conditions for growth, reproduction, and survival. The heaviest mortality has been observed to occur along ephemeral channels in heavier soils where water availability is usually good to excellent in normal years. The most robust plants are currently associated with higher-elevation sandy loam soils on the leeward (usually east) side of slopes where snowdrifts accumulate, thereby increasing water availability. The same beneficial effect can be seen on the leeward side of the many snow fences in the project area, especially along I-80 and WY 789.

3.6.2.4 Juniper Woodland Cover Type

The juniper woodland cover type occupies about 536 acres on the project area or about 0.05 percent of the project's total land surface area (**Table 3.6-1**). Utah juniper (*Juniperus osteosperma*) is the dominant tree within this cover type. The preferred habitat of Utah juniper is usually associated with shallow, rocky soil with a fractured rock substrate, where the tree can root down to and take advantage of collected water. Juniper will also encroach into adjacent sagebrush stands. This can be seen west of the Bluffs in the extreme southern end of the project area, north of Baggs along the west side of WY 789. In April 2007, several hundred mule deer were seen daily on the cuesta west of the bluffs. They appeared to be using the tree area for bedding and thermal cover during the day and then trailing down the slopes to the Muddy Creek drainage for food and water at night. The dominant sagebrush taxon on the cuesta is ATVP, which is ranked as more palatable than ATW and ATT (Rosentreter 2005).

Common understory species associated with this cover type include the following:

- Beardtongue
- Bitterbrush
- Black sagebrush
- Bluebunch wheatgrass
- Canby bluegrass (*Poa canbyi*)
- Goldenweed
- Groundsel
- Indian ricegrass
- Little bluegrass
- Miner's candle (*Cryptantha* ssp.)
- Phlox
- Twin bladderpod (*Physaria* ssp.)

When stands of Utah juniper become too dense, the understory of native grasses and forbs dies out and is usually replaced by invasive species such as downy brome (*Bromus tectorum*) and annual forbs. Fire can be a useful tool in reducing juniper overstory and maintaining understory cover and composition. Where the understory is too sparse to carry a fire, some form of mechanical treatment may be required to restore species diversity. A great number of Utah juniper in this area were logged to produce charcoal for the Union Pacific Railroad (UPRR) smelters in Rawlins in the 1870s–80s (Bennett 2004).

3.6.2.5 Greasewood Flats and Fans

The greasewood cover type occupies approximately 246,273 acres within the project area or about 23 percent of the project's total land surface area (**Table 3.6-1**). Greasewood is a native, deciduous perennial shrub and can attain heights of 8 feet under ideal growing conditions.

Greasewood inhabits a wide range of plant communities within the project area. Plants are typically found growing in saline soils that can be quite moist (wet saline meadows) to dry uplands. Greasewood is often the dominant species in the plant community, but plants are also found associated with saltbush, saltgrass, shadscale, and ATT and ATW sagebrush communities. Ideal habitat for greasewood within the project area is often located on saline valley bottoms (e.g., Muddy Creek floodplain) and on salt-bearing shale outcrops in canyons and on foothills. Sites vary in respect to soil texture and availability of groundwater. Some sites are wet with high water tables, and others are dry with well-drained soils. Greasewood occurs in the project area as smaller, mixed stands to large, monotypic stands. The latter were observed in several large saline basins located in the northern portion of the project area (e.g. Lost Creek and Red Desert Basins). Greasewood can be found at all elevations of the project area. It often encroaches into the big sagebrush and saltbush cover types, especially where additional moisture is available, such as on the many vegetated sand dunes in the southwestern portion of the project area (e.g., north of Mexican Flats).

Greasewood is the dominant shrub associated with the large, vegetated sand-dune complex extending west to east across the northern portion of the area. The most extensive vegetated dune complex is located in T23N:R97W and T23N:R96W. Within this complex, several active dunes are also present. The established greasewood in this sandy area serve as a valuable soil stabilizer by decreasing wind and water erosion. Black greasewood is also the dominant shrub species in the Chain Lakes region in the northern portion of the project area. An unusual greasewood growth form was observed in the vicinity of the several small lakes in this area. The usual upright stature of the plant has been replaced by a low, prostrate, spreading form which rarely exceeds 10–12 inches in height. It is unknown at the present time if this is an ecotypic adaptation or if the plants represent a different subspecies. Greasewood distribution and abundance in the southern portion of the project area is greatest along portions of the Muddy Creek floodplain corridor and in a large, flat basin immediately north of the Mexican Flats area.

The palatability of greasewood in Wyoming is reported as fair for cattle, domestic sheep, horses, pronghorn, mule deer, and small mammals, and as poor for elk, white-tailed deer, small non-game birds and waterfowl (Dittberner & Olson 1983). Poisonous oxalates, found in the leaves, have caused mortality in sheep. Cattle are rarely poisoned, but spines are reported to puncture the rumen (the first chamber of the alimentary canal). Greasewood understory composition is not as diverse as in the big sagebrush cover types.

Common understory species in the black greasewood cover type include the following:

- Basin wildrye
- Biscuitroot
- Bottlebrush squirreltail
- Gardner's saltbush
- Inland saltgrass (*Distichlis spicata*)
- Little bluegrass
- Western wheatgrass
- Wild onion

3.6.2.6 Saltbush Flats and Fans and Sub-type Inclusions

Gardner's saltbush (saltbush) is a native, spreading, low-growing, evergreen perennial sub-shrub and grows from 8–20 inches in height (McArthur *et al*. 1978). Saltbush is the third-largest primary cover type on the project area following the ATW and black greasewood cover types at 172,699 acres or about 16 percent of the project's total land surface area (**Table 3.6-1**).

This cover type is found on saline soils in small to large openings or can occur as "stringer" inclusions within the ATW or greasewood primary cover types. These saltbush stands are sparsely vegetated and bare soil often exceeds 60 percent of the total ground-cover. Average vegetative stem height of saltbush on the project area ranges from 4–10 inches but several robust plants in the 16- to 18-inch range were observed south of the Chain Lakes area along Riner Road. Saltbush reproductive stems were observed to be particularly abundant during the 2007 growing season at all sites within the project area.

The largest monotypic saltbush communities within the project area are located in the Mexican Flats area. However, the northern portion of the project area also contains several sizable communities, and mountain plovers (*Charadrius montanus*) were observed at all locations where this cover type was dominant. The most common sub-type inclusion in this cover type is birdfoot sagebrush (*A. pedifidita*) which may occur as a pure stand or, more typically, intermixed with the saltbush plants.

The persistent leaves of saltbush provide nutritious winter forage for livestock and wildlife species throughout its range (Nord *et al.* 1969). It is particularly important for domestic sheep because it provides the minimum nutritional maintenance requirement for gestating ewes (Fisser & Joyce 1984).

Other common plant species associated with this cover type include the following:

- Biscuitroot
- Western wheatgrass
- Bottlebrush squirreltail
- Little bluegrass
- Indian ricegrass
- Plains prickly-pear cactus
- Threadleaf sedge (most common associate on the project area)
- Wild onion
- Winterfat

Commonly observed inclusions in the saltbush and desert shrub vegetation types are cushion plant communities. Cushion-plant vegetation is found on suitable sites scattered across much of the project area. In the cushion growth form, stems and leaves are densely aggregated near ground level, probably to reduce the stresses of severe environmental conditions (e.g. cold, high winds, desiccation). Cushion-plant vegetation has been divided into two broad categories—alpine and lowland—with completely different species compositions (Knight 1994). The lowland type is found on RFO lands.

According to Jones (2005), a “cushion-plant” is typically defined as a prostrate, acaulescent (having no stem or only a very short stem), tap-rooted forb that typically grows in a dense mat. Examples can be found in a number of plant families and include *Arenaria hookeri* (Caryophyllaceae), *Astragalus spatulatus* (Fabaceae), *Erigeron composites* (Asteraceae), *Eriogonum acaule* (Polygonaceae), *Draba oligosperma* (Brassicaceae), and *Phlox muscoides* (Polemoniaceae). Cushion-plant vegetation is the short, often sparse vegetation on rims and outcrops formed in resistant bedrock, where cushion-plants contribute a major proportion of the plant canopy cover. *Arenaria hookeri* and *Pseudoroegneria spicata* are almost always present in the cushion-plant vegetation and often contribute a substantial amount of the canopy cover. At many sites, these species are joined by *Phlox muscoides* (a cushion-plant) as a dominant or co-dominant. Elsewhere, *P. muscoides* is absent, and a number of other cushion-plants (*Astragalus spatulatus*, *Astragalus simplicifolius*, *Tetraneuris acaulis*, *Stenotus armerioides*) or non-cushion forbs (especially *Phlox hoodii*) are regularly present and sometimes contribute much of the canopy cover (Jones 2005).

The concept of cushion-plant vegetation usually excludes sparse vegetation dominated by non-cushion forbs or sub-shrubs (such as *Atriplex nuttallii* or *Artemisia pedatifida*) that occurs on soft bedrock. In the field, the Wyoming Natural Diversity Database (WYNDD) defines cushion-plant vegetation as vegetation in which cushion-plants are estimated to contribute at least 50 percent of the canopy cover and the grasses and shrubs common in the surrounding shrub-steppe vegetation contributes less than 50 percent of the canopy cover (Jones 2005).

3.6.2.7 Mixed Desert-Shrub

The mixed desert-shrub cover type occupies approximately 142,062 acres on the project area or about 13 percent of the project’s total land surface area (**Table 3.6-1**). The mixed desert shrub cover type as described in this document is a mixture of shrubs and sub-shrubs occurring in dry, saline upland habitats.

Shrub cover is often dominated by shadscale but can be a mixture of saltbush, black greasewood and/or desert cushion plants. Several small sites were observed in the northern portion of the project area along Red Creek Road where bud sage (*Picrothamnus desertorum*) is the dominant shrub with plants reaching 10 inches in height with a robust form which is unusual for this species in Wyoming. A herbaceous understory of forbs and grasses is usually present within this cover type and biological soil crusts are usually present on the soil surface. This cover type exhibits three phases including: (1) sites dominated by sagebrush, (2) sites dominated by saline-tolerant shrubs such as greasewood and saltbush, and (3) discontinuous areas devoid of woody shrubs, but with the same herbaceous understory components characteristic of shrub-covered areas. As with the saltbush vegetation cover type, cushion plant communities are often observed in the mixed desert shrub cover type.

Common herbaceous ground-cover species in desert shrub communities include the following:

- Bluebunch wheatgrass
- Buckwheat
- Common yarrow *(Achillea millefolium)*
- Indian paintbrush (*Castilleja* spp.)
- Indian ricegrass
- Needle-and-thread grass
- Plains prickly-pear
- Sandberg bluegrass
- Threadleaf sedge
- Western wheatgrass

In addition to sagebrush, other shrubs commonly observed in this cover type often include the following:

- Gray rabbitbrush
- Green rabbitbrush
- Shadscale
- Spiny hopsage
- Spiny horsebrush

3.6.2.8 Vegetated Sand Dunes

Vegetated sand dunes occupy approximately 276 acres within the project area, or about 0.03 percent of the project's total land surface (**Table 3.6-1**). The largest sand-dune complex in the project area is in the northern portion of the project area and primarily located in T23N:R97W and T23N:R96W in Sweetwater County, north of County Road (CR) 67 and CR 20. Several dunes in this complex are currently active and vegetation is absent. Many smaller, vegetated dune sites are located throughout the west-central portion of the project area west of Dad and near the southern edge of the Chain Lakes area. Greasewood is the dominant shrub on many of these dunes and serves as a valuable soil stabilizer by decreasing wind and water erosion. A recent investigation of the Killpecker sand dune area in southwest Wyoming by Mayer and Mahan (2004) found that the age of eolian sand (15,000 years before present [B.P.]), combined with those of Folsom (12,950–11,950 years B.P.) and Agate Basin artifacts (12,600–10,700 years B.P.) overlying eolian sand, indicates the dune field existed at least during the late Pleistocene.

These unique sites provide micro-environments that allow for greater plant diversity than adjacent upland sites. Steidtmann (1973) found that snow may become incorporated in eolian sand dunes of southwestern Wyoming when snow cornices on dune crests begin to melt, slide down the lee slope, and are covered by sand during subsequent lee-slide deposition. In some cases burial is rapid enough to provide the insulation necessary to preserve the ice and snow within the dune throughout the year. The smaller dunal areas such as those found west of Dad are predominantly oriented perpendicular to the westerly prevailing winter wind, forming natural snow-breaks that trap snow on their leeward side. It is not uncommon to observe ATW (arid form), spiny hopsage, and prickly-pear cactus on the western aspect and ATW (mesic form), ATT, and greasewood on the leeward side of these smaller, stabilized sand dunes.

The small dune sites south of the Chain Lakes complex often occur within other primary cover types (e.g., ATW and saltbush) and form hummocks covered with a diverse shrub and herbaceous understory very different than the surrounding vegetation. At several sites it was observed that a combination of budsage, ATW, shadscale, spiny hopsage, fringed sage, greasewood, and green rabbitbrush intermixed with grasses and forbs were all occupying these small hummocks.

3.6.2.9 Riparian Cover Types

The riparian/wet-meadow cover type occupies about 1,004 acres on the project area or about 0.10 percent of the project's total land surface area (**Table 3.6-1**). Riparian sites often occur as narrow corridors traversing many different plant zones. Streams and drainages often occupy very small but important sites within major land types. The vegetation and habitat provided by the riparian zone is extremely important to the management of associated lands. Riparian sites attract and sustain livestock and wildlife and are particularly important during the midsummer months. The recent extended drought has concentrated the use of riparian sites by livestock, wildlife, and wild horses—usually with deleterious effects. The two allotments that did not meet Standard # 2 (Riparian/Wetland Health) of the Standards for Public Land Health (See **Section 3.6.3**.) were the Cyclone Rim (10103) and Jawbone (00709) allotments. The Cyclone Rim allotment failed the Standard because of non-functional or Functioning-At-Risk springs and seeps. Identified causes included previous excessive use by wild horses during the growing season, often complicated by livestock grazing (BLM 2001a). There is only one permanent water source (Mud Springs) in the Jawbone allotment (23,000 acres/9,307 ha.) in addition to one well and ten semi-reliable reservoirs. Summer cattle use was identified as the primary factor affecting the wetland habitat/vegetation in this allotment. Since the 1998-2000 PFC evaluations, fencing and off-site water development have been installed at many of these sites (BLM 2001a).

Riparian communities often provide diversity to otherwise rather barren and exposed wildlands. Riparian habitat within the project area occurs along perennial and intermittent drainages, around seeps and springs, and around man-made reservoirs. Although small in extent, these areas are the most productive of all vegetation types and therefore are extremely important for wildlife habitat and livestock forage.

The major drainage in the southern portion of the project area is Muddy Creek (HUC 14050004). Muddy Creek is described as a high-elevation, cold-desert stream originating in the Sierra Madre Range east of the project area and terminating at its confluence with the Little Snake River near Baggs, Wyoming. Upstream from this confluence, numerous unnamed ephemeral channels and named draws flow into Muddy Creek.

The northern portion of the project area generally drains into the Great Divide Basin (HUC 14040200) via Separation Creek. The Great Divide Basin is a closed basin bounded by the Continental Divide on all sides and has no hydrologic outlet (Seaber *et al*. 1987). The Great Divide Basin is a relatively shallow depression with isolated buttes, pan-like depressions, and sparse vegetation. Numerous ephemeral streams flow toward the center of the Basin before disappearing into the soil or man-made impoundments. The Chain Lakes complex is located approximately 32 miles northwest of Rawlins. Two large lakes and several small lakes extend from west to east across the flats. This general area supports greater sage-grouse, migratory waterfowl, and shorebirds, and provides winter habitat for pronghorn. Small bands of wild horses from the Lost Creek Herd Management Area (HMA) are commonly observed in this part of the project area.

Riparian/wetland habitat within the project area can be defined and described in the following groups: desert springs and seeps, and streams supported by them; playa lakebeds; wetlands in the Chain Lakes area; and man-made wetlands around artesian wells. Streams in the area generally flow short distances supporting riparian vegetation before turning into ephemeral/intermittent drainages that do not support riparian vegetation. A good example is Lost Creek which is fed by Eagle's Nest Spring. Riparian conditions exist above the Red Creek Road culvert before the stream disappears underground. However, from the culvert and continuing to Lost Lake, the creek's stream bed is normally dry and its riparian corridor supports mainly greasewood and non-riparian vegetation. The Lost Creek drainage corridor was observed to provide excellent pygmy rabbit habitat and appears to be a major travel route and bedding area for elk from the Red Desert Migratory Elk Herd. Three to seven head of elk were consistently seen in this area during Apri – May, 2007. The Lost Creek streambed below Eagle's Nest Spring was documented by HWA to contain persistent sepal yellowcress (*Rorippia calcycina*), a BLM-designated special status plant species. The 2006 and 2007 HWA special status plant species survey results are available as a separate Technical Report (HWA 2008a).

Riparian grassland habitat types are the most common forms of vegetation found within riparian areas in the project area. Riparian grasslands are wetland-, stream-, or spring-associated grass and grass-like communities, which are maintained by a water table within rooting depth during most of the growing season. Common species include the following:

- Alkali sacaton *(Sporobolus airoides)*
- Asters
- Baltic rush *(Juncus balticus)*
- Basin wildrye
- Beaked sedge (*C. utriculata*)
- Cinquefoil *(Dasiphora floribunda)*
- Horsetail *(Eqisetum arvense)*
- Inland saltgrass (*Distichlis spicata*)
- Kentucky bluegrass
- Liddon sedge (*C. petasata*)
- Mat muhly *(Muhlenbergia richardsonis)*
- Mint (*Mentha* spp.)
- Nebraska sedge (*Carex nebrascensis*)
- Redtop *(Agrostis stoloifera)*
- Spike sedge (*C. nardina*)
- Thistle
- Tufted hairgrass *(Deschampsia caespitosa)*
- Wheatgrass

The majority of the project area consists of ephemeral drainages (washes, draws, gullies) which flow only in response to snowmelt in early spring or as a result of summer precipitation events which are usually of short but intense duration. Soil erosion may be severe where erosion devices are not present or ground cover is sparse.

The most prominent natural wetland system in the northern portion of the project area is the Chain Lakes complex. These lakes and adjacent habitats support riparian grassland and open aquatic-emergent wetland habitats. Within these alkaline wetlands, the shallow pools where salts accumulate are the harshest growing environment for plants. Plants must tolerate not only standing water in spring, but also dry and extremely alkaline soils in late summer. Stunted, scattered plants of arrowgrass (*Triglochin* spp.), an exceedingly salt-tolerant, grass-like forb, are frequently the sole inhabitants of these highly alkaline depressions. Alkali plantain (*Plantago eriopoda*) and inland saltgrass can survive in less alkaline depressions. Like most halophytes (plants adapted to grow on salty soils) these plants have the ability to accumulate higher concentrations of salts in their cell sap than salt concentrations in the soil water. By concentrating salts, these halophytes can draw soil water into their roots, since water generally flows from areas of low salt concentration to areas of higher salt concentrations

Plant species in these areas are saline/alkali tolerant and may include:

- Alkali plantain
- Alkali saltgrass (*Distichlis stricta*)
- American bulrush *(Schoenoplectus americanus)*
- Arrowgrass
- Baltic rush
- Buttercup
- Cinquefoil (*Potentilla* spp.)
- Greasewood
- Hairy goldaster *(Heterotheca villosa)*
- Nuttal’s alkaligrass (*Puccinellia nuttalliana*)
- Rocky Mountain glasswort (*Salicornia rubra*)
- Sea milkwort (*Glaux maritima*)
- Slim sedge *(Carex praegracilis)*
- Tufted hairgrass *(Deschampsia caespitosa)*

The Chain Lakes wetlands also provide habitat for meadow milkvetch (*Astragalus diversifolius* var. *diversifolius*), recently discovered in 2008 by the WYNDD (Heidel 2008). The species has now been documented in three extant occurrences in south-central Wyoming, totaling approximately 8,000 plants within about 187 acres, near the Chain Lakes region of the project area (Heidel 2009) and was recently added to the BLM sensitive plant list (BLM 2010) (see **Section 3.9.2.3 Sensitive Plant Species**).

Man-made wetlands occur primarily next to artesian wells and reservoirs or pits. Wetlands supported by artesian wells are mostly composed of sedges, bulrushes, and several grass species. Many reservoirs and pits in the project area do not hold water on a year-long basis and the perennial drought that began with the 2000 growing season has had negative effects on water-storage capabilities and wetland vegetation health.

An extensive wetland complex known as the George Dew/Red Wash Wetland Complex is located near Dad about 25 miles north of Baggs, west of and adjacent to WY 789. This site encompasses approximately 6 miles of willow-dominated (*Salix* sp.) riparian corridor along Muddy Creek with associated floodplain and meadows ranging from 0.25 to 0.75 mile wide, constructed and natural impoundments, and adjacent upland sites dominated by greasewood, sagebrush, and Gardner saltbush. The George Dew/state land wetlands project is within the Muddy Creek Wetland Complex. The wetland component of this project was designed to protect and enhance about 1,100 acres of existing wetlands and create 125 acres of new wetlands (Wyoming Riparian Association 1997).

3.6.2.10 Basin Grassland

The basin grassland vegetation cover type occupies approximately 5,122 acres within the project area or about 0.5 percent of the project's total land surface area (**Table 3.6-1**). This cover type is found in scattered park-like patches throughout the project area. Shrubs such as the native rabbitbrushes, winterfat, and various sagebrush species and subspecies may be present but cannot occupy more than 25 percent of the total ground cover to be classified as basin grassland. Herbaceous species often include western wheatgrass, blue grama, needle-and-thread, threadleaf sedge, Sandberg bluegrass, and prairie junegrass. Plains prickly-pear is also commonly observed in this cover type.

3.6.2.11 Non-vegetated Cover Type—Bare Ground

Bare ground on the project area accounts for approximately 4,117 acres or about 0.4 percent of the project's total land surface area (**Table 3.6-1**). Bare ground, as defined in this EIS, contains less than 7.5 percent vegetated ground cover. The soils in these relatively low-production areas and underlying parent materials are very soft and highly erosive, and the landscape is cut with a large number of drainage channels. Vegetation, if present in these sites, is sparse and may include various species ranging from stunted shrub forms to scattered bunchgrasses (e.g., Indian ricegrass and needle-and-thread).

3.6.2.12 Non-vegetated Cover Type—Water

This non-vegetated cover type occupies approximately 2,129 acres or about 0.2 percent of the project area (**Table 3.6-1**).

3.6.2.13 Non-vegetated Cover Type—Rock or Talus Slope

This non-vegetated cover type occupies approximately 1,034 acres or about 0.1 percent of the project area (**Table 3.6-1**), and includes naturally occurring areas of bare rock such as canyon cliffs, spires, rock outcrops, and talus fields.

3.6.2.14 Non-vegetated Cover Type—Playa

Playas occupy approximately 124 acres in the project area (**Table 3.6-1**). Playas are characterized as water catchments that are most often ephemeral, drain internally, accumulate sediment, and serve as recharge points to underground aquifers. While playas themselves are usually devoid of vegetation, they are commonly ringed by greasewood, shadscale, saltbush, and other salt-tolerant plants that provide critical winter forage for livestock and other herbivores. In Wyoming, playas, when flooded, are important sources of habitat for wildlife including waterfowl such as ducks and geese, along with sandhill cranes and shorebirds. Amphibians such as frogs, toads, and salamanders also depend on playas, as do several major orders of insects.

In most years playas are dry or water may only cover the lowest portion, the portion near a water source such as a spring, or the portion where an ephemeral stream discharges onto the playa surface. Between wet periods the surface of the playa typically dries out completely and may even become desiccated, forming polygonal cracks and fissures in clay-rich sediments. In playas where the groundwater table is at or near the surface, soluble salts will precipitate, forming ephemeral crusts that may or may not survive subsequent wetting episodes. The high salt and clay content of playa surface mud, and the dry and hot conditions that prevail most of the year, usually prevent plants from becoming established.

3.6.3 Watershed-Based Land Health Assessment

In 2008 the RFO finished conducting Standards and Guidelines Assessments for all the watersheds within the field office. These are watershed-based land health assessments mandated by the Director of the BLM on a 10-year basis. From 1998 through 2000, the RFO conducted Standards and Guidelines Assessments on an allotment basis; however, in 2001 to meet this 10-year timeframe, larger-scale watershed-based reports were undertaken. The Upper Colorado River and the Great Divide Basin were the first two watershed reports completed (2002 and 2003 respectively). Because these two watersheds were the first completed they are due for reassessment, at which time progress towards management objectives will be evaluated. Two of the standards apply to vegetation. Standard 2, Riparian and Wetland Vegetation, states that "riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge." Standard 2 is considered to be met if riparian/wetland habitat is rated in Proper Functioning Condition (PFC) and existing management will lead to maintaining and/or improving resource conditions (BLM 2002).

Standard 3, Upland Vegetation, states that "vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance." Standard 3 is considered to be met if plant communities are sustaining themselves under existing conditions and management.

During the 2001 field season, project area watersheds within the Upper Colorado River Basin were assessed (BLM 2002). Results of the 2001 assessment indicated that Standard 2 – Riparian/Wetland Health, was being met by most allotments within the assessment area with the exception of 14 allotments, two of which are located in the project area (Cherokee 00408 & Red Creek 10521).

Most of the lentic and lotic sites that are not meeting the standard have been, or are in the process of being, addressed in management plans or as range improvement projects (BLM 2002). Assessment results for Standard 3 – Upland Vegetation Health, indicated that natural and ecological processes were functioning adequately for most vegetation communities. However, the review team had concerns about the uniformity of age classes in many shrub stands which may lead to over-maturity/decadence on a large scale if not properly managed. Shrub communities in this late-seral stage are particularly susceptible to large-scale die-offs due to many environmental and biological factors including drought, insect infestations, and disease.

3.6.4 Fugitive Dust Effects on Vegetation

The Environmental Protection Agency (EPA) states that the largest single source of fugitive dust in the U.S. is from unpaved roads which contribute about 10 million tons of particulate matter (PM) air pollution each year (EPA 1998). Dust from roads can contain very fine particles known as PM_{10} (particulate matter less than 10 microns in diameter) and $PM_{2.5}$ (particulate matter less than 2.5 microns in size). Ten microns equals about 1/7th the diameter of a human hair. Of greatest concern are the $PM_{2.5}$ particles that make up part of a dust cloud. Although PM and other air-quality issues are described more completely in **Section 3.5 Air Quality**, a brief discussion of the negative effects of fugitive dust on roadside/rangeland vegetation is presented in this section.

Dust deposits on plants can have important effects on plant life. These effects may include (but are not limited to):

- Reduced photosynthesis due to reduced light penetration through the leaf surface. This may cause stunting and/or reduced growth rates and plant vigor.
- Increased incidence of plant pests and disease. Dust deposits can act as a medium for the growth of fungal diseases.
- Reduced efficacy of herbicide sprays due to reduced penetration of the herbicide through the leaf surface.
- Reduced productivity and changes in community structure (the species of plants present) (Farmer 1993).
- Increased leaf temperatures and water loss, with decreasing carbon dioxide uptake (Eller 1977, Hirano *et al*. 1995, Ricks and Williams 1974, Fluckinger *et al*. 1979, Thompson *et al*. 1984).
- Decreased palatability and avoidance by wildlife and livestock.
- Increased tooth wear for herbivores.
- Greater biomass of annual plants within the dust-plume-affected area. Phenological differences (see **Glossary**) among the vascular plants are possibly due to differences in soil temperature on and off the dust-plume area early in the growing season (Spencer and Tinnin 1997).
- Susceptibility of vegetation in proximity to roads to chronic diseases affiliated with photosynthesis and growth, which may eventually lead to accelerated erosion problems from lack of adequate roadside vegetation, reduction in quality and quantity of available browse for livestock and wildlife, and creation of new sites for noxious weed infestations (Gebbhart and Hale 1996).
- Potential contamination of native wildflowers and their blossoms, altering patterns of pollen dispersal (and thus gene flow) among plants by altering the foraging behavior of pollinating insects. This impact could be important in habitats in proximity to unpaved roads occupied by USFWS or BLM special status plant species of concern.

GIS analysis of the road system within the project area indicates a total of about 5,736 miles of roads within the project's boundaries. This total includes: about 126 miles of paved roads (mainly I-80 and WY 789), about 2,055 miles of improved maintained exotic (e.g. graveled/rocked) roads, about 86 miles of improved maintained natural (e.g., natural surface) roads, and about 3,469 miles of unimproved, unmaintained natural (e.g., two-track) roads. These totals indicate that the total mileage of paved roads within the project area represents only about 2.2 percent of the total road system. **Section 3.16 Transportation and Access** describes the local and regional transportation network associated with the project area.

The primary factors that generate dust on unpaved roads include (Bolander 1999, Addo and Sanders 1993):

- Vehicle speed
- Number of wheels per vehicle
- Number of vehicles
- Vehicle weight
- Particle size distribution (gradation) of the surface material
- Restraint of the surface fines (compaction, cohesiveness/bonding)
- Durability of the road surface

A 1993 U.S. Department of Transportation study cites a 1983 Forest Service estimate that for every vehicle traveling one mile of unpaved roadway once a day, every day for a year, one ton of dust is deposited along a corridor extending 500 feet on either side of the roadway (Addo and Sanders 1993). In a study conducted in Australia, McCrea (1984) estimated the potential losses in crop productivity for various rates of dust deposition. The main focus of the report was on horticultural crops grown alongside unpaved roads, and in this case the losses occurred within about 656 feet of the source.

To estimate the acreage of the project area that could be affected by road-generated fugitive dust, a GIS-generated mileage total for all improved exotic and improved natural surface roads within the project area was calculated and then buffered on each side of the road centerline by 578 feet to equal the average total width from the above two mentioned studies (1,156 feet). The two-track road mileage was not included in the calculations because of their minimal use. The results indicate that approximately 260,483 acres could be affected by road-generated fugitive dust deposition, or about 24.3 percent of the project's total land-surface area. This total, at any given time, would be dependent upon season of use, the primary factors listed in this section, and weather-related factors, especially the timing and amount of precipitation events (or lack thereof). A proactive and aggressive road-watering/dust-suppression program could noticeably lower this estimate during the hotter and drier summer months that are generally associated with greater dust-generation potential.

3.6.5 Biological Soil Crusts

Biological soil crusts (BSCs), also referred to as cryptogamic, microbiotic, cryptobiotic, and microphytic crusts, are a complex assemblage of organisms including cyanobacteria, green algae, mosses, lichens, microfungi, and other bacteria that colonize the first few millimeters of the soil surface. Soil crusts are found in all hot, cool, and cold arid and semi-arid regions and may constitute up to 70 percent of the living cover in some plant communities (Belnap 1994). The functions of BSCs in rangeland ecosystems include retention of soil moisture by serving as a living mulch on the soil surface; reduction of wind and water erosion; fixing atmospheric nitrogen; and contributing to soil organic matter (Eldridge and Greene 1994).

The primary environmental factors that influence the distribution of biological soil crusts include elevation, precipitation volume, timing of precipitation, physical and chemical properties of the soil, topography, and disturbance regimes (Belnap 2001). The historic and current distribution of BSCs in the project area is largely unknown. However, field work conducted by HWA during May and June of 2007 found soil crusts at several locations within the project area, with moss crusts the most frequently encountered. Moss crusts were found growing within cacti aggregations or underneath shrub canopies, and less frequently in the open plant interspaces. Moss crusts were also observed in several plant communities including those dominated by Wyoming big sagebrush, mountain big sagebrush, saltbush, and greasewood. Cyanobacterial crusts were observed in portions of the project area where the soils were less stable (e.g., sandy areas) or the crusts were re-establishing after disturbance. Lichen crusts were observed less frequently than moss or cyanobacterial crusts. The Creston grazing exclosure within the project area was observed to have a well-established lichen crust, including: *Aspicilia, Caloplaca, Collema, Xanthoparmelia,* and *Psora*. The most common moss was *Tortula*. Crustal development was greatest underneath shrub canopies or on the edges of bunchgrasses and less so in the plant interspaces. The assemblage of species present at this Wyoming big sagebrush site indicates a late-successional stage of crust development. This provides evidence that mature and diverse soil crusts have the potential to occur within the project area, given suitable environmental conditions.

3.7 INVASIVE, NON-NATIVE PLANT SPECIES

Generally, the term “weed” can be used for any unwanted plant. Terms such as aliens, exotics, and invasives are used interchangeably to describe specific weeds. All these descriptions have a common concept: plants introduced into an area in which they did not evolve that have the potential to cause noticeable economic and/or ecological impacts. When weeds become so widespread that they threaten crops, livestock, or native species, they may become more than just a “weed.” They might then be termed “noxious weed,” “invasive species,” “exotic species,” “alien species,” or some similar term as set forth in law by each governing body or land-management agency.

Invasive plant species pose a threat to the long-term productivity, diversity, and aesthetic values of lands within the RFO. Recent extended drought conditions in Wyoming, in conjunction with unprecedented energy development and other construction activities in western Wyoming, have favored the establishment and spread of invasive weed species.,This has occurred not only in disturbed habitats, but also in native rangeland where the stress of drought has resulted in decreased vigor, annual production, resilience, and competitive capabilities of native grassland and shrub communities, thus creating an ideal environment for invasion and establishment of aggressive and invasive weedy species.

The principal invasive weeds known to occur in or near, or which have been treated within, the project area include (BLM 2002) Russian knapweed (*Centaurea repens*), houndstongue (*Cynoglossum officinale*), halogeton (*Halogeton glomeratus*), hoary cress (whitetop) (*Cardaria draba* and *Cardaria pubescens*), perennial pepperweed (giant whitetop) (*Lepidium latifolium*), spotted knapweed (*Centaurea maculosa*), common burdock (*Arctium minus*), and saltcedar (*Tamarix* spp.). The primary impact of these invasive species to the range resource is their ability to out-compete native species; in addition to their competitive nature, Russian knapweed, halogeton, and houndstongue are poisonous to wildlife and/or livestock.

Many of these invasive species are associated with disturbed areas such as road/pipeline rights-of-way and well pads. Other common invasive weed species observed in the project area include cheatgrass (*Bromus tectorum*), Russian thistle (*Salsosa kali*), netseed lambsquarter (*Chenopodium berlandieri*), bull thistle (*Cirsium vulgare*), black henbane (*Hyoscyamus niger*), common mullein (*Verbascum thapsus*), clasping pepperweed (*Lepidium perfoliatum*), kochia (*Kochia scoparia*), as well as several wild mustards.

Of the invasive plant species found in the project area, halogeton represents an ecological and economic threat to the area due to its unparalleled rapid infestation and widespread establishment. Prior to the onset of extended drought conditions in Wyoming beginning in 2000, halogeton was present at low densities in southwest and south-central Wyoming but its presence was primarily restricted to range sites degraded over time by heavy livestock concentrations such as near feed-grounds, corrals, and travel-ways or disturbed sites such as the reclaimed Santa Fe Browning gravel pit near Wild Horse Butte (Bennett 2004). Extensive invasive weed surveys conducted by HWA during the 2007 growing season indicated that approximately 13,353 acres, or about 1.2 percent of the surface area of the project area, were infested with halogeton. This is a conservative estimate based upon surveys at specific sites such as well pads and road/pipeline rights-of-way (HWA 2008b).

Although not quantified, the actual surface area infested by halogeton could be greater based on field observations that halogeton spreads laterally from infested road/pipeline rights-of-way into adjoining native rangeland. Observations made during the 2007 growing season, especially along the major north/south-oriented roads (e.g., Wamsutter Road) indicated that the lateral spread of halogeton was usually minimal ($\pm$ 15–20 feet) on the windward (west) side of the road but could extend as far as 0.25 mile on the leeward side (east) of the road right-of-way. The direction of the prevailing winds during October and November when the plants are in the seed-drop stage is probably the dominant variable that controls dispersal direction. Halogeton seed is extremely light and fluffy and easily transported by even a slight breeze. If the same criteria are used as with fugitive dust impacts (**Section 4.7.3.1**), it is evident that as many as 260,000 total acres of disturbed and native rangeland in the project area may be at risk of infestation with halogeton.

3.8 WILDLIFE

3.8.1 Terrestrial Wildlife

Information concerning current and historical wildlife observations and distribution within and near the CD-C project area were obtained from a variety of sources including BLM, USFWS, Wyoming Game and Fish Department (WGFD), Wyoming Natural Diversity Database (WYNDD), and information compiled from personal communications and unpublished data from BLM, WGFD, and USFWS biologists. The WGFD Wildlife Observation System (WOS) and WYNDD are the primary repositories for wildlife information in the state of Wyoming and contain records of wildlife observations for birds, mammals, herptiles (amphibians and reptiles), fish, and species of special concern. Wildlife information for the project area was supplemented with survey data collected by Hayden-Wing Associates, LLC (HWA) during 2006–2007 as part of the baseline and monitoring data requirements for the EIS.

At least 396 wildlife species occur in and around the project area including: 77 mammal, 273 bird, six amphibian, 10 reptile, and 30 fish species (**Appendix H**). All wildlife species are important members of a functioning ecosystem and wildlife community, but most are common and have wide distributions in the region. Consequently, the relationships of most of these species to the proposed project are not discussed in the same depth as species that are Threatened, Endangered, rare, of special concern, of special economic interest, or otherwise of high interest or unique value.

3.8.1.1 Wildlife Habitat

A wide variety of wildlife habitats and associated species occur in the project area. Wildlife habitats that would be affected by the project include the areas that would be physically disturbed by the construction of gas wells, related roads, pipelines, and production facilities, as well as zones of influence surrounding them. Zones of influence are defined as those areas surrounding or associated with project activities where impacts to a given species or its habitat could occur. The shape and extent of such zones varies with species and circumstances.

The project area is located in the Wyoming Basin Omernik Level III Ecoregion (18) and includes portions of the Rolling Sagebrush Steppe (18a) and Salt Desert Shrub Basins (18e) Level IV Ecoregions (Chapman *et al*. 2004). Topography in the project area is characterized by rolling plains interrupted by hills and strike-dip ridges dissected by alluvial and outwash fans that empty into broad, level basins. Ridges, hills, and rolling plains support vast areas of mixed-grass prairie and Wyoming, mountain, and basin big sagebrush communities. Active and stabilized sand dunes, as well as disjunct playas and alkaline flats, are interspersed throughout the project area where existing conditions are favorable for their formation. Vegetation communities in the poorly drained, alkaline basins are dominated by arid-land shrubs like greasewood, shadscale, and Gardner's saltbush. Riparian and wetland habitats are scarce and found only at a few locations in the project area. Freshwater wetlands in the northern portion of the project area occur along Riner Road (BLM 3203) in the Chain Lakes area, and along Luman Road (i.e., SCR 20) north of Horseshoe Bend where a flowing well supplies year-round water to an enclosed water impoundment surrounded by emergent vegetation. A few large water impoundments along Muddy Creek create a series of connected semi-permanent wetlands in moist years in the southeastern portion of the project area. Detailed descriptions of vegetation community types within the project area are discussed in **Section 3.6 Vegetation**.

3.8.1.2 Big Game

Big game are included in the discussion due to their high interest and economic values. Three big game species occur in the project area, including pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*). Big game populations are managed by the WGFD within areas designated as Herd Units. Hunt Areas are the geographic boundaries within which hunting licenses are valid. Herd size and viability of big game populations are dependent on the combination, availability, and quality of seasonal ranges, which overlap among species and fulfill different requirements for resident and migratory big game populations. **Table 3.8-1** shows Herd Unit population sizes and parameters within the project area from WGFD Job Completion Reports. Herd population objectives are set by WGFD each year based on a variety of factors including, but not limited to, the carrying capacity of the habitat, weather (e.g. drought), habitat fragmentation, and competition with other ungulates.

Extreme drought occurred in the Green River Basin from 2000–2004, lessened in 2005, and then returned again in 2006 and 2007. Higher-than-normal snowfall during the winter of 2007–2008 increased winter mortality above normal. The winters of 2008–2009 and 2009–2010 were mild and drier than normal and winter mortalities were few. The springs of 2009 and 2010 saw above-average precipitation and seasonable temperatures resulting in above-average forage production.

Table 3.8-1. Big game Herd Unit population parameters within the CD-C project area

Species	Herd Unit (number)	Herd Unit total acreage	Percent within project area	Acreage within project area	Population Trend 2001-2009	Population Estimate 2009	WGFD Population Objective	Fawn:Doe Ratio 2009
Pronghorn	Baggs (438)	890,200	9.2	81,530	Slight increase	6,849	9,000	61:100
	Bitter Creek (414)	183,6992	23.3	428,104	Slight decrease	8,594	25,000	36:100
	Red Desert (615)	2,167,952	25.9	560,439	Slight decrease	14,355	15,000	60:100
Mule Deer	Baggs (427)	2,142,656	23.8	509,650	Slight increase	19,845	18,700	64:100
	Steamboat (430)	2,567,106	13.4	343,863	Increasing	4,600	4,000	47:100
	Chain Lakes (650)	699,626	30.9	216,560	Increasing	475	500	Not available
Elk	Sierra Madre (425)	363,651	22.7	82,511	Slight increase	8,957	4,200	37:100
	Steamboat (426)	2,533,733	13.6	343,765	Decreasing to meet objective	1,500	1,200	54:100
	Petition (430)	1,838,167	23.3	427,496	Stable	Not available	300	Not available
	Shamrock (643)	699,477	30.9	216,301	Decreasing to meet objective	130	75	Not available

Source: WGFD 2011b

Pronghorn are the most abundant big game within the project area. The project area includes portions of five Hunt Areas (53, 55, 57, 60, and 61) and three Herd Units (**Table 3.8-1**; **Map 3.8-1**). All three Herd

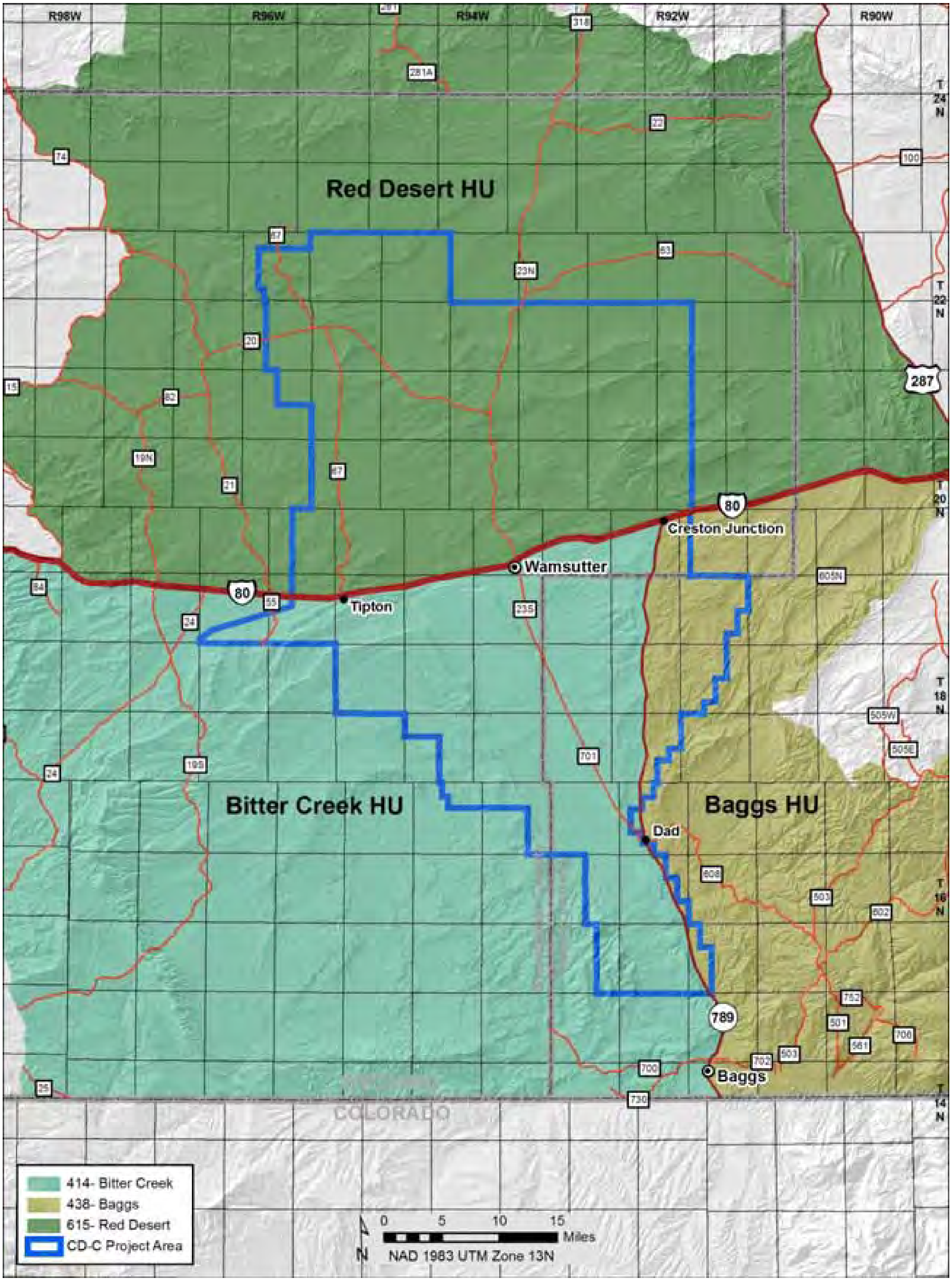
Units are much larger than the portion within the project area, with 26 percent of the Red Desert Herd Unit, 23 percent of the Bitter Creek Herd Unit, and 9 percent of the Baggs Herd Unit acreages contained within the project area. Herd numbers can be affected by several factors including weather events (drought and severe winters), the impacts of excess population numbers (over acceptable management levels) upon habitat, hunting quotas, and disease. Meeting population objectives can depend upon the availability of human resources, the accuracy of wildlife information collected, weather variables, disease, and hunter harvest rates. Average hunter success in the pronghorn Hunt Areas in the CD-C project area is 92 percent, resulting in a prorated annual harvest of approximately 640 animals (WGFD 2009 data). Refer to **Section 3.12 Recreation** for a more detailed discussion. Pronghorn seasonal ranges within the project area include spring/summer/fall (3.3 percent), winter/yearlong (88.3 percent), and crucial winter/yearlong (8.4 percent) (**Table 3.8-2**; **Map 3.8-2**). Although over a dozen pronghorn migratory movements have been documented within the project area, the corridors are broad and poorly defined (Map 3.8-2).

Table 3.8-2. Big game seasonal ranges (acres) within the project area

Species	SEASONAL RANGE[1]							
	CW	CW/Y	W	W/Y	Y	S/S/F	OUT	UND
Pronghorn	--	90,310	--	944,678	--	35,085	--	--
Mule Deer	3,973	13,876	--	491,800	89,039	--	471,385	--
Elk	--	--	26,894	--	64,797	--	550,343	428,039

[1] *Seasonal ranges include: Crucial Winter (CW) and Crucial Winter/Year-long (CW/Y) and describe ranges that have been identified as a determining factor in a population's ability to maintain itself at a specified level (theoretically at or above the population objective) over the long term. Not all habitats within designated crucial winter range are of equal quality. Areas with higher quantity and quality of forage and areas that provide cover from extreme winter weather conditions provide the best-quality crucial winter range habitat. Crucial ranges are typically used 8 out of 10 winters; Winter (W) are used by a substantial number of animals during winter months (December through April; WGFD 2011b); Winter/Year-long (W/Y) ranges are occupied throughout the year but during winter they are used by additional animals that migrate from other seasonal ranges; Year-long (Y) ranges are occupied throughout the year but additional animals do not migrate to this type of seasonal range during winter; Spring/Summer/Fall (S/S/F) ranges are used before and after winter conditions persist; Non-use areas (OUT) contain habitats of limited or no importance to the species; Undetermined use areas (UND) are areas or habitats which are expected to or do support a population or portion of a population of animals, but for which the distribution and importance of the area has not been sufficiently documented to designate a seasonal range.*

Only 16 percent of the CWR for the Red Desert, Bitter Creek, and Baggs Herd Units occurs within the project area. In the springs of 2007, 2008 and 2010, a pronghorn CWR habitat assessment was conducted to attempt to define current conditions and identify factors that may be limiting the pronghorn population within the project area. CWR has long been established, and is accepted, as the most limiting factor for overall pronghorn populations within the state of Wyoming. However, several other factors can affect population trends including severe drought, winter severity, hunter harvest, or the impacts of excess individuals (over acceptable management levels) on habitat. For this assessment, the focus was placed on the identified CWRs within the project area which also serve as yearlong habitat for pronghorn. Therefore, an assessment was performed to determine the relative condition of the CWRs as both winter and yearlong range. In coordination with the WGFD, seven locations were identified to conduct the condition-class studies. Standard 100-foot line-intercept transects were used to gather vegetation quality and quantity data. The Extensive Browse method was used to gather utilization, age-class, and form-class information, and density board measurements were used to gather vertical cover and vegetation height estimates. The above data were then analyzed by two separate methods. The first method employed a Habitat Suitability Index model developed in Wyoming specifically for analysis of pronghorn winter ranges (Allen et al. 1984). The second is a BLM-accepted method for analysis of yearlong pronghorn range (BLM 1980). The results from these utilization analyses establish a baseline for future year-to-year comparisons and trends at these sample points (**Table 3.8-3**).



Map 3.8-1. Pronghorn Herd Units in and around the CD-C project area

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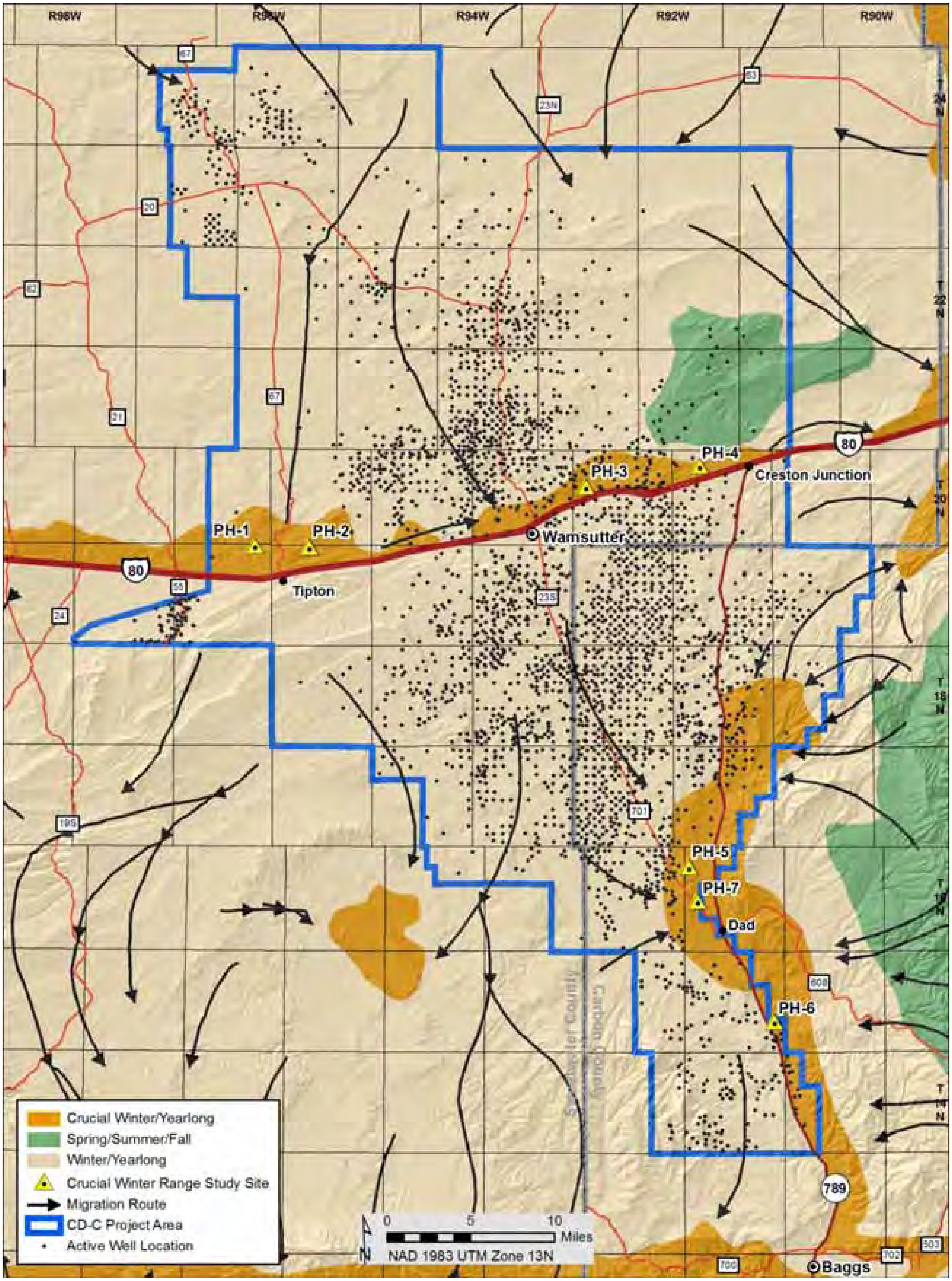

Map 3.8-2. Pronghorn seasonal ranges and migratory movements in and around the CD-C project area

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Table 3.8-3. Pronghorn Crucial Winter Range condition assessment results, 2007, 2008, and 2010

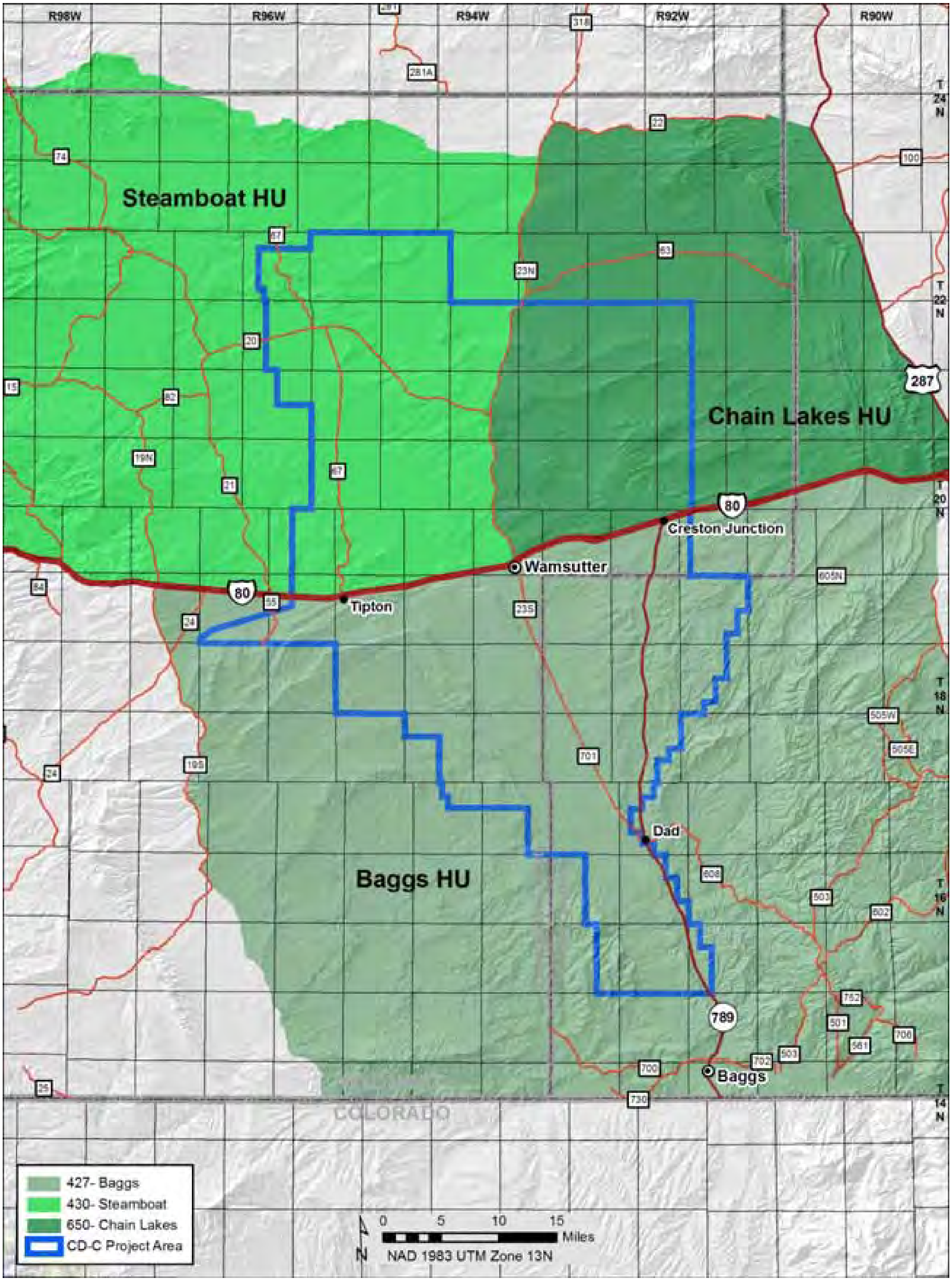
Study site (Map 3.8-2)	Year	Crucial Winter Range Rating[1]	Crucial Winter Range Score [1,]
PH-1	2007 2008 2010	Fair Fair Fair	45 33 33
PH-2	2007 2008 2010	Fair Fair NA	32 26 0
PH-3	2007 2008 2010	Fair Fair Poor	30 26 20
PH-4	2007 2008 2010	Fair Fair Fair	43 45 43
PH-5	2007 2008 2010	Fair Fair Fair	30 33 43
PH-6	2007 2008 2010	Poor Poor Fair	24 24 31
PH-7	2007 2008 2010	Poor Fair Fair	19 26 28

[1] *CWR score is the calculated WFCI (Winter food/cover index)Wyoming pronghorn winter range habitat suitability index, Allen et al. (1984).*
[2] *Fair, poor, and good are all relative ratings as defined by the BLM based on the numerical outcome of the condition assessment.*

Generally, current conditions of pronghorn CWR are rated as “fair,” reflecting the moderate use of mature stands of Wyoming and mountain big sagebrush. In addition, CWRs north of I-80 are experiencing slightly less use than the CWRs along WY 789.

Mule Deer are common year-round residents within the project area. The project area supports resident and migratory mule deer populations, and includes portions of five Hunt Areas (82, 84, 98, 100, and 131) and three Herd Units (**Table 3.8-1, Map 3.8-3**). Average hunter success in the five mule deer Hunt Areas in the CD-C project area is 45 percent, resulting in a prorated annual harvest of approximately 2,100 animals (WGFD 2009 data). Refer to **Section 3.12 Recreation** for a more detailed discussion. At least a dozen mule deer migratory movements have been documented in the southern portion of the project area (**Map 3.8-4**). In addition, a telemetry study has revealed migratory movements through the southeastern portion of the project area (Sawyer 2007).

Assessments conducted in 2001 determined that mule deer CWR located along and near the far southeastern edge of the project area was not meeting Standard #4 – Wildlife Habitat Health (BLM 2002; **Map 3.8-4**). Juniper and sagebrush dominance, declining shrub communities, over-browsing of favored shrub species, and low forb composition were some of the habitat concerns cited (BLM 2002). Although this site may not be meeting the standard, broader areas within the landscape may be ecologically functional. Changes in management may be necessary to address making progress toward meeting this standard in the future.



Map 3.8-3. Mule Deer Herd Units in and around the CD-C project area

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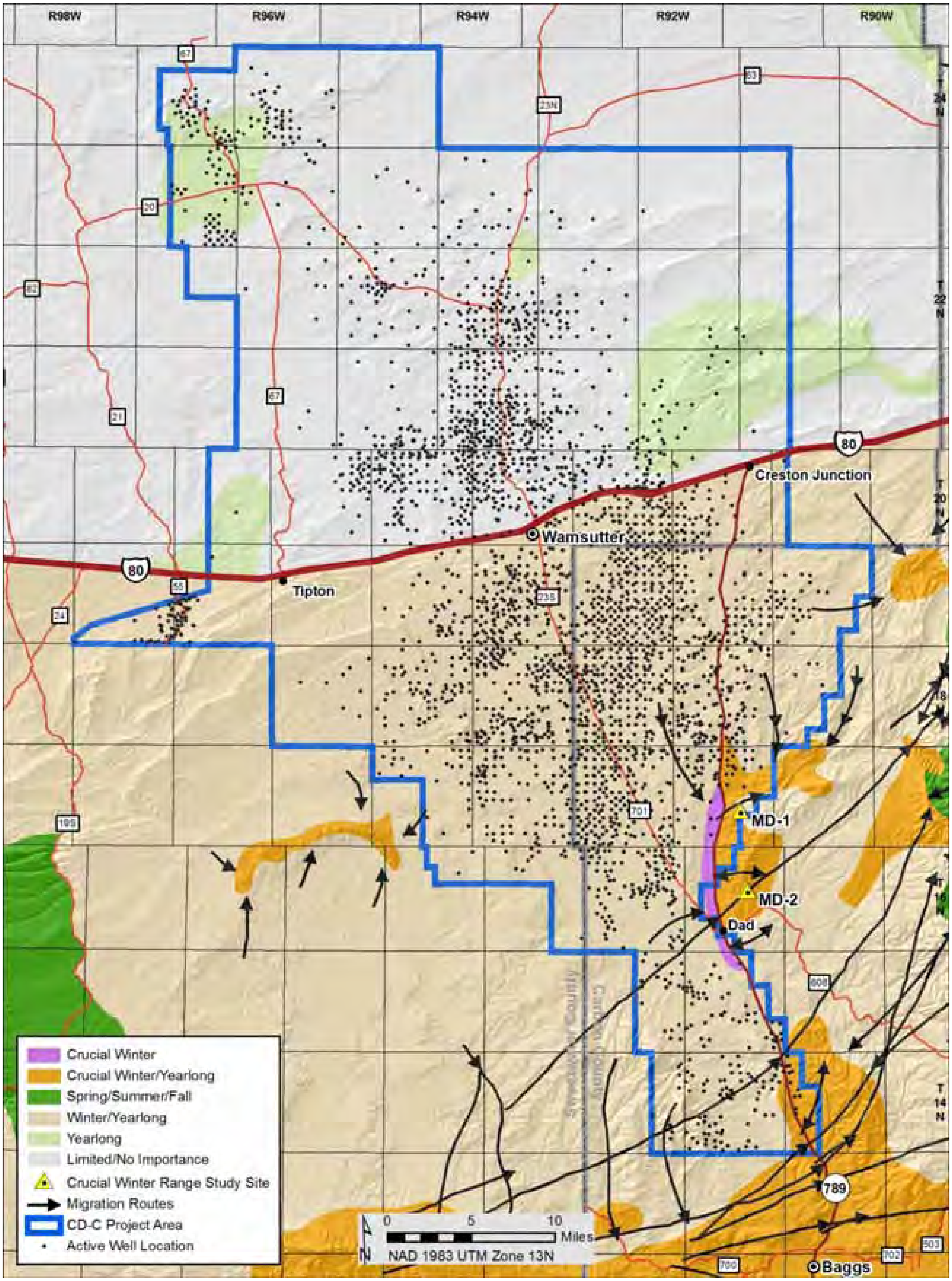


Map 3.8-4. Mule deer seasonal ranges and migratory movements in and around the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Only 6.3 percent of CWR acreage for the Baggs Herd Unit occurs within the project area. Mule deer CWR habitat assessments were conducted concurrent with pronghorn CWR habitat assessments conducted in 2007, 2008, and 2010. As with pronghorn, mule deer CWR is the most limiting factor for populations within the state of Wyoming. In coordination with the WGFD, two locations were identified to conduct the condition-class studies. The Extensive Browse and density board methods were also employed to collect data on mule deer CWR sites. The data were then analyzed according to BLM-accepted methods for analysis of mule deer winter range (BLM 1979). The results from these utilization analyses establish a baseline for future year-to-year comparisons and trends at these sample points (**Table 3.8-4**).

Table 3.8-4. Mule deer Crucial Winter Range condition assessment results, 2007, 2008, and 2010

Study site (Map 3.8-4)	Year	Crucial Winter Range Rating[1]	Crucial Winter Range Score[1, 2]
MD-1	2007 2008 2010	Fair Poor Fair	54.39 42.63 54.39
MD-2	2007 2008 2010	Good Good Good	64.68 61.74 63.21

[1] Fair, poor, and good are all relative ratings as defined by the BLM based on the numerical outcome of the condition assessment.

[2] Mule deer CWR score and rating calculated by BLM (2008).

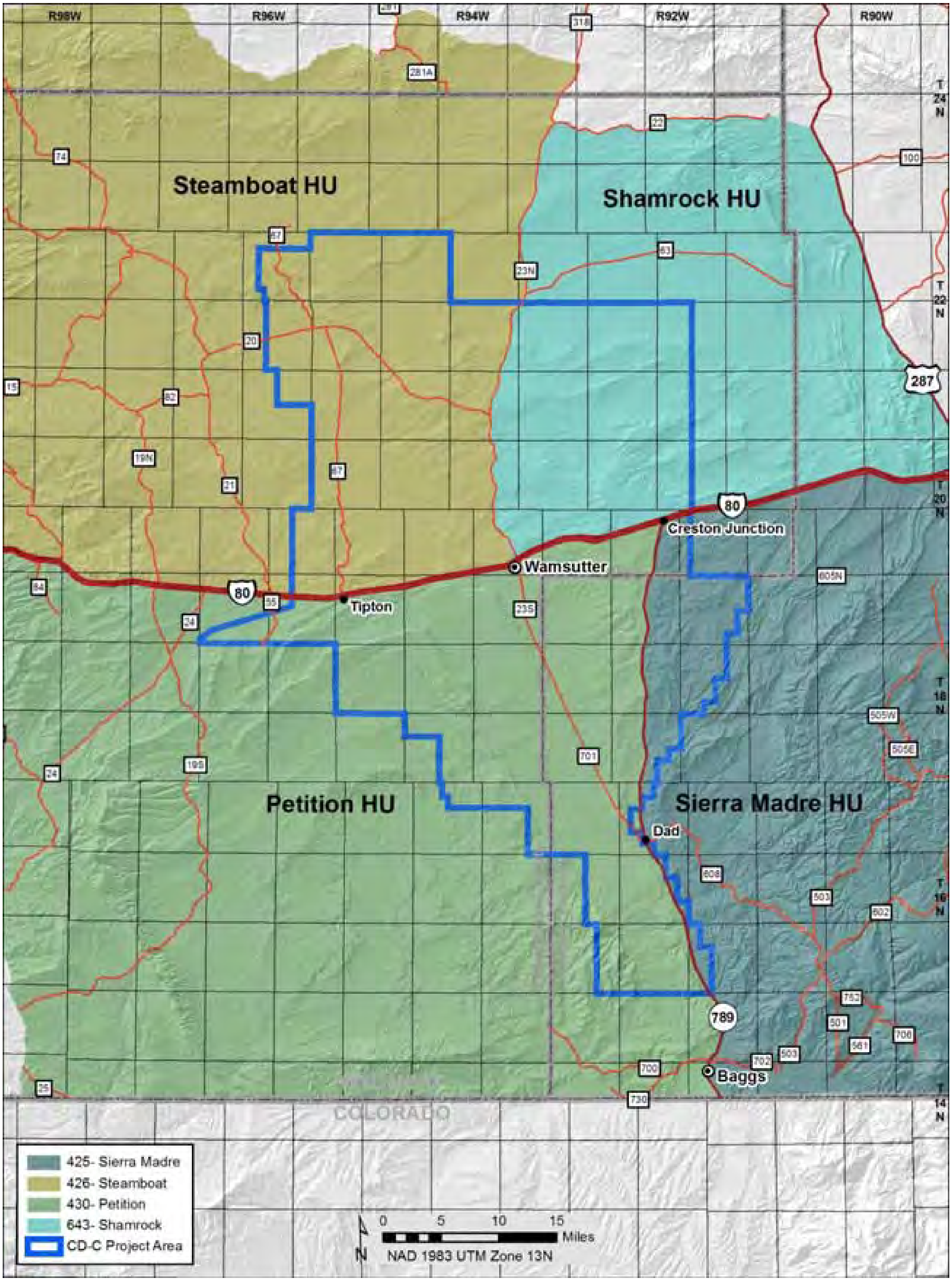
Data are available for only two sites and may indicate that variable forage conditions likely exist across the analysis area. Current forage conditions in mule deer CWR associated with the project area were similar to those of pronghorn; however, heavier use was evident at mule deer sites. At least a dozen mule deer migratory movements have been documented in the southern portion of the project area (**Map 3.8-4**). In addition, a telemetry study has revealed migratory movements through the southeastern portion of the project area (Sawyer 2007). As discussed above, animal movement along known migratory routes in the southeastern portion of the project area are compromised by WY 789, energy development, and numerous rangeland and highway fences (Feeney et al. 2004, WGFD 2010). Mule deer use of the underpasses constructed under WY 789 has been well documented using remote cameras (WYDOT 2012). The range condition data provided in Table 3.8-4 is indicative of the forage condition within migration routes. Although current conditions of mule deer CWR associated with the project area were similar to those of pronghorn, heavier use was evident at mule deer sites. Nevertheless, results indicated that mule deer CWR sites have mature stands of big sagebrush with adequate canopy cover and overall production.

Elk are locally common in certain areas within the project area. The project area includes portions of five Hunt Areas (21, 100, 108, 118, and 124) and four Herd Units (**Table 3.8-1, Map 3.8-5**). Average hunter success in the five elk hunt areas in the CD-C project area is 47 percent, resulting in a prorated annual harvest of approximately 1,440 animals (WGFD 2009 data). Refer to **Section 3.12 Recreation** for a more detailed discussion. Elk seasonal ranges located within the project area include yearlong (6.1 percent), winter (2.5 percent), non-use (51.4 percent), and undetermined use areas (40.0 percent; **Table 3.8-2, Map 3.8-6**). No elk CWR has been designated or elk migration routes documented within the project area (Map 3.8-6). Therefore no elk CWR site-sampling was conducted. Although no elk migration routes have been mapped in the project area, they may be present. Elk do migrate from the Sierra Madre mountain range to winter range along the Atlantic and Red Rims east of the project area (Map 3.8-6), and elk have been documented using the Baggs/WY 789 underpasses (WYDOT 2012)

Big Game Summary

The project area is used by pronghorn, mule deer, and elk, although the areas and season of use vary by species. CWR (i.e., crucial winter and crucial winter/yearlong ranges) of pronghorn and mule deer collectively comprise approximately 92,842 acres (8.7 percent) of the project area (**Map 3.8-7**). The Rawlins RMP (BLM 2008a) states that habitat quality will be functionally maintained within areas of overlapping big game CWR. Overlapping pronghorn and mule deer CWRs comprise 15,314 acres (1.4 percent) of the project area (Map 3.8-7).

The project area also hosts wild horses, which over time may result in direct (competitive displacement) and indirect (resource-sharing) competition with pronghorn, mule deer, and elk (see **Section 3.10 Wild Horses**). Wild horse populations may impact ungulate habitat over an extended period of time.



Map 3.8-5. Elk Herd Units in and around the CD-C project area

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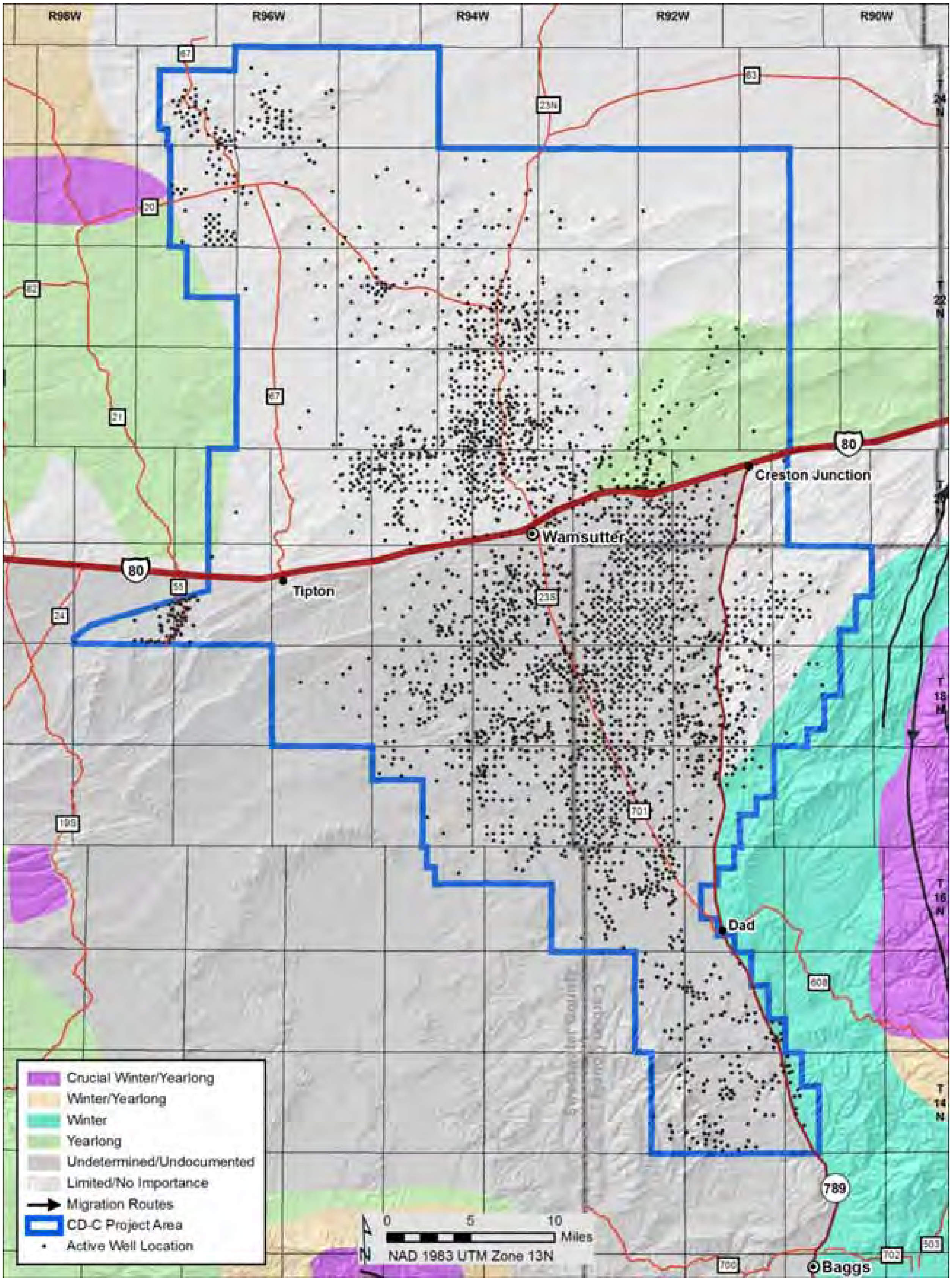

Map 3.8-6. Elk seasonal ranges and migratory movements in and around the CD-C project area

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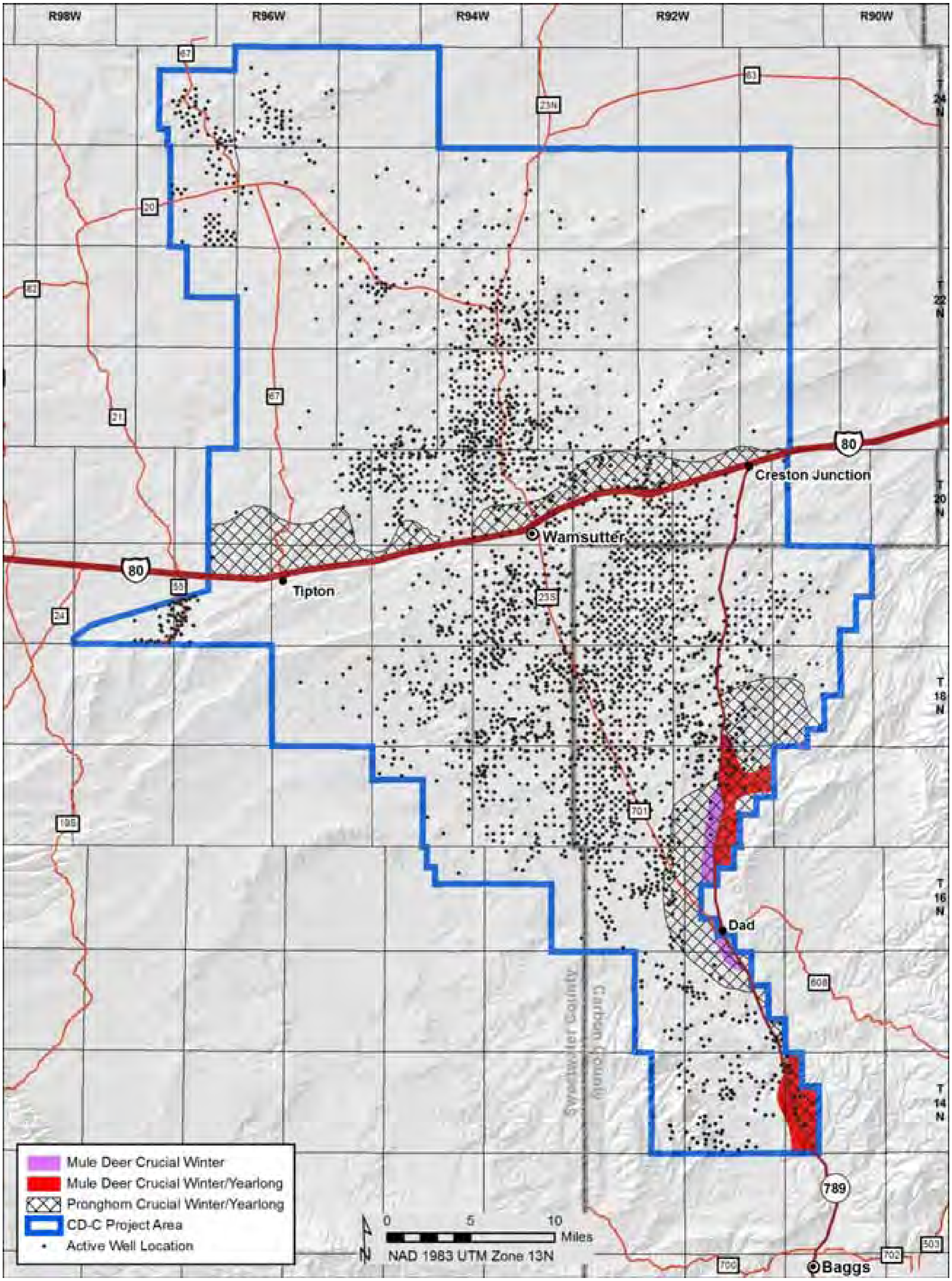


Map 3.8-7. Big game Crucial Winter Ranges in the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.8.1.3 Upland Game Birds

Greater sage-grouse (*Centrocercus urophasianus*), Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*), and mourning doves (*Zenaida macroura*) occur within the project area (WGFD 2004a). Suitable habitat for chukar (*Alectoris chukar*), gray partridge (*Perdix perdix*), ring-necked pheasant (*Phasianus colchicus*), blue grouse (*Dendragapus obscurus*), ruffed grouse (*Bonasa umbellus*), and wild turkey (*Meleagris gallopavo*) does not exist within the project area, although these species are present in surrounding areas (WGFD 2004a). Upland game birds are managed by the WGFD within upland game management areas. The project area includes parts of three Upland Game Management Areas (UGMAs): Red Desert UGMA 9; Bitter Creek UGMA 10; and Sierra Madre UGMA 25. Greater sage-grouse is a Candidate species for listing under the ESA and Columbian sharp-tailed grouse is designated as a sensitive species by the BLM. These species are discussed in **Section 3.9 Special Status Species**.

Mourning doves occupy a wide variety of habitats. Within the project area, mourning doves occur in sagebrush-grassland, mountain shrub, and riparian vegetation communities. Mourning doves breed within and migrate through the project area (WGFD 2004a). Based on recent records, mourning doves harvested within the project area account for a very small percentage of the state total (WGFD 2005b).

3.8.1.4 Raptors

Twenty-six raptor species are known to occur in or around the project area, including 14 that breed or potentially breed, two that over-winter, and ten that have been recorded as transients or migrants (**Table 3.8-5**). Five species are designated as sensitive by the BLM and are discussed in detail in **Section 3.9 Special Status Species**.

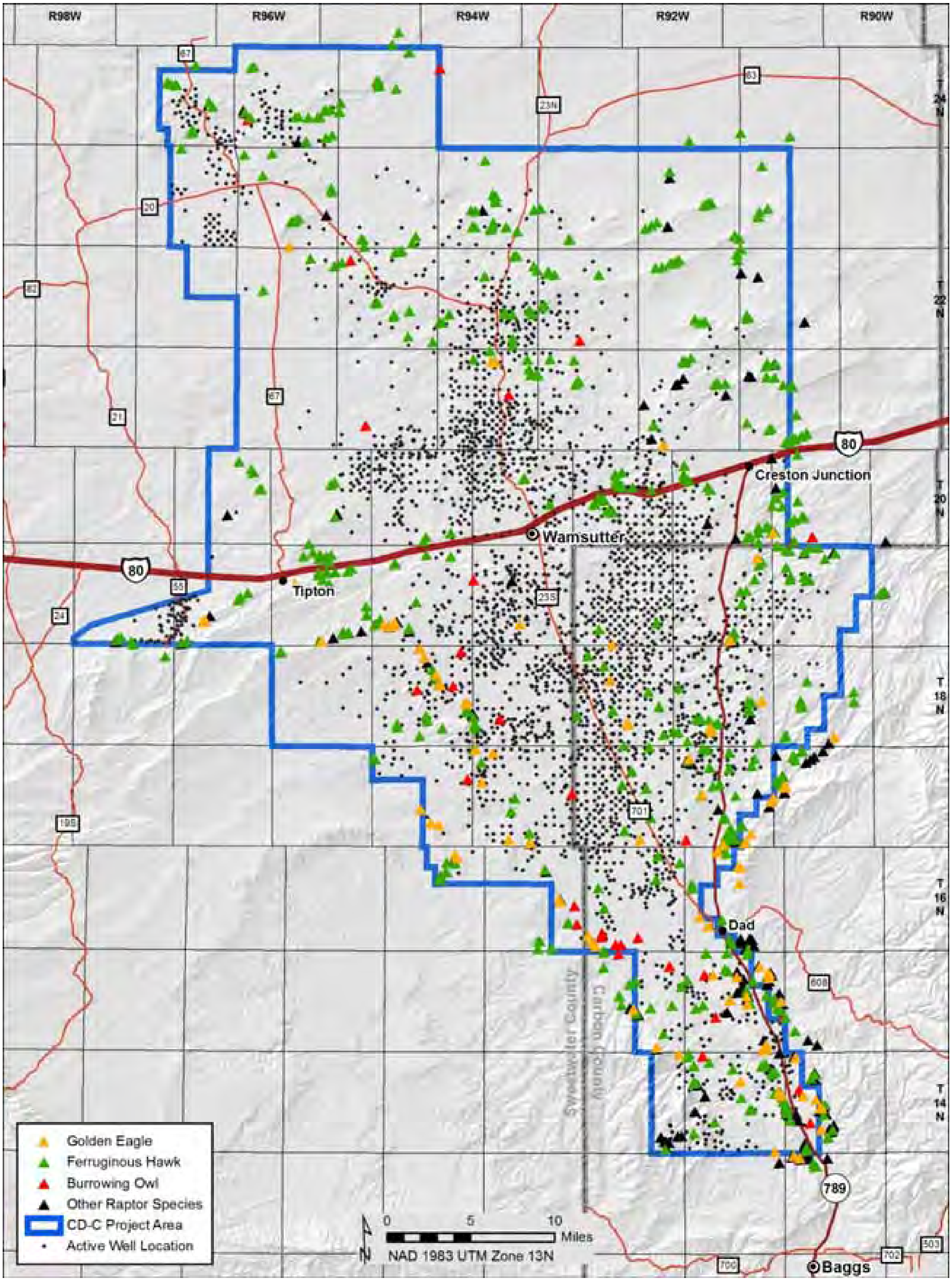
A variety of raptor breeding, hunting, and winter habitats occur within the project area. Grasslands, shrublands, trees and shrubs in riparian areas, and cliffs, low bluffs, rocky outcrops, and badland breaks all provide suitable nest substrates throughout the project area. Muddy Creek and drainages that support trees and other riparian vegetation provide habitat for tree-nesting species and provide potential roosting sites for wintering raptors. Agency and contract wildlife biologists have located at least 938 raptor nests belonging to at least 11 species in or within one mile of the project area (BLM 2007a; **Table 3.8-5**; **Map 3.8-8**). The raptor species utilizing 79 of these nest sites are unknown.

Table 3.8-5. Occurrence potential and documented nest sites of raptor and vulture species within the CD-C project area

Common Name[1]	Scientific Name	Occurrence Potential[2]	Documented Nest Sites
American kestrel	*Falco sparverius*	B	18
Bald eagle*	*Haliaeetus leucocephalus*	t	--
Barn owl	*Tyto alba*	t	--
Broad-winged hawk	*Buteo platypterus*	t	--
Burrowing owl*	*Athene cunicularia*	B	31
Cooper's hawk	*Accipiter cooperii*	B	4
Ferruginous hawk*	*Buteo regalis*	B	577
Golden eagle	*Aquila chrysaetos*	B	108
Great horned owl	*Bubo virginianus*	B	15
Gyrfalcon	*Falco rusticolus*	t	--
Long-eared owl	*Asio otus*	B	1
Merlin	*Falco columbarius*	W	--
Northern goshawk*	*Accipiter gentilis*	t	--
Northern harrier	*Circus cyaneus*	B	9
Northern pygmy owl	*Glaucidium gnoma*	t	--
Northern saw-whet owl	*Aegolius acadicus*	t	--
Osprey	*Pandion haliaetus*	t	--
Peregrine falcon*	*Falco peregrinus*	t	--
Prairie falcon	*Falco mexicanus*	B	34
Red-tailed hawk	*Buteo jamaicensis*	B	48
Rough-legged hawk	*Buteo lagopus*	W	--
Sharp-shinned hawk	*Accipiter striatus*	pB	--
Short-eared owl	*Asio flammeus*	pB	--
Snowy owl	*Bubo scandiacus*	t	--
Swainson's hawk	*Buteo swainsoni*	B	14
Turkey vulture	*Cathartes aura*	pB	--

[1] *Special-status species indicated by asterisk*
[2] *Occurrence potential of raptor species includes: known breeding (B); known to be present during breeding season and potentially breed (pB); known to over-winter (W); and known transient or migrant (t)*

It is possible that some of the older documented raptor nests may have deteriorated beyond being suitable for raptor nesting and the nest sites are no longer available or used by breeding raptors. Nevertheless, nest sites with nests in suitable condition have the potential to be active in any given year. Moreover, each year new nests are built. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treaty Act (16 USC, §703 *et seq.*) and Wyoming [Revised] Statute (WRS 23-1-101 and 23-3-108). Golden and bald eagles also are afforded additional protection under the Bald and Golden Eagle Protection Act, amended in 1973 (16 USC, §669 *et seq.*).



Map 3.8-8. Raptor nest site locations in or within one mile of the CD-C project area

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3.8.1.5 Neotropical Songbirds

Many species of neotropical songbirds utilize the project area for breeding, feeding, migration, and as year-round habitats (**Appendix H, Occurrence Potential of Wildlife in the CD-C Project Area**). All habitats throughout the project area are used to some degree by these species, but especially sagebrush-grassland, mountain shrub, and riparian vegetation communities. The Migratory Bird Treaty Act (16 USC, §703 *et seq.*) protects 836 migratory bird species (to date) and their eggs, feathers, and nests from disturbances. Several migratory raptors and songbird species are also listed as BLM Sensitive Species (**Section 3.9.2**).

3.8.2 Fish

Almost all of the CD-C project area drains into two basins: the Little Snake River Basin (a component of the Colorado River system) and the Great Divide Basin. A very small proportion of the far western part of the project area drains into Bitter Creek, also a component of the Colorado River system. The Little Snake River Basin is fed by Muddy Creek, which drains the southeastern portion of the project area. The majority of the northern part of the project lies within the Great Divide Basin. The Great Divide Basin is closed, with no eventual outflow to an ocean (**Map 3.4-1**).

3.8.2.1 Fish Habitat

Due to limited precipitation, the majority of drainages within the project area are ephemeral. Ephemeral water tables are always below the stream channel, only flowing in direct response to precipitation or snow-melt. Ephemeral waters only support very limited aquatic communities for short periods when surface flow is present, although some ephemeral streams in the project area may be used for spawning. The largest stream within the project area is Muddy Creek, a high-elevation, cold desert stream that is designated as class 2AB by the WDEQ, and supports game and non-game species. Muddy Creek exhibits perennial flow for the majority of its length, and in some years flows intermittently as a result of irrigation water removal south of the George Dew/Red Wash wetlands complex. In years with high runoff amounts, Muddy Creek flows perennially throughout its length. Streamflow varies with location along the drainage.

About 286 reservoirs and ponds (<1–960 acres) are present within the project area (**Section 3.4.2.1**). Some of the ponds and reservoirs that currently exist within the project area are fed by waters recovered from wells drilled at upstream locations, while others are impoundments on small drainages. These man-made impoundments are generally designed to supply water for livestock and wildlife use. Only one of these, Little Robbers Gulch Reservoir, is stocked annually with Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) by the WGFD. None of the others are known to sustain fisheries.

3.8.2.2 General Fish

About 30 species of fish may occur in the project area or in streams upstream or downstream of the project area (**Table 3.8-6**), including ten game-fish species and 20 non-game fish species. This information is based upon species potentially found in the Great Divide and Little Snake River Basins, plus four Threatened and Endangered species present downstream in the Colorado River System. About 14 of the 30 species, including six native species, are likely to be present within the project area. Four of the 30 species are Threatened or Endangered (**Section 3.9.1.3**) and four are BLM Sensitive Species (**Section 3.9.2.3**).

No fish have been collected from any streams within the Great Divide Basin. Consequently, all of the fish present within streams in the project area are found within the Muddy Creek watershed. Some impoundments in the Great Divide Basin portion of the project have been stocked with fish in the past, but none are known to sustain fisheries at the present.

Table 3.8-6. Fish species observed within, or that may potentially occur immediately upstream or downstream of, the CD-C project area

Common Name	Scientific Name	Game or Non-game	Basin[1]	Present in project area	Native	WYNDD	FOW	BLM	MCBMP	WSAM	WGFD	Beatty 2005
Black bullhead	*Ameiurus melas*	Non-game	LSR									x
Bluehead sucker	*Catostomus discobolus*	Non-game	LSR	Yes	Yes	X	X	X	X	X		
Bonytail	*Gila elegans*	Non-game	CR		Yes							
Brook trout	*Salvelinus fontinalis*	Game	LSR, GDB	Yes			X	X	X	X		
Brown trout	*Salmo trutta*	Game	LSR				X					
Channel catfish	*Ictalurus punctatus*	Game	LSR				X					
Colorado pikeminnow	*Ptychocheilus lucius*	Non-game	LSR, CR		Yes		X	X				
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	Game	LSR			X	X	X	X	X		
Common carp	*Cyprinus carpio*	Game	LSR, GDB				X	X				
Creek chub	*Semotitus atromaculatus*	Non-game	LSR	Yes			X	X	X	X		X
Fathead Minnow	*Pimephales promelas*	Non-game	LSR	Yes				X				X
Flannelmouth sucker	*Catostomus latipinnis*	Non-game	LSR	Yes	Yes	X	X	X	X	X		
Humpback chub	*Gila cypha*	Non-game	CR		Yes							
Iowa darter	*Etheostoma exile*	Non-game	LSR				X	X	X	X		
Longnose dace	*Rhinichthys cataractae*	Non-game	LSR	Yes			X		X	X		
Longnose sucker	*Catostomus catostomus*	Non-game	LSR				X					
Mottled sculpin	*Cottus bairdi*	Non-game	LSR	Yes	Yes		X	X	X	X		
Mountain sucker	*Catostomus platyrhynchus*	Non-game	LSR	Yes	Yes		X	X	X	X		
Mountain whitefish	*Prosopium williamsoni*	Game	LSR		Yes		X		X	X		
Northern Pike	*Esox lucius*	Game	LSR								X	
Rainbow trout	*Oncorhynchus mykiss*	Game	LSR, GDB	Yes			X		X	X		
Razorback sucker	*Xyrauchen texanus*	Non-game	CR		Yes							
Red Shiner	*Cyprinella lutrensis*	Non-game	LSR									X
Redside shiner	*Richardsonius balteatus*	Non-game	LSR	Yes			X	X	X	X		X
Roundtail chub	*Gila robusta*	Non-game	LSR	Yes	Yes	X	X	X	X	X		
Sand Shiner	*Notropis stramineus*	Non-game	LSR	Yes								X
Speckled dace	*Rhinichthys osculus*	Non-game	LSR	Yes	Yes		X	X	X	X		
Walleye	*Stizostedion vitreum*	Game	LSR							X	X	
White sucker	*Catostomus commersoni*	Non-game	LSR	Yes			X	X				X

[1] *Basins LSR = Little Snake River Basin*
GDB = Great Divide Basin
CR = These species are downstream residents of the Colorado River system.

Data Sources:
- Wyoming Natural Diversity Database (WNDD 2003)
- Fishes of Wyoming (FOW) (Baxter and Stone 1995)
- Muddy Creek Basin Management Plan (MCBMP)(WGFD 1998)
- M. Fowden, pers.comm. 2004
- Bureau of Land Management (BLM) (BLM 2001)
- Warmwater Stream Assessment Manual (WSAM) (WGFD 2004)
- BLM 2001
- Beatty 2005

3.9 SPECIAL STATUS SPECIES

Special-status species include: (1) Threatened, Endangered, Proposed, Candidate, or those petitioned for listing as Threatened or Endangered by the USFWS under the Endangered Species Act (ESA) of 1973, as amended; and (2) those designated by the BLM State Director as sensitive (BLM 2010).

3.9.1 Threatened, Endangered, Proposed, or Candidate Species of Wildlife, Fish, and Plants

Seven species listed by the USFWS as Threatened, Endangered, Proposed, or Candidate pursuant to the ESA, that may be found in the RFO are or potentially are present within the project area (USFWS 2010, **Table 3.9-1**). Four fish species are found downstream of the RFO in the Colorado River system and may be impacted if water depletions occur, or if environmental contaminants are increased within the system. The other four species—Canada lynx, yellow-billed cuckoo, Wyoming toad, and the blowout penstemon—are located within the RFO; however, they are not located nor do they have habitat within or near the CD-C project area.

Table 3.9-1. Occurrence potential of Threatened, Endangered, Proposed, and Candidate species within or near the CD-C project area

Species[1]	Scientific Name	Occurrence Potential within the project area[2]	Status[3]
Mammals			
Black-footed ferret	*Mustela nigripes*	U	Endangered
Birds			
Greater sage-grouse	*Centrocercus urophasianus*	P	Candidate
Amphibians			
Fish			
Bonytail*	*Gila elegans*	PAD	Endangered
Colorado pikeminnow*	*Ptychocheilus lucius*	PAD	Endangered
Humpback chub*	*Gila cypha*	PAD	Endangered
Razorback sucker*	*Xyrauchen texanus*	PAD	Endangered
Plants			
Ute ladies'-tresses	*Spiranthes diluvialis*	pp	Threatened

[1] Presence in the Colorado River system downstream of the project area is indicated by asterisk.
[2] Occurrence potential includes: present (P); potentially present (pp); unlikely (U); very unlikely (VU); and potentially affected downstream (PAD).
[3] Candidate species are those for which the USFWS has sufficient information to propose for listing as threatened or endangered under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing actions. Proposed species are those Candidate species that were found to warrant listing as either threatened or endangered and are currently undergoing a 12-month status review. Conservation measures for candidate and proposed species are voluntary but recommended because, by definition, the species may warrant future protection under the ESA if adequate conservation measures are not in place.

3.9.1.1 Threatened or Endangered Wildlife Species

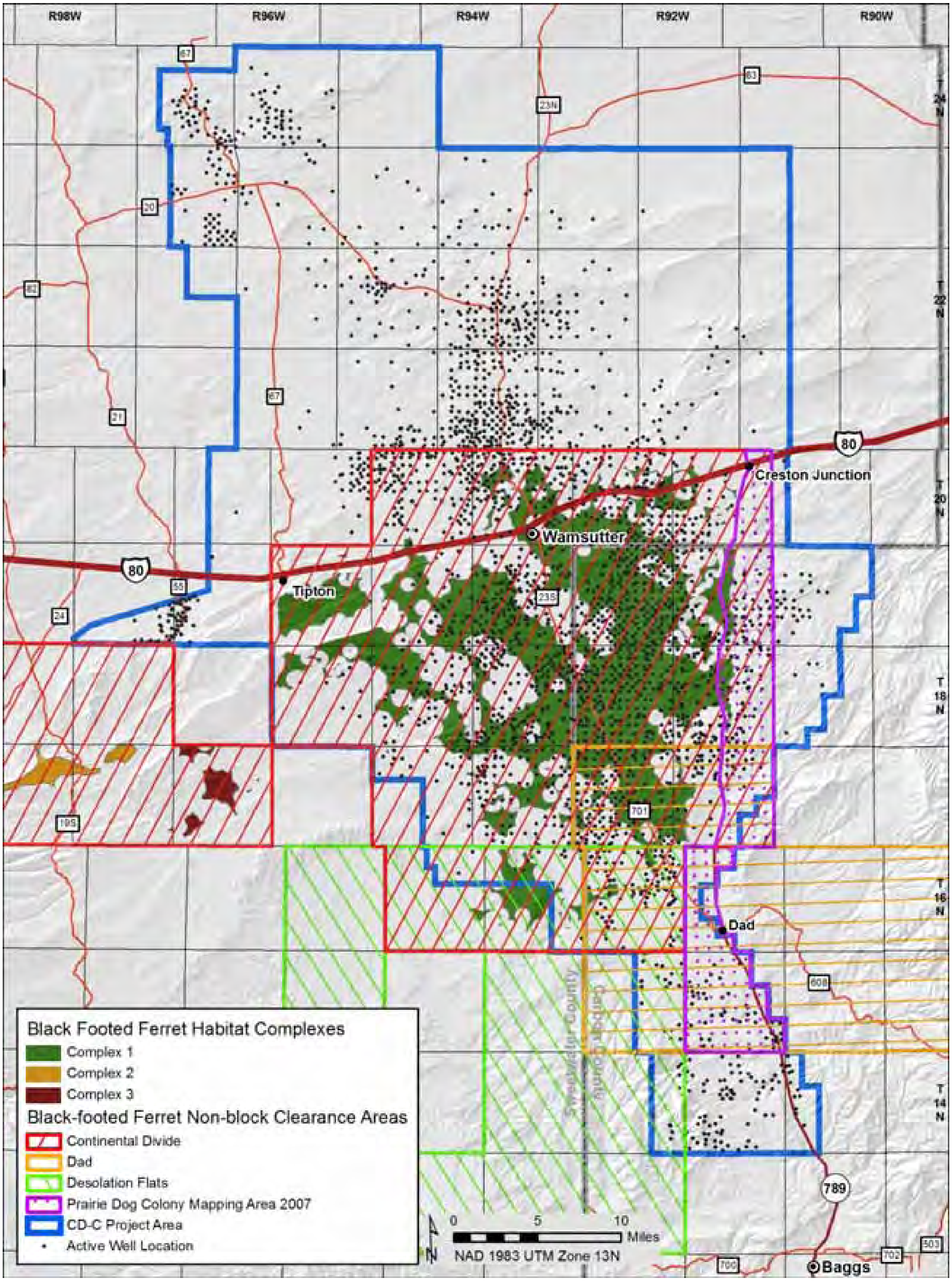
Black-footed ferret. This species is considered the most endangered mammal in the United States. The original distribution of the black-footed ferret in North America closely corresponded to that of the prairie dog (*Cynomys* spp.; Hall and Kelson 1959, Fagerstone 1987). Black-footed ferrets depend almost exclusively on prairie dogs for food and also use prairie-dog burrows for shelter, parturition, and raising young (Hillman and Clark 1980, Fagerstone 1987). The species historically ranged throughout most of the sagebrush and grasslands habitats in Wyoming. Today, the only known population of black-footed ferrets in Wyoming is the result of the reintroduction of captive-bred ferrets in the Shirley Basin (approximately 65 miles northeast of the project area). Reintroductions occurred in Wyoming on federal and state lands from 1991 to 1995. The reintroduced population is classified as nonessential experimental, and currently is self-sustaining.

The USFWS has designated some areas of Wyoming as not likely to have black-footed ferret habitat present; these areas have been "Block Cleared" and do not require ferret surveys prior to activities being permitted. "Non-Block Cleared areas" may contain suitable black-footed ferret habitat. Forty-five percent of the project area is within portions of the Continental Divide, Desolation Flats, and Dad Non-Block Clearance areas, which were not included under the black-footed ferret block clearance letter (**Map 3.9-1**; USFWS 2004b). Prairie-dog colonies occurring within the Continental Divide, Desolation Flats, and Dad non-block clearance areas meet requirements for consideration as black-footed ferret habitat (Biggins *et al.* 1989), and black-footed ferret surveys may be necessary prior to ground-disturbing activities (Biggins *et al.* 1989, USFWS 1989). Mapping and ground surveys indicate that the area and density of active prairie-dog colonies within the project area may be sufficient to support black-footed ferrets. The RFO, in coordination with the USFWS, has refined and mapped the white-tailed prairie dog complex areas that would require pre-disturbance surveys (**Map 3.9-1**, BLM M. Read, pers. com. 2012).

Numerous historical records of black-footed ferrets have been documented within the project area (WYNDD 2007, WGFD 2007). Within the Continental Divide/Wamsutter II project area, two young black-footed ferrets were sighted in 1972 about five miles south of I-80; one adult was sighted in August 1975 in the northern portion; and a black-footed ferret skull was found in 1981 along the northeastern border. Wild-born black-footed ferrets currently exist in the Shirley Basin; at least 88 ferrets were observed during a partial survey conducted in 2004 (WGFD 2005b). Various barriers exist between the Shirley Basin black-footed ferret population and the project area, including highways (i.e., U.S. 287, I-80), mountain ranges (i.e., Freezeout, Shirley, and Seminoe), reservoirs (i.e., Pathfinder and Seminoe), and the North Platte River.

Greater sage-grouse is a sagebrush obligate found entirely in the western United States and Canada, primarily in the Intermountain West. Wyoming contains more sage-grouse than all other states combined. The species remains common in Wyoming because its habitat is relatively intact compared to other states. In south-central Wyoming, the harsh climate has limited habitat loss and conversion to settlements and agriculture. Historically, disturbance to greater sage-grouse habitat in south-central Wyoming has occurred as a result of livestock grazing, associated sagebrush-control treatments, and oil and gas development. Landscape-scale disturbance to this habitat has resulted more recently from the increased development of a variety of energy resources and the associated workforce. The greater sage-grouse is considered a sagebrush ecosystem umbrella species, which assumes that conserving its habitat will benefit other species of conservation concern that share the same habitats (i.e., pygmy rabbit, sage thrasher, and sage sparrow; Rowland *et al.* 2006).

Sage-grouse depend on extensive areas of sagebrush for food and cover throughout the year. Typically, strutting grounds or leks are located in open patches within sagebrush habitat and the surrounding area is considered potential nesting habitat. Nesting habitat tends to have higher sagebrush density, taller live and residual grasses, more live and residual grass cover, and little bare ground (Connelly *et al.* 2004). Sage-grouse are dependent upon sagebrush habitats for their year-round survival. This dependency includes using sagebrush for forage, nesting habitat, brood-rearing habitat, and winter thermal cover. In addition, sage-grouse require a variety of sagebrush habitat types to meet life-history requirements. Mesic habitats are also important for brood-rearing during the summer and fall months. The proximity of nesting habitat to brood-rearing habitat increases its value for broods, but may increase risk for nests (Dzialak *et al.* 2012).



Map 3.9-1. Black-footed ferret Non-Block Clearance areas and 2007 prairie-dog colony mapping area in and around the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Sage-grouse exhibit site fidelity to leks, winter and summer areas, and nesting areas (Schroeder *et al.* 1999). They may be affected by sagebrush community disturbance and removal. Sage-grouse tend to avoid areas that may provide perching or roosting opportunities for raptors (i.e., fence posts, power lines, and other structures) (Connelly *et al.* 2000 and 2004). Human activity during the breeding season may disrupt lek attendance and affect local breeding success. Populations across the west have declined from historic levels due to a wide range of factors including drought, habitat loss, and habitat degradation (Connelly and Braun 1997, Braun 1998, Connelly *et al*,. 2000 and 2004).

In 2004, the USFWS conducted a status review of greater sage-grouse throughout their range in response to petitions requesting the listing of the species under the ESA. On January 7, 2005, the USFWS determined that the greater sage-grouse did not warrant protection under the ESA. Nevertheless, on December 4, 2007, U.S. District Court Judge B. Lynn Winmill reversed the USFWS decision and remanded the case to the agency for further consideration. After another status review, the USFWS concluded in 2010 that the greater sage-grouse warranted protection under the ESA; however, ESA protection was precluded due to other species facing more immediate extinction threats (a warranted but precluded decision). As a result, the greater sage-grouse was added to the list of Candidate species under the ESA, which provides a status review every 12 months to determine if immediate attention is warranted.

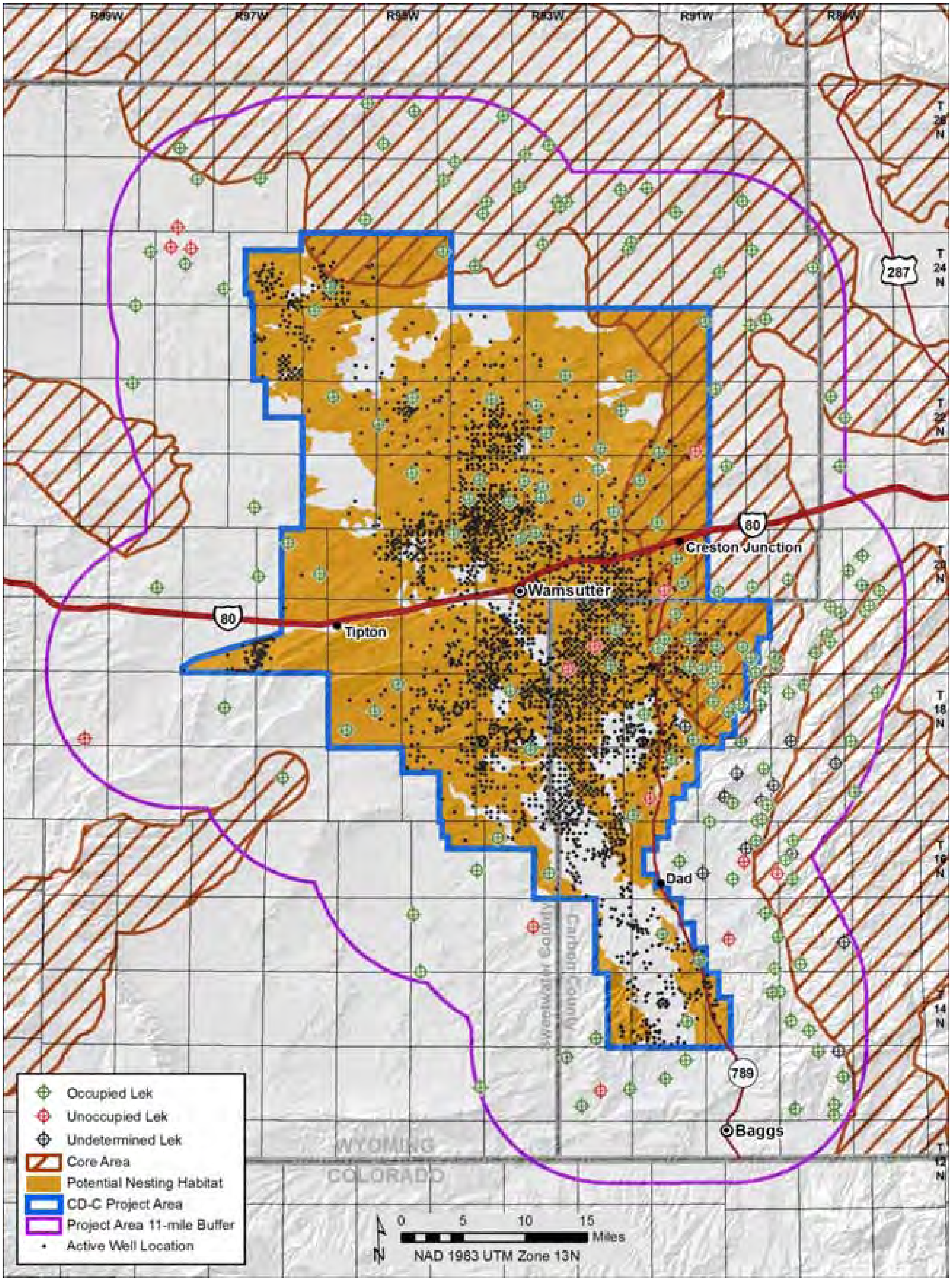
Although greater sage-grouse is currently a Candidate species, it receives no statutory protection under the ESA. However, certain conservation measures and stipulations are enforced by the BLM in accordance with BLM Sensitive Species management and by state agencies under the Statewide Executive Directive #2011-5 (SWED 2011, WGFD 2011c), Greater Sage-grouse Core Area Protection (SGEO) program. The SGEO enhanced habitat protection in sage-grouse core population areas on public as well as on private lands, when the activities on private land are subject to review or approval by state or federal statutes. In December 2011, BLM issued Instruction Memorandum (IM) 2012-043 (BLM 2012b) which provides rangewide interim management policies and procedures for conserving sage-grouse and their habitats. This IM reaffirms the application of the Wyoming Core Population Area Protection process, as follows:

> "The BLM field offices do not need to apply the conservation policies and procedures described in this IM in areas in which (1) a state and/or local regulatory mechanism has been developed for the conservation of the Greater Sage-Grouse in coordination and concurrence with the USFWS (including the Statewide Executive Directive 2011-5, Greater Sage-Grouse Core Area Protection); and (2) the state sage-grouse plan has subsequently been adopted by the BLM through the issuance of a state-level BLM IM."

On February 10, 2012, the BLM released IM WY-2012-019, Greater Sage-Grouse Habitat Management Policy on Wyoming BLM Administered Public Lands Including the Federal Mineral Estate. This document provides guidance to BLM Wyoming field offices regarding management consideration of greater sage-grouse habitats for proposed activities until resource management planning updates are completed (BLM 2012c). The IM is consistent with IM WY-2012-043 (BLM 2012b) and is generally consistent with the SGEO (SWED 2011, WGFD 2011c). The conservation strategy for greater sage-grouse in the State of Wyoming continues to evolve. The Wyoming BLM is currently amending the Field Office RMPs regarding sage-grouse management and the requirements that would be applied to activities in sage-grouse habitat will change in accordance with those RMP amendments.

As required by IM WY-2012-019, an 11-mile analysis buffer is required around the project boundary for large-scale proposed actions (e.g. oil and gas full-field developments). According to the WGFD database, 192 known leks are located within 11 miles of the CD-C project area; 105 are occupied, 13 are unoccupied, and 74 have undetermined status (**Map 3.9-2**, WGFD 2010c). Leks are assigned an annual status of active, inactive, or unknown, and based on this leks are assigned a management status of occupied, unoccupied (destroyed or abandoned), or undetermined. Within 11 miles of the CD-C project area, there are approximately 546,600 acres of state-designated core population areas on BLM-managed land and 244,890 acres on state or private lands.

Prohibition of surface occupancy will be considered and evaluated by the BLM (2012c) and SGEO (SWED 2011) within 0.25 miles of non-core area leks and 0.6 miles of core area leks, measured from the perimeter of occupied or undetermined leks. Quarter-mile buffers around the perimeter of occupied or undetermined status leks located in non-core areas within the project area comprise approximately 3,072 acres (0.29 percent of the project area), which includes 1,215 acres of BLM, 0.17 acres of state, and 1,858 acres of private lands. The 0.6-mile buffers around the perimeter of occupied or undetermined status leks located in core areas within the project area compromise approximately 4,185 acres (0.3 percent of the project area), which includes 2,167 acres of BLM, zero acres of state, and 2,018 acres of private lands. BLM WY IM 2012-019 provides the following management actions for greater sage-grouse (BLM 2012c) and allows for local variation in the timing stipulation applicability dates.



Map 3.9-2. Greater sage-grouse potential nesting/brood-rearing habitat, leks, core areas, and 11-mile CD-C project area buffer

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

The Rawlins RMP timing stipulation dates are reflected below:

- In core population areas, surface-disturbing and disruptive activities will be prohibited in all nesting and early brood-rearing habitat, regardless of the distance from the nearest lek (**Map 3.9-2)** from March 1 to July 15 (BLM 2012, BLM 2008a).
- In non-core areas, surface-disturbing and disruptive activities will be prohibited within all identified nesting and brood-rearing habitat (Map 3.9-2) from March 1 to July 15 (BLM 2012, BLM 2008a).
- Surface-disturbing and/or disruptive activities are prohibited or restricted from November 15 – March 14 in mapped or modeled winter habitats/concentration areas (BLM 2012, BLM 2008a).
- Additional greater sage-grouse conservation measures that may be applied by the BLM can be found in the IM WY-2012-019 (BLM 2012c) and the Rawlins RMP.

BLM and other partners are working to develop statewide seasonal habitat models to identify important sage-grouse seasonal habitats. Until such time as those models are complete, and in the event there is a question that suitable nesting and early brood-rearing habitats exist in a particular area, the IM WY-2012-019 states that seasonal habitats will be determined using appropriate methods found in the Habitat Assessment Framework, or HAF. The Rawlins RMP (BLM 2008a, p. 2-55) states that surface-disturbing and/or disruptive activities are to be avoided in all identified nesting and early brood-rearing habitat (**Map 3.9-2)** from March 1 to July 15. The RFO also applies this level of protection to nesting and early brood-rearing habitat in non-core areas (M. Read, pers. com., February 2012). Currently, RFO wildlife biologists have defined “identified nesting and brood-rearing habitat” as any mesic shrub-dominated vegetative community (R. M. Etzelmiller, pers. com., May 2011). Map 3.9.3 provides an overview of areas where seasonal nesting and early brood-rearing restrictions would be applied unless site-specific field work indicates that nesting and early brood-rearing habitat is not actually present at a particular location.

Surface-disturbing and disruptive activities are defined in the Wyoming BLM Guidance for Use of Standardized Surface Use Definitions (WY Information Bulletin 2007-029). For sage-grouse, disruptive activity typically includes people and/or the activity in nesting habitats for a duration of one hour or more during a 24-hour period during the nesting season (BLM IM WO-2010-071 2010).

Greater sage-grouse populations are hunted in some areas of Wyoming, including the project area; the harvest from the South Central Conservation Area, which contains the project area (Upland Game Management Areas 9, 10, 24, 25, and 45), comprised 10.2 percent of the statewide yield in 2010 (**Table 3.9-2**; WGFD 2011). Since 1995, sage-grouse harvest numbers have been reduced by earlier opening dates, shorter hunting season length, and lower bag limits.

Table 3.9-2. Greater sage-grouse harvest numbers for the South Central Conservation Area

Year	Harvest (South Central)	Statewide Harvest	Percent of Statewide Harvest
1998	1,681	16,720	10.1
1999	1,931	21,407	9.0
2000	3,106	20,347	15.3
2001	1,641	12,577	13.0
2002	1,021	4,557	22.4
2003	664	4,835	13.7
2004	1,472	11,783	12.5
2005	2,519	13,178	19.1
2006	1,342	12,920	10.4
2007	1,163	10,378	12.1
2008	1,773	10,303	17.2
2009	1,619	11,162	14.5
2010	1,126	11,057	10.2

A sage-grouse population trend analysis (**Figure 3.9-1**) was conducted to compare sage-grouse populations associated with the CD-C project area to other related sage-grouse populations in southwestern Wyoming and the state as a whole. Specifically, the populations compared include (1) CD-C plus 11-mile analysis area, (2) the Core Population Areas affected by the CD-C project (Greater South Pass), (3) the statewide population, and (4) the "count" leks in the CD-C project area. The WGFD sage-grouse database (WGFD 2010) was used for this analysis. A count lek is a lek, designated by WGFD, on which the count lek protocol is performed annually. The count lek protocol is a survey method that is designed to give greater assurance that the actual peak male attendance is observed for that lek. There are five count leks related to CD-C; three are located in the east-central project area, one is in the northeast corner of the project area, and one is in the southeast corner. Average peak male attendance is used as an index of overall population size because the information is the most readily available and comprehensive. It has been suggested that a ratio of two hens per male in attendance could be used to determine the overall population size of grouse in an area. However, there have been a number of studies that call this ratio into question. Since it is not currently known what conversion factor should be used in the project area to achieve an accurate total population size, no attempt was made to do so here.

The year 1990 was chosen as a beginning point of the comparison analysis to demonstrate the cyclical nature of the species. Also during this period, throughout the state, sage-grouse survey and count protocols were improved and more consistently applied. As demonstrated in **Figure 3.9-1**, the population trend in all study groups is similar regardless of the size of the population involved. This comparison of four different groups of sage-grouse leks removes the question of local weather conditions affecting the population or the level of survey effort or of any one sub-set of leks affecting or controlling the overall trend.

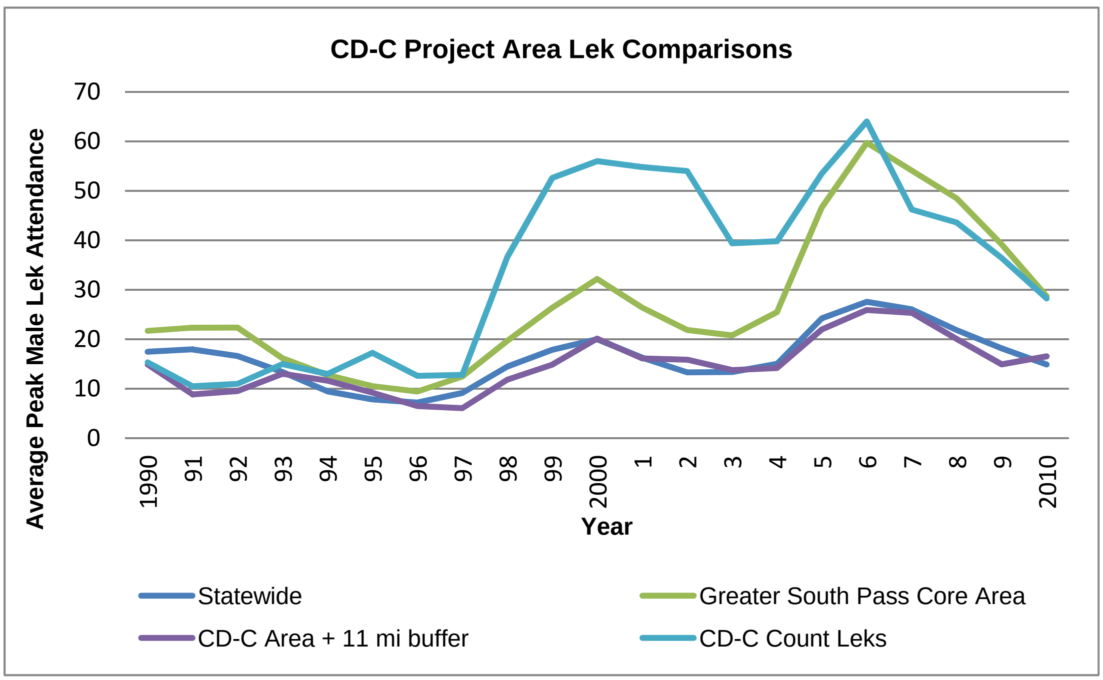


Figure 3.9-1. Average peak observed male attendance for leks associated with the project area (WGFD 2011)

As can be seen in **Figure 3.9-1**, all populations analyzed experienced similar increases and decreases in numbers of individuals observed. It is generally agreed (Connelly 2004) that sage-grouse populations are cyclical; **Figure 3.9-1** indicates an apparent seven-year cycle.

3.9.1.2 Threatened or Endangered Fish Species

Four federally Endangered fish species may occur as downstream residents of the Colorado River System: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USFWS 2004a). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development (e.g. dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USFWS 1993).

The last sighting of any of these fish species in the Little Snake River was of a single Colorado pikeminnow in 1990. No critical habitat for these species has been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity and/or quality to these tributaries to the Colorado River warrant their inclusion in this document.

Bonytail. Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and whitewater areas (Valdez and Clemmer 1982, Archer *et al.* 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be the rarest of the Endangered fishes in the Colorado River System.

The bonytail historically inhabited portions of the upper and lower Colorado River basins. Today in the upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border, and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Colorado pikeminnow. The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of the Colorado River basins. The species was once abundant in the mainstem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the City of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995). Subsequent survey attempts to collect Colorado pikeminnow from this area of the Little Snake River by WGFD personnel failed to yield any other specimens.

Humpback chub. Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and whitewater areas (Valdez and Clemmer 1982, Archer *et al.* 1985, Upper Colorado River Endangered Fish Recovery Program 1999).

The humpback chub was historically found throughout the Colorado River System and its tributaries, which are used for spawning (Valdez *et al.* 2000). It is estimated that the humpback chub currently occupies 68 percent of its original distribution in five independent populations that are thought to be stable (Valdez *et al.* 2000).

Razorback sucker. The razorback sucker is an omnivorous bottom-feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado, and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

3.9.1.3 Threatened, Endangered, Proposed, Candidate, or Experimental Plant Species

The USFWS (2002) has determined that one threatened plant species, **Ute ladies'-tresses**, may potentially be present within the project area (**Table 3.9-1**). This species is not known to occur within the project area, but it may potentially be affected by the proposed project. The known locations of this species in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. This species is not known to occur within the project area and the likelihood of it occurring there is low for the following reasons: (1) much of the project area is very arid and there are few perennial streams; (2) the elevation of the project area is near the upper limit for the species; (3) very few moist riparian area meadows are present; (4) where present, the transition from stream margins to upland vegetation is abrupt; and (5) in Wyoming, the species has only been located in the eastern and southeastern portions of the state (Fertig 2000).

3.9.2 BLM Sensitive Species

The BLM has developed a Sensitive Species List for public lands in Wyoming (**Table 3.9-3**). The list includes species that are not listed as Endangered or Threatened by the USFWS but may be rare or declining in the state.. The objective of the Sensitive Species designation is to ensure that the overall welfare of these species is considered when undertaking actions on public lands**,** and that these actions do not contribute to the need to list the species under the provisions of the ESA. It is the intent of this policy to emphasize the inventory, planning consideration, management implementation, monitoring, and information exchange for the sensitive species on the list. The BLM Sensitive Species List is meant to be dynamic and is reviewed annually with recommendations from BLM and appropriate non-BLM authorities for additions and deletions (BLM 2010). Twenty-eight species on the BLM Sensitive Species List that occur in the RFO may occur in or near the CD-C project area.

Table 3.9-3. Occurrence potential and habitat associations of BLM Sensitive Species within or near the CD-C project area

Common Name	Scientific Name	Occurrence Potential[1]	Habitat Association[2]
Mammals			
Fringed myotis	*Myotis thysanodes*	pp	Caves, forest, shrublands
Long-eared myotis	*Myotis evotis*	U	Caves, forest, shrublands
Pygmy rabbit	*Brachylagus idahoensis*	P	Sagebrush
Spotted bat	*Euderma maculatum*	pp	Cliffs, sagebrush
Swift fox	*Vulpes velox*	pp	Grasslands
Townsend's big-eared bat	*Corynorhinus townsendii*	pp	Caves, forest, shrublands
White-tailed prairie dog	*Cynomys leucurus*	P	Sagebrush-grasslands
Wyoming pocket gopher	*Thomomys clusius*	P	Sagebrush-grasslands
Birds			
Bald eagle	*Haliaeetus leucocephalus*	P	Rivers, stream and lakes
Brewer's Sparrow	*Spizella breweri*	P	Sagebrush
Burrowing owl	*Athene cunicularia*	P	Grasslands
Ferruginous hawk	*Buteo regalis*	P	Sagebrush-grasslands
Loggerhead shrike	*Lanius ludovicianus*	P	Shrublands
Long-billed curlew	*Numenius americanus*	P	Grasslands
Mountain plover	*Charadrius montanus*	P	Grasslands
Peregrine falcon	*Falco peregrinus*	U	Cliffs, rivers
Sage sparrow	*Amphispiza belli*	P	Sagebrush
Sage thrasher	*Oreoscoptes montanus*	P	Sagebrush

Table 3.9-3. Occurrence potential and habitat associations of BLM Sensitive Species within or near the CD-C project area, *continued*

Common Name	Scientific Name	Occurrence Potential[1]	Habitat Association[2]
Amphibians			
Great Basin spadefoot	*Spea intermontana*	P	Sagebrush
Northern leopard frog	*Rana pipiens*	pp	Plains and foothills ponds
Fish			
Roundtail chub	*Gila robusta*	P	Rivers, stream and lakes
Bluehead sucker	*Catostomus discobobulus*	P	All waters
Flannelmouth sucker	*Catostomus latipinnis*	P	Rivers, stream and lakes
Colorado River cutthroat trout	*Onchorhynchus clarki pleuriticus*	pp	Mountain streams
Plants			
Meadow milkvetch	*Astragalus diversifolius*	P	Moist, salt-accumulating habitats such as alkaline meadows and playa shorelines
Cedar Rim thistle	*Cirsium aridum*	pp	Barren, chalky hills, gravelly slopes, and fine textured, sandy-shaley draws
Gibben's beardtongue	*Penstemon gibbensii*	pp	Barren south-facing slopes on loose sandy-clay derived from Brown's Park formation
Persistent sepal yellowcress	*Rorippia calcycina*	P	River banks and shorelines

[1] *Occurrence potential includes: present (P), potentially present (pp), unlikely (U), and very unlikely (VU);(WGFD 2004a; HWA, unpublished data).*
[2] *WGFD 2004a.*

3.9.2.1 Sensitive Wildlife Species

Twenty terrestrial species and four fish species designated by the BLM as Sensitive that occur in the RFO may occur in or near the CD-C project area and thus potentially could be affected by the Proposed Action (**Table 3.9-3**; BLM 2010, WGFD 2007, WYNDD 2007). The black-tailed prairie dog, Baird's sparrow, Columbian sharp-tailed grouse, northern goshawk, trumpeter swan, white-faced ibis, hornyhead chub, and boreal toad are located within the RFO; however, they are not located nor do they have habitat within or near the CD-C project area.

Mammals

Fringed myotis. This bat species occupies a variety of coniferous forests, woodland chaparral, and basin-prairie shrubland habitats throughout western North America from British Columbia to southern Mexico. In Wyoming, its residency status is currently unknown (WGFD 2004a). This species could potentially utilize the project area for feeding; roosting sites may occur in the project area as suitable habitat (i.e., caves and mines) is present.

Long-eared myotis may hibernate in Wyoming, but the species is considered uncommon and its residency status currently is unknown (WGFD 2004a). Long-eared myotis has been documented approximately 15 miles west of the project area (WYNDD 2007). Suitable habitat for the species occurs in the project area.

Pygmy rabbit. A sagebrush obligate, the pygmy rabbit requires tall sagebrush and deep, soft soil for burrowing. Therefore, it is not distributed uniformly across the sagebrush shrub-steppe ecosystem. The species occurs in eight western states (California, Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming), and has been documented throughout western Wyoming including Carbon and Sweetwater counties. It should be noted that the Columbia Basin Distinct Population Segment in

Washington State is managed differently and is currently listed as Endangered under the ESA. In September 2010, the USFWS released its 12-month finding on a petition to list the pygmy rabbit as Endangered or Threatened range-wide under the ESA and found that listing was not warranted. Although listing was not warranted, the USFWS acknowledged several threats to pygmy rabbit habitat including sagebrush conversion for agricultural purposes, livestock grazing, and energy development. Suitable pygmy rabbit habitat is patchily distributed but abundant in the Continental Divide Basin and surrounding areas. Pygmy rabbits have been documented throughout the project area (WYNDD 2007, HWA unpublished data).

Spotted bat. Although it occurs sporadically as a summer resident across the western United States, the spotted bat has not been documented in the project area (WGFD 2007, WYNDD 2007). Spotted bat is associated with juniper shrublands and desert-sagebrush grasslands in Wyoming (WGFD 2004a). The species may occur in the project area. Roosting habitat such as cliffs is present although perennial water is lacking.

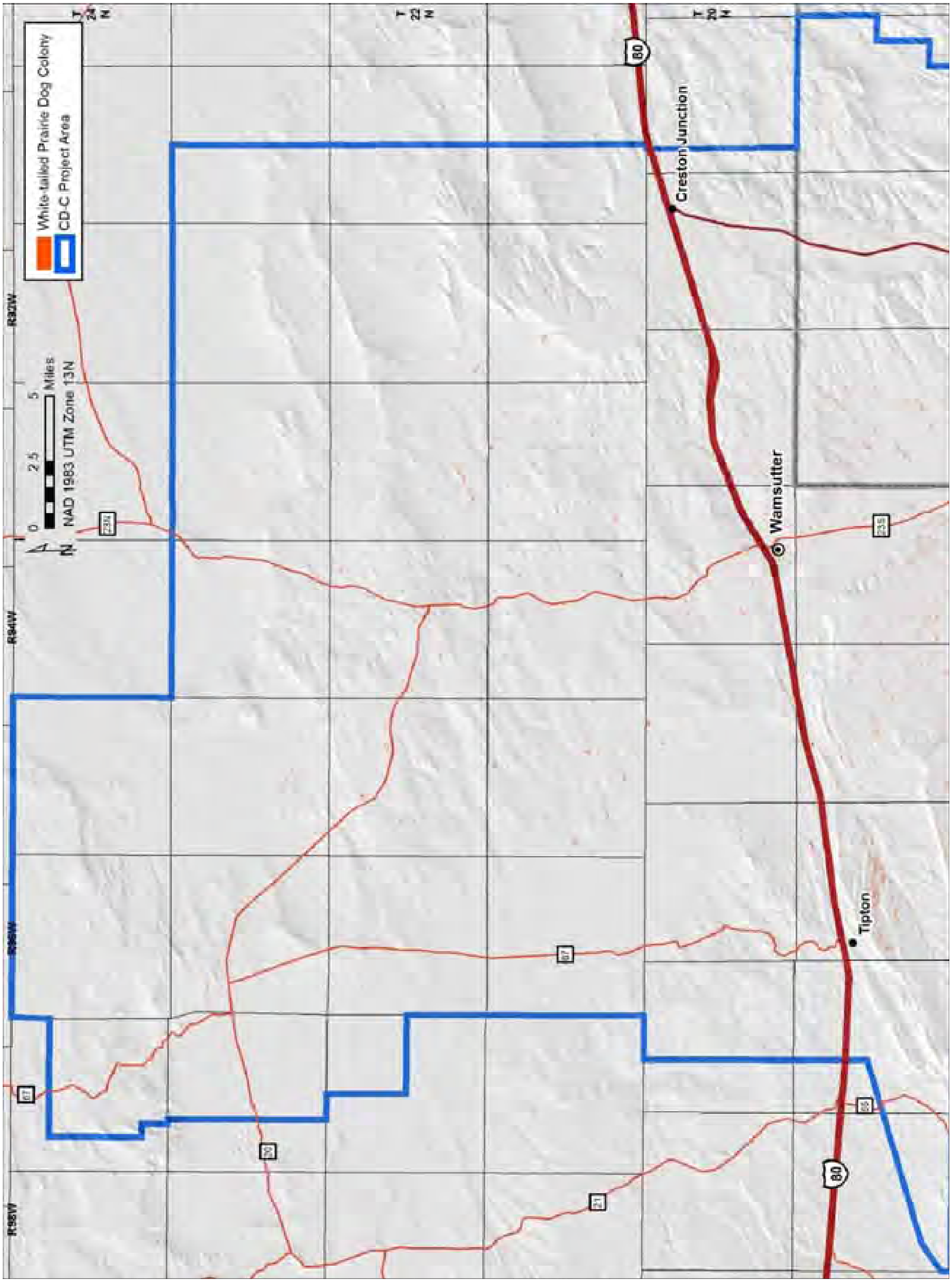
Swift fox. The swift fox inhabits short-grass and mixed-grass prairies over most of the Great Plains, including eastern Wyoming (Clark and Stromberg 1987). Studies have documented swift fox in Carbon and Sweetwater Counties within the project area and the species potentially may occur (Woolley *et al.* 1995). However, no swift fox have been documented in Sweetwater County in recent years (WGFD 2007, WYNDD 2007).

Townsend's big-eared bat can be found throughout Wyoming and its distribution is likely determined by the availability of roosts such as caves, mines, tunnels, and crevices with suitable temperatures (Clark and Stromberg 1987). Although its residency status is currently unknown, it may hibernate in Wyoming in caves (WGFD 2004a). This species has not been observed within or near the project area (WGFD 2007, WYNDD 2007). It may be present in the project area as forage and roosting habitat (caves, mines, rock outcrops, and buildings) are present.

White-tailed prairie dog. This species occupies grassland, sagebrush, and arid shrubland habitats in central and western Wyoming (Clark and Stromberg 1987) and is found in scattered colonies throughout the project area. Approximately 8,818 acres of white-tailed prairie-dog colonies have been mapped within the project area to date (**Map 3.9-3a and 3.9-3b**; BLM RFO unpublished data; HWA unpublished data).

Wyoming pocket gopher. Endemic to southeastern Sweetwater County and southwestern Carbon County, the Wyoming pocket gopher has been documented within the project area (WYNND 2007, HWA 2008 and 2009). Another population has been recorded in Carbon County approximately 20 miles east of the project area near Bridger's Pass, and the species may occur elsewhere (Clark and Stromberg 1987). In August 2007, the Wyoming pocket gopher was petitioned for listing under the ESA. The rationale for petitioning the species included a lack of knowledge regarding its taxonomy, abundance, population trends, distribution, habitat requirements, and the potential effects from energy development within their range. In April 2010, the USFWS determined the Wyoming pocket gopher did not warrant protection as a threatened or endangered species under the ESA.

As part of the survey efforts for the 12-month status review, HWA biologists collaborated with the BLM-RFO and WYNDD to conduct an extensive trapping effort during 2008 and 2009. The objective of the study was to capture Wyoming pocket gophers to genetically verify its status as a separate species, and to collect additional information on its distribution within the project area and across its predicted range in general. In 2008, 10 Wyoming pocket gophers and 20 northern pocket gophers were trapped in 351 trap-nights within the project area. Capture locations were concentrated within 15 miles southwest of Wamsutter on the plateaus above Wamsutter and Delaney Rims (HWA 2008c). In 2009, ten Wyoming pocket gophers and 12 northern pocket gophers were trapped in 550 trap nights within the project area. Capture locations were distributed throughout the project area, including eight captures approximately 20 miles southwest of Creston Junction (I-80 and WY 789) and two captures 10 miles north of Creston Junction (HWA 2009). Wyoming and northern pocket gophers appear to be sympatric (have overlapping ranges) within the project area.



Map 3.9-3a. White-tailed prairie-dog colonies within the CD-C project area

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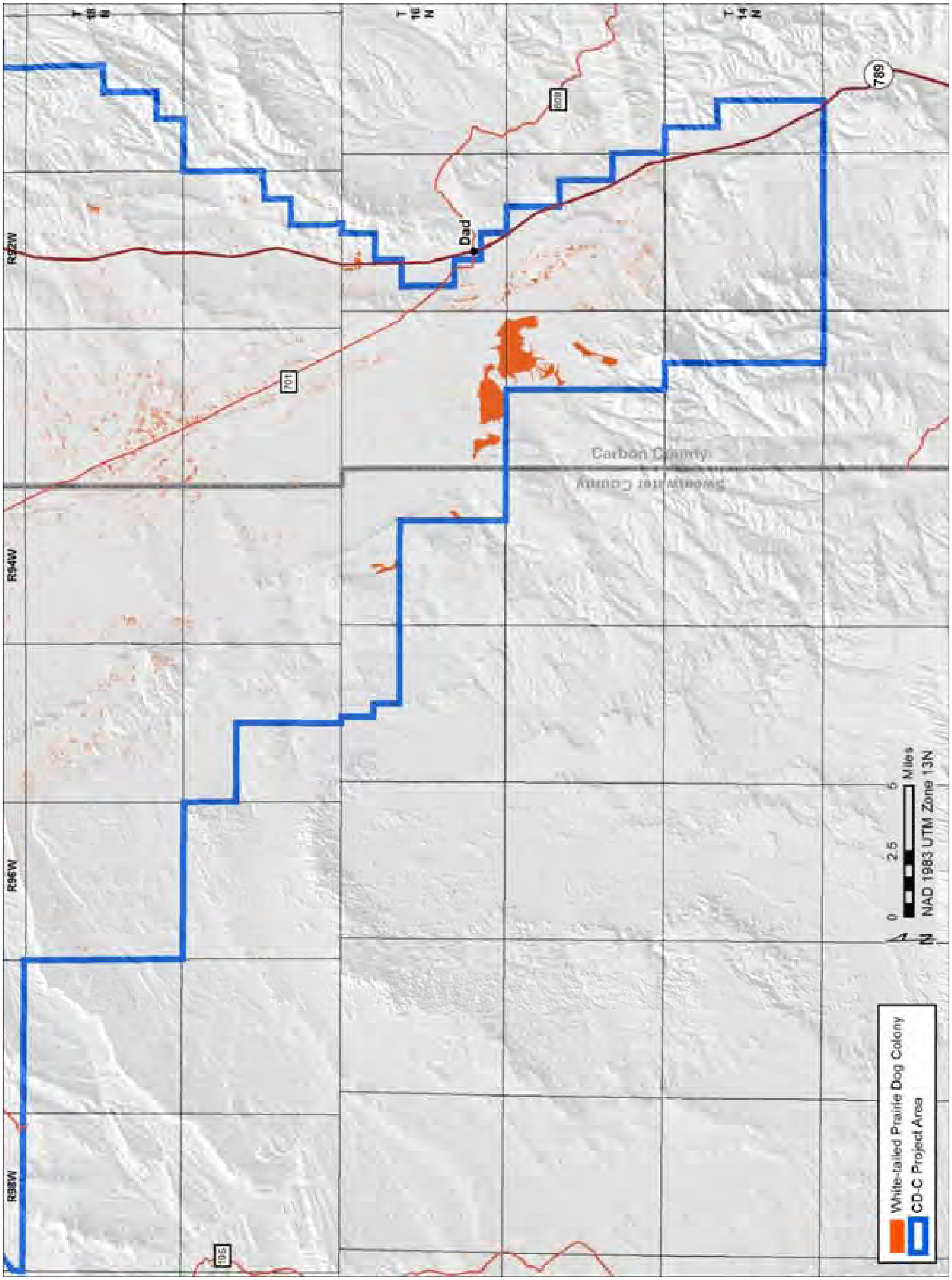

Map 3.9-3b. White-tailed prairie-dog colonies within the CD-C project area

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Birds

Bald eagle. This large North American eagle is normally found near water. It is found throughout North America, but primarily breeds in Canada, Alaska, the Pacific Northwest, the Rocky Mountains, and the Great Lakes region. Bald eagles have been observed in the project area primarily from November through March (WGFD 2004a, HWA unpublished data). The species may forage within the project area during the winter months because of carrion associated with pronghorn, mule deer, and elk winter ranges (**Maps 3.8-2**, **3.8-4**, and **3.8-6**). No bald eagle nests or nesting habitat (mature, large diameter trees near open water) occur within the project area. The nearest potential nesting habitat occurs along the Little Snake River approximately nine miles south of the project area.

Brewer's sparrow. A sagebrush obligate, Brewer's sparrow breeds throughout the intermountain west of the United States and winters in southern portions of California, Arizona, New Mexico, and western Texas, and south through the central part of Mexico (Rotenberry *et al.* 1999, Sibley 2000). Brewer's sparrows will breed in a variety of shrubland habitats, but prefer areas dominated by big sagebrush (*Artemisia tridentata*; Rotenberry *et al.* 1999). It prefers to nest in shrubs that are taller and denser than average (Petersen and Best 1985). This species may be particularly sensitive to habitat fragmentation, and appears to be affected more by changes at the landscape level than at the local level (Knick and Rotenberry 1995). Brewer's sparrow is expected to breed and has been observed within the project area (WGFD 2004a, WYNDD 2007, HWA unpublished data).

Burrowing owl. The burrowing owl is found throughout the plains and prairies of the western United States during the spring, summer, and fall (Haug *et al.* 1993). While the species has the capacity to excavate its own burrow, it seldom does, relying instead on mammals such as prairie dogs, ground squirrels, and badgers (Thomsen 1971). The burrowing owl's close association with burrowing mammals suggests dependence on them (Haug *et al.* 1993). Knowles (1999) suggested that the burrowing owl is a near prairie-dog obligate species because its distribution is so closely tied to that of prairie dogs. Burrowing owls also use isolated ground-squirrel and badger burrows in hillsides, and road borrow ditches.

Burrowing owl is listed as a species of special concern across Wyoming, as a consequence of long-term population declines (Haug *et al.* 1993). Because of the strong association between burrowing owls and prairie dogs, declines in the burrowing-owl population have been linked to many of the same factors associated with declining prairie-dog populations (i.e., rodent-eradication programs and habitat loss). Furthermore, long-term conservation of the burrowing owl will likely be closely linked to the conservation and preservation of prairie-dog complexes, and other burrowing mammals. Burrowing owl occurs and breeds within the project area (BLM 2007a, WGFD 2004a, WYNDD 2007, HWA unpublished data).

Ferruginous hawk. Primarily found in mixed-grass prairie and sagebrush steppe habitats during the spring, summer, and fall, the ferruginous hawk generally builds nests on rock outcrops, the ground, or cliff ledges. Although a small population overwinters in Wyoming, most individuals migrate south for the winter. Ferruginous hawks are common in south-central Wyoming and breed within the project area (BLM 2007a, WGFD 2006, WYNDD 2007). The western two-thirds of Carbon County hosts one of the highest nesting densities of ferruginous hawks within Wyoming (BLM 2007a). BLM records document the occurrence of 577 ferruginous hawk nest sites (**Table 3.8-5**; BLM unpublished data) in or within one mile of the project area.

Loggerhead shrike. This species breeds and winters throughout the United States in a wide variety of open habitats with some shrub or scattered-tree component. A summer resident, it usually builds its nest within large shrubs such as sagebrush, bitterbrush, or greasewood (Woods and Cade 1996). Loggerhead shrike populations have experienced declines across much of the species' range primarily due to loss of habitat. Livestock grazing in combination with drought is a major factor in the decline. In addition, the loggerhead shrike is prone to the negative effects of pesticide use because its diet consists largely of insects. The species is expected to breed and has been observed within the project area (WGFD 2006, WYNDD 2007, HWA unpublished data).

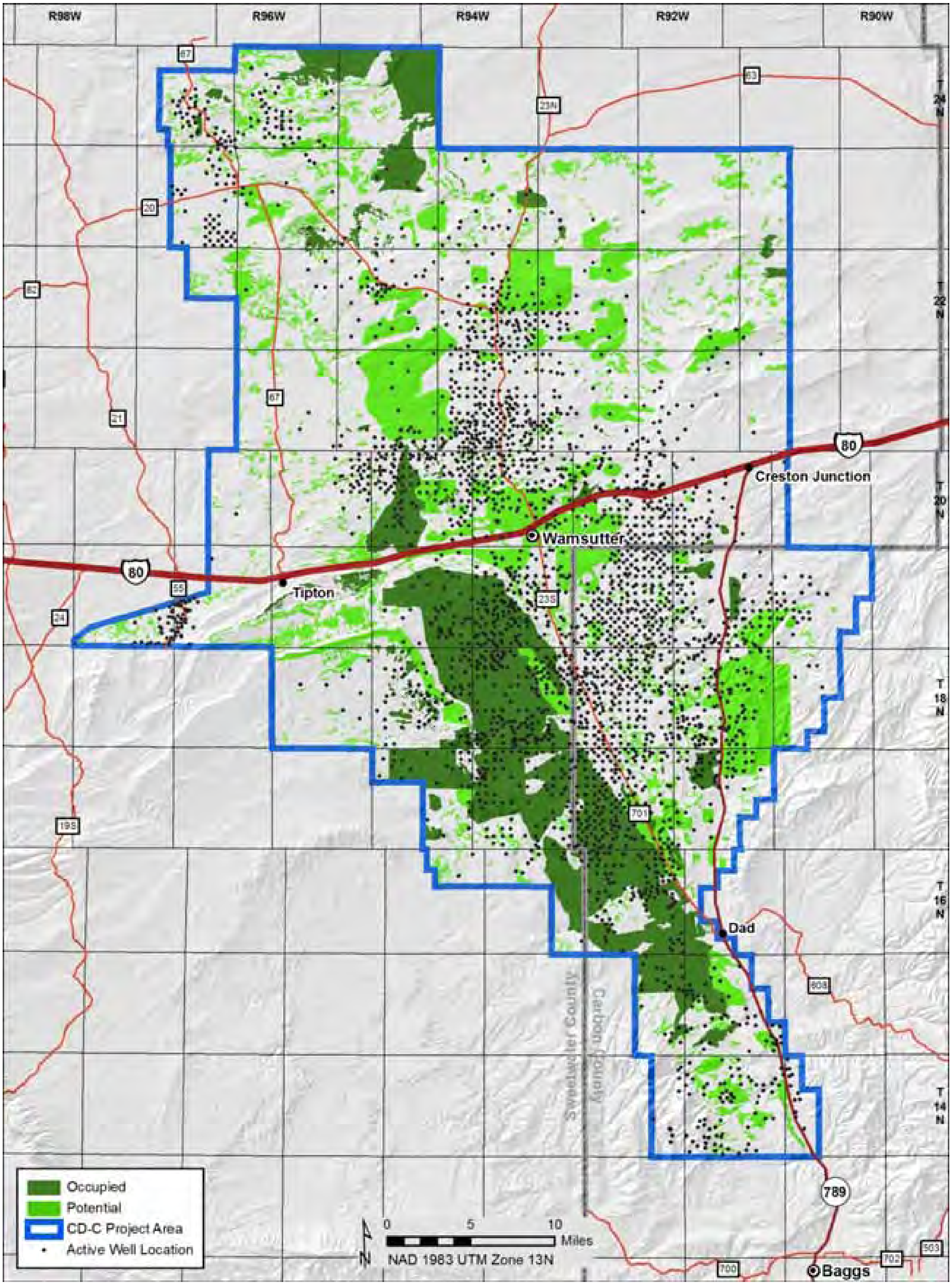
Long-billed curlew. A locally common summer resident of Wyoming (WGFD 2004a), the long-billed curlew prefers gentle, rolling topography in native grasslands, sagebrush, and agricultural lands that can be arid as long as a water source is relatively nearby. One observation of a long-billed curlew has been documented in the extreme south of the project area (WGFD 2006). It is unlikely the species breeds in the project area because suitable breeding habitat and water are limited.

Mountain plover. The mountain plover is dependent on short-grass prairie and also is frequently associated with prairie-dog towns (Knowles *et al*. 1982). The species nests on the ground in large grassland areas with short, sparse vegetation and substantial amounts of bare ground. In May 2011 the USFWS determined that the mountain plover is not threatened or endangered throughout all or a significant portion of its range. Numerous observations of mountain plovers have been recorded within the project area (WGFD 2007, BLM unpublished data, HWA unpublished data). Approximately 342,393 acres of occupied or potential mountain plover habitat have been mapped, comprising approximately 32 percent of the project area (**Map 3.9-4**; HWA unpublished data).

Peregrine falcon. The peregrine falcon breeds throughout North America, including the Arctic, the Pacific coast, the Rocky Mountains, and scattered areas across the eastern United States. Although populations of avian prey species in and around the project area may be abundant and diverse enough to support the species, breeding is unlikely due to the lack of high cliffs suitable for nesting. Nevertheless, peregrine falcons may be present within the project area during migration.

Sage sparrow. A sagebrush obligate found throughout much of the western United States, the sage sparrow breeds in sagebrush expanses from the northern edges of the Great Basin west of the Rocky Mountains to the chaparral and sagebrush scrub in Baja California (Martin and Carlson 1998). Suitable sagebrush habitat is widespread and abundant within the project area. The sage sparrow is expected to breed and has been observed within the project area (WGFD 2006, WYNDD 2007, HWA unpublished data).

Sage thrasher. A sagebrush obligate found throughout the intermountain west, the sage thrasher builds nests in shrub-steppe communities dominated by sagebrush. Suitable sagebrush habitat is widespread and abundant within the project area. The sage thrasher is expected to breed and has been documented within the project area (WGFD 2007, WYNDD 2007, HWA unpublished data).



Map 3.9-4. Occupied and potential mountain plover habitat within the CD-C project area

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Amphibians

Great Basin spadefoot. An occupant of sagebrush and greasewood communities as well as playas below 6,000 feet, the Great Basin spadefoot deposits eggs in springs or flooded areas formed by heavy rains (WGFD 2004a). Its life history requires suitable foraging areas, ephemeral breeding ponds, and overwintering sites. In the winter this species digs its own burrow and will overwinter underground, sometimes as deep as 15 feet. The Great Basin spadefoot has been documented in Sweetwater, Lincoln, Fremont, and Natrona Counties, and has been documented within the project area (Baxter and Stone 1992, WGFD 2006, WYNDD 2007). Playas and riparian areas within the project area likely support this species.

Northern leopard frog. This frog species is usually found close to wetlands, cattail marshes, and along vegetated shorelines during summer, but will venture several hundred meters along wet drainages during wet periods (Werner *et al.* 2004). A member of the true frog family (*Ranidae*), the northern leopard frog is an obligate of permanent water in the plains, foothills, and montane zones of Wyoming up to 9,000 feet above sea level (WGFD 2004a). This species has been documented within six miles of the project area and has a high probability of occurring in any area having perennial water (WYNDD 2007). The northern leopard frog was petitioned for listing under the ESA; in October 2011 the USFWS determined at listing was not warranted.

3.9.2.2 Sensitive Fish Species

Fish species that are not listed as Endangered or Threatened by the USFWS, but that may be rare or declining in the state, have been included on the BLM's Wyoming Sensitive Species List (BLM 2002). The intent of the sensitive species status is to ensure that actions on BLM-administered lands consider the welfare of these species and do not contribute to the need to list any other species under the provisions of the Endangered Species Act (BLM 2001).

Four BLM Wyoming State sensitive fish species are known to occur in portions of streams on or adjacent to the project area. These include the roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (WYNDD 2003, BLM 2002). The three non-game fish species (roundtail chub, bluehead sucker, flannelmouth sucker) have been found within Muddy Creek downstream, within, and upstream of the project area, and in Bitter Creek downstream of the project area (WGFD 1998, 2004c, 2007a). In general, all three species are associated with hard substrates and deep pool habitat (Bower 2005).

The Muddy Creek watershed is one of the few stream systems in Wyoming where these three native, non-game fish species exist together (WGFD 2004b) and the only watershed where these species and Colorado River cutthroat trout are known to coexist. It has also been designated as Aquatic Crucial Habitat by the WGFD because the area addresses Goal 1 of the WGFD Strategic Habitat Plan (WGFD 2009). Because of the high conservation value of Muddy Creek for these species, multiple studies have been conducted to increase understanding of their ecology in the creek. The BLM is a signatory to the range-wide (Wyoming and other states) conservation agreement and strategy for roundtail chub, bluehead sucker, and flannelmouth sucker where these three non-game species are present. The BLM, WGFD, and University of Wyoming completed a study to better characterize the abundance, distribution, behavior, habitat requirements and genetics of the three non-game sensitive species within the Muddy Creek watershed, which included part of the project area (Beatty 2005). The following is a summary of those study results for 2004.

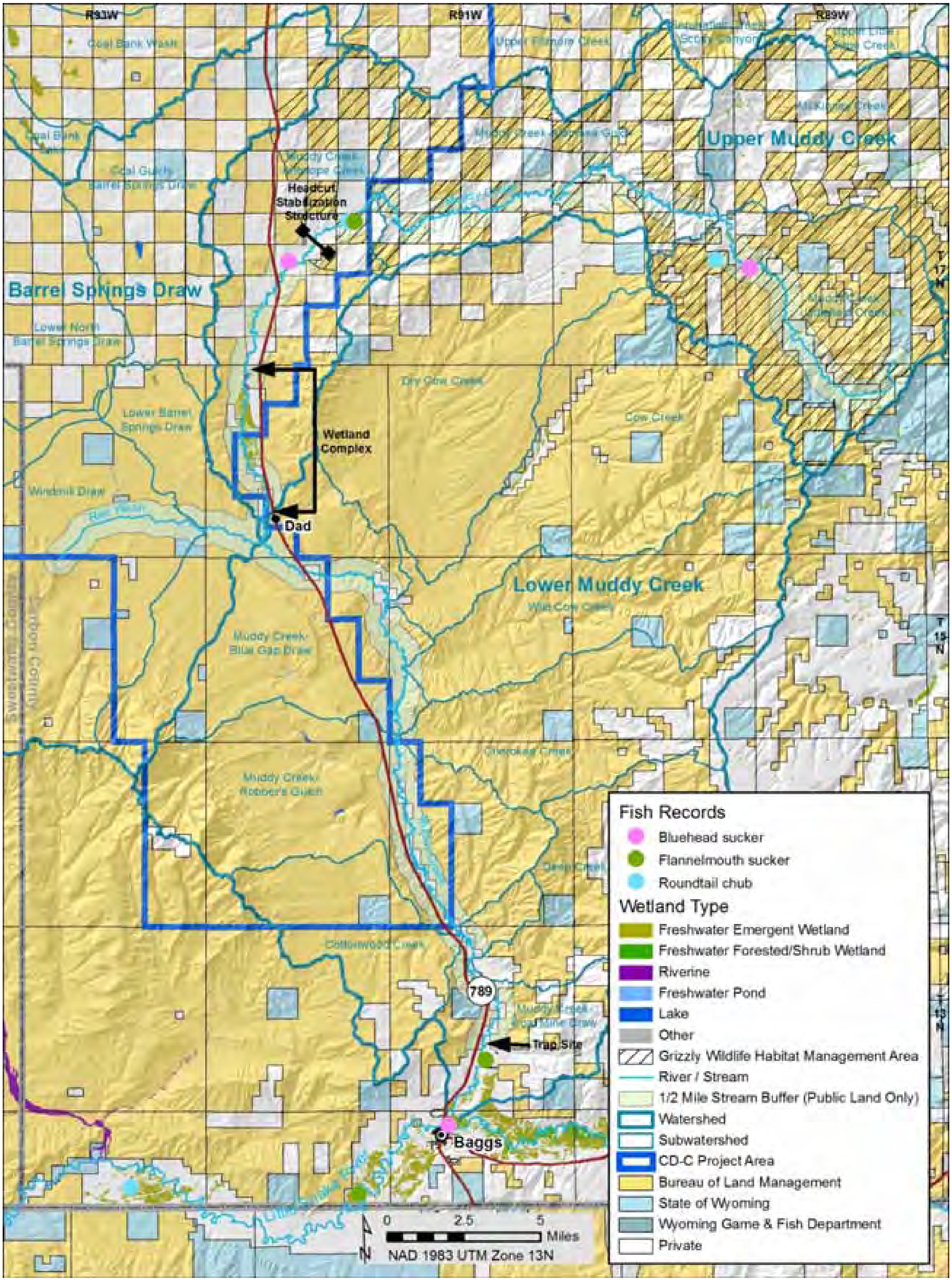
Man-made structures have resulted in three fragmented stream segments in the lower Muddy Creek watershed (Beatty 2005, **Map 3.9-5**). The farthest downstream segment (segment 1) begins at the confluence of Muddy Creek with the Little Snake River and extends upstream to a wetland complex with water-control structures that inhibit fish movement. The farthest downstream segment experiences periods of no surface flow with isolated pools and was dominated by non-native fishes in 2004. The middle segment (segment 2) consists of a wetland complex with numerous water-control structures and was dominated by non-native species, particularly the fathead minnow (*Pimephales promelas*). The upstream segment (segment 3) extended from upstream of the wetland complex to a headcut stabilization structure that prevents upstream movement by fish. The upstream segment was dominated by two native species: roundtail chub (*Gila robusta*) and speckled dace (*Rhinichthys osculus*). Constructed wetlands and barriers to upstream movements by fishes appear to influence native fishes and the structure of fish communities in lower Muddy Creek, similar to the effects of fragmentation and intermittent stream flows in other areas of the Colorado River Basin.

Compton (2007) completed a study on the effects of barriers on these three sensitive species in Muddy Creek upstream of the wetland complex. Instream structures prevented or severely limited upstream movements, but downstream movements over structures occurred. Within each segment in this study area, roundtail chubs were most abundant and flannelmouth suckers were least abundant among the three native species. A core population of the three native species existed in one segment and supported the highest densities of juveniles and adults and the broadest length ranges. Non-native white suckers, *Catostomus commersoni*, were the most abundant species in the study area. Their highest densities occurred in altered habitat. Substantial hybridization with the two native catostomid species was evident. Compton (2007) concluded that native fish populations in the most upstream segment may be at risk of extirpation due to low abundance and reproduction. Connectivity among habitats is required to carry out the life-cycles of native fishes and fragmentation by man-made structures is affecting their abundance and distribution patterns.

WGFD (2007a) sampled these three species in the Muddy Creek and Bitter Creek watersheds in 2006 as part of a study of these species within the Green River watershed in Wyoming. Of the three species, only roundtail chubs were found in lower Muddy Creek. However, flannelmouth sucker-white sucker hybrids were found there. In upper Muddy Creek within the CD-C project area, all three species were found as well as flannelmouth sucker-white sucker hybrids and blue sucker-white sucker hybrids. Flannelmouth suckers also were found in the headwaters of Bitter Creek. WGFD (2007a) concluded that perhaps the biggest threat to native bluehead and flannelmouth suckers in the Green River drainage of Wyoming is the occurrence of and subsequent hybridization with nonnative white sucker.

The Colorado River cutthroat trout, which is a native game fish, has been re-introduced into Muddy Creek upstream of the project area and into Littlefield Creek, a tributary to Muddy Creek, upstream of the project area. Before the introduction was made, all fish in these segments of these creeks were eliminated and a fish barrier was installed on Muddy Creek immediately upstream of McKinney Creek to prevent non-native fish from gaining access to the stream. In addition to the Colorado River cutthroat trout, the WGFD is planning to re-introduce all native species into the segment of Muddy Creek upstream of the barrier. Colorado River cutthroat trout also occur downstream from the project area in the Little Snake River (Baxter and Stone 1995). This species had been petitioned for listing as Threatened or Endangered; however, the decision “not warranted to list” was made in June 2007.

Besides Muddy Creek, all of the other streams on the project area are ephemeral and therefore do not have the potential to support BLM Wyoming State sensitive fish species on a year-round basis. Studies indicate that the non-game, native species may ascend ephemeral tributary streams to spawn (USFWS 1985, Maddux and Kepner 1988, Weiss *et al.* 1998). Thus, ephemeral drainages fed by runoff from the project area may provide habitat for sensitive fish on a seasonal basis.



Map 3.9-5. Lower Muddy Creek Watershed

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Bluehead sucker. Present in the Little Snake, Green, Snake, and Bear River basins in Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004a), the bluehead sucker occupies habitats similar to that of the roundtail chub. This species is considered rare in Wyoming in comparison with other sucker species. This species occurs in the Little Snake River and is found in Muddy Creek upstream of and within the project area (Baxter and Stone 1995, WGFD 1998, WGFD 2004a, Bower 2005, Beatty 2005, Compton 2007, WGFD 2007a). It has hybridized with non-indigenous white suckers (*Catostomus commersoni*) in Muddy Creek (Compton 2007, WGFD 2007a).

Colorado River cutthroat trout. This is the only trout native to the Green River and Little Snake River drainages in Wyoming (Baxter and Stone 1995). Historical records indicate it was present in Muddy Creek in the mid-1800s (Fowden, WGFD, personal communication). Historically, this subspecies inhabited clear-water tributaries of the Colorado River in Colorado, Utah, Wyoming, and probably also in New Mexico and Arizona (Behnke 1992). This species now occupies only a fraction of its former range. Some of the most genetically “pure” of the remaining populations of this trout subspecies are found in the Little Snake River upstream of the project area in Carbon County, Wyoming (Baxter and Stone 1995). Colorado River cutthroat trout have been re-introduced into Littlefield Creek and Muddy Creek upstream of the project area. Therefore, this species occasionally may occur within the project area, although suitable habitat is not present to sustain it. The species is generally associated with steep, clear, cold-water streams around rocky areas, riffles, deep pools, and near or under overhanging banks and logs (Binns 1977). Colorado River cutthroat trout have been extirpated from much of their original range through competition with brook trout, rainbow trout, and brown trout, and hybridization with rainbow trout (Binns 1977).

Flannelmouth sucker. One of the most abundant and widely distributed sensitive fish species of the tributaries and mainstream portions of the Upper Colorado River Basin, the flannelmouth sucker is found primarily in the Yampa, Little Snake, Colorado, Green, and Gunnison River. It is also common in Muddy Creek in Carbon County, Wyoming, upstream of and within the project area (Bower 2005, Beatty 2005, Compton 2007, WGFD 2007a). There is limited information on the life history of this species. The available information suggests that flannelmouth suckers utilize habitats in medium to large rivers and are seldom found in smaller creeks, doing poorly in impoundments (Lee *et al.* 1980, Baxter and Stone 1995, and Colorado Water Resources Research Institute [CWRRI] 2000). Causes for their decline include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Minckley 1973). The species has hybridized with white suckers in Muddy Creek (Compton 2007, WGFD 2007a).

Roundtail chub. The roundtail chub is a close relative of the federally Endangered humpback chub and bonytail. Its habitat consists of warm streams and larger rivers, usually in areas with slow-flowing water adjacent to areas of faster current (CWRRI 2000). This species is common within the Little Snake River drainage and is found in Muddy Creek upstream of and within the project area (Baxter and Stone 1995, WGFD 1998, WGFD 2004a, Bower 2005, Beatty 2005, Compton 2007, WGFD 2007a).

3.9.2.3 Sensitive Plant Species

Four BLM sensitive plant species may potentially occur within the project area. Two of the species are known to occur within the project area (BLM 2002b, Heidel 2008). The names and probability of occurrence of these species are listed in **Table 3.9.1**. The following species are located within the RFO; however, they are not located nor do they have habitat within or near the CDC project area: Laramie columbine, Trelease’s milkvetch, many-stemmed spider-flower, dune wild rye, limber pine, and Laramie false sagebrush.

Gibben’s beardtongue. In Wyoming, the known occurrences of Gibben’s beardtongue are confined to extreme southwest Carbon County and extreme southeast Sweetwater County near the state line. This plant has been documented approximately 9 miles west of the southern tip of the project area (WYNDD 2007) and it has the potential to likely occur within the project area. Gibben’s beardtongue may occur in grass-dominated sites with scattered shrubs, semi-barren fringed sagebrush/thickspike wheatgrass communities with 15–20 percent vegetation cover, or on ashy slopes amid *Cercocarpus montanus*. It may also occur on outcrops of the Green River Formation on steep yellowish sandstone-shale slopes below caprock edges.

Cedar Rim Thistle is endemic to the Wind River and Green River basins of central Wyoming. This plant has the potential to occur in the project area; however, the species has not been found within the project area (WYNDD 2007).

Persistent sepal yellowcress is generally found along moist, sandy stream banks, stock ponds, and man-made reservoirs near the high-water line. This species was located by HWA near Lost Creek below Eagles Nest Spring during special status plant surveys during the 2006 and 2007 growing seasons (HWA 2008a). Results of the surveys indicate the occurrences of persistent sepal yellowcress are mainly associated with the Lost Creek drainage near the Eagles Nest Spring site in the northern portion of the project area.

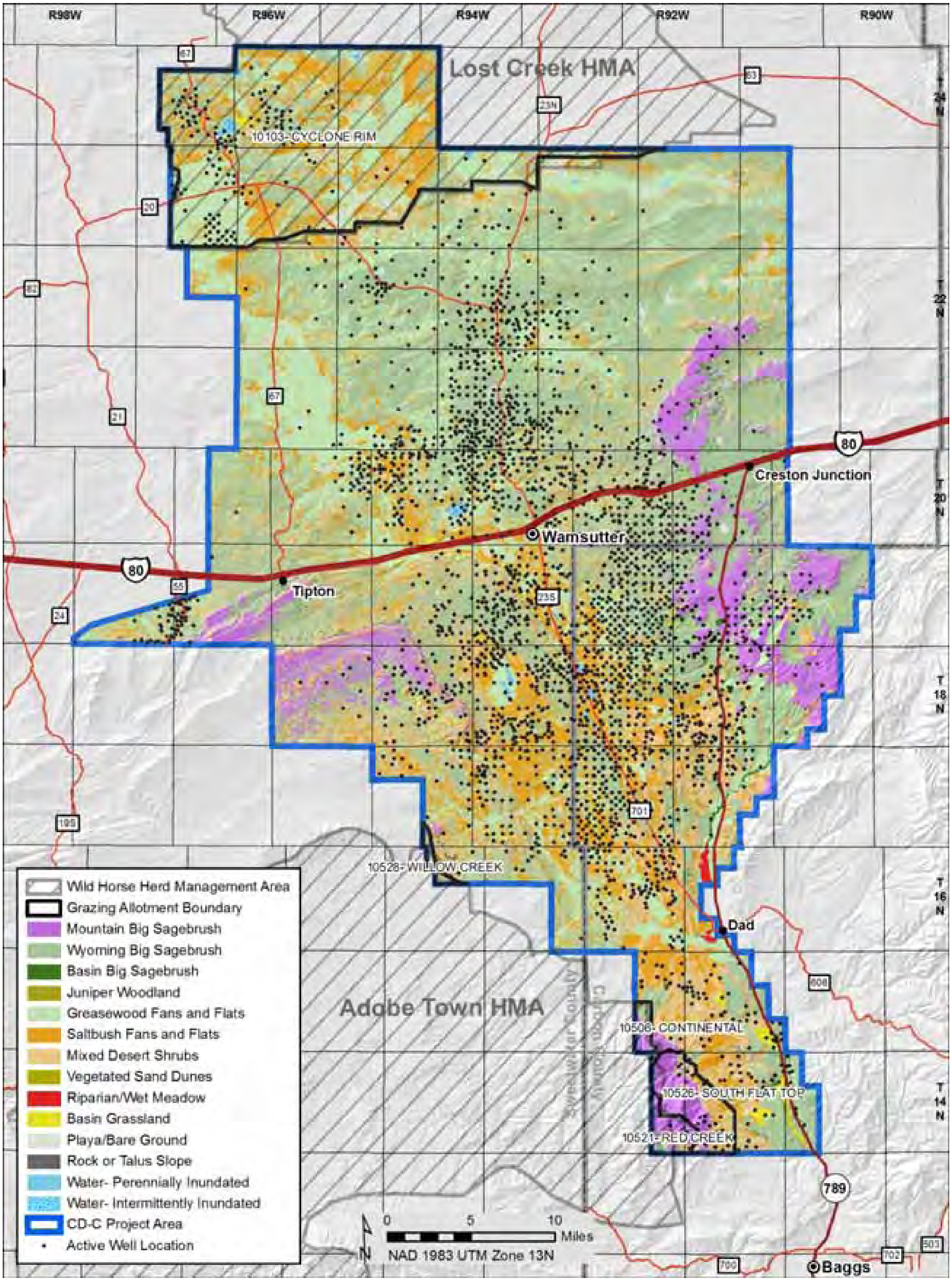
Meadow milkvetch is a perennial halophytic herb found in moist, salt-accumulating habitats. It is restricted to low topographic positions within the sagebrush zone of valleys and closed-basin drainages in alkaline meadows, playa shorelines, discharge zones, mounds, and shrub patches (Heidel 2008). The species has been documented in three extant occurrences in south-central Wyoming, totaling approximately 8,000 plants within about 187 acres, near the Chain Lakes region of the project area (Heidel 2009).

3.10 WILD HORSES

The Rawlins Field Office (RFO) maintains and manages wild horses (*Equus caballus*) in herd management areas (HMAs) and establishes an appropriate management level (AML) for each HMA. There are no wild burros within the project area and there will be no further discussion concerning wild burros in this EIS. The AML is the population objective for the HMA that will ensure an ecological balance for all users and resources of the HMA (e.g., wildlife, livestock, wild horses, vegetation, water, and soil). The current AMLs were established in 1994 from a process that included five years of focused and intensive monitoring, evaluation of data, public input, and environmental analysis (BLM 2005b).

The RFO has the responsibility to protect, manage, and control wild horses in its resource area pursuant to the Wild Horse and Burro Act of 1971 (Public Law 92-195). The wild-horse program is responsible for monitoring both the land and the herds, removing excess animals, and preparing animals for adoption.

The RFO manages three HMAs, two of which are partially located within the CD-C project area: the Lost Creek HMA and a small portion of the Adobe Town HMA (**Map 3.10-1**). The Lost Creek HMA encompasses approximately 251,000 acres, of which 235,000 are BLM-administered public lands. Of the BLM-administered total, approximately 119,600 acres of the HMA are located within the project area, virtually all of that acreage within the Cyclone Rim Grazing Allotment. The Lost Creek HMA is located within the closed Great Divide Basin with annual precipitation averaging a little less than six inches. With the exception of its northern border, all of the Lost Creek HMA surface area in the project area is located within the Cyclone Rim grazing allotment.



Map 3.10-1. Wild horse management areas within the CD-C project area in relation to major land cover types and affected grazing allotments

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The current AML for this HMA is approximately 60 to 82 horses which represents the high and low AML targets in relation to the gather-and-removal cycle. The current population estimate for the Lost Creek HMA is 120 adult animals (Mirati 2010). It was last gathered in the fall of 2009. The Lost Creek HMA is partially fenced from the checkerboard lands to the south. The Antelope Hills HMA adjoins the Lost Creek HMA to the north and is administered by the Lander Field Office.

The Adobe Town HMA is located approximately 20 miles west of Baggs, within Carbon and Sweetwater counties. The HMA encompasses approximately 472,812 acres, of which 444,744 acres are BLM-administered public lands. Of the BLM-administered total, approximately 5,826 acres of the HMA—1.2 percent of the total—are located within the CD-C project area (**Map 3.10-1**), including portions of the Continental, South Flat Top, Red Creek, and Willow Creek grazing allotments in the southwestern portion of the project area. Average annual precipitation in this area ranges from 7 inches in the desert basins to more than 12 inches at some of the higher locations. The current AML for this HMA is approximately 610 to 800 horses which represents the high and low AML targets in relation to the gather-and-removal cycle (BLM 2005b, updated June 2011).

The Salt Wells Creek HMA, managed by the Rock Springs Field Office (RSFO), adjoins the Adobe Town HMA to the west and both share a common, unfenced border. Past capture, census, and distribution data collected by both the RFO and RSFO indicate considerable movement and interchange takes place among the horses of these two HMAs (BLM 2005b). Consequently, both the RSFO and RFO work cooperatively to manage the two HMAs in the most efficient manner. The most recent gather of the Adobe Town/Salt Creek Complex was conducted in the fall of 2010 resulting in 1,939 horses removed from the complex. It is estimated that approximately 860 adult horses remain in this complex (Mirati 2010). In the majority of cases, wild horses have no natural enemies and population growth rates have been shown to be capable of 16- to 25-percent annual increases. This can result in a doubling of the wild-horse population every three to five years (BLM 2005b). However, in several instances, mountain lion (*Felis concolor*) predation has been documented to affect population growth rates (Turner and Morrison 2001). In the southern Great Basin of Nevada, mountain lion predation on the young was believed to be a major population-limiting factor (Greger and Romney 1999) with the recruitment-rate reduction due to take of foals. It seems reasonable to assume that historically, the gray wolf (*Canis lupis*) may have had the same effects on horse-population growth as reported for mountain lion. An unnatural cause, illegal killing, is also an unfortunate mortality agent. Where predation is not a factor, natural causes such as starvation, dehydration, disease, and injury are the primary wild-horse mortality agents. In a typical Rawlins wild-horse population, the highest mortality rates are for the young in their first winter (BLM 2005b).

Wild horses generally prefer perennial grass species as forage. Shrubs are more important during the fall and winter. On the CD-C project area, the species of grasses preferred depends on the season of the year. Needle-and-thread and Indian ricegrass are most important during the winter and spring, and wheat grasses during the summer and fall (BLM 2005b). Crane *et al.* (1997) determined that wild horses in south-central Wyoming spent about 61 percent of their daytime hours feeding and selected stream-sides, bogs/meadows, and mountain big sagebrush habitats over low sagebrush habitats. Sedges (*Carex* sp.) were an important component in the horses' spring/summer diet. This study concluded that palatability and abundance of graminoid vegetation and proximity to preferred habitats seemed to be the primary influences on habitat selection by wild horses within their study area.

Several studies address the question of direct competition (displacing a species when they arrive) and indirect competition (use of the same resources). Olsen and Hanson (1977) conducted a study to determine dietary overlaps and composition between wild horses, cattle, elk, sheep, and pronghorns in the Wyoming Red Desert. The percent of season dietary overlaps were most noticeable between wild horses, cattle, and elk. The study also showed that wild horses, cattle, and elk seemed to be tolerant of feeding on the same plants in different seasons and the strategy of grazing differed among species. Although this study only focused on the Red Desert area, there was enough variation in selection of diets between the different species that there was minimal overlap for the same resources.

In a similar study conducted in southeastern Oregon, McInnis and Vavra (1987) found that at least 88 percent of the mean annual diets of feral horses and cattle consisted of grasses. The researchers concluded that because dietary overlap between horses and cattle was high each season (62–78 percent), a strong potential existed for exploitive competition under conditions of limited forage availability (e.g., extended drought effects). McInnis and Vavra (1987) also determined in this two-year study that dietary overlap between horses and pronghorn varied from 7 percent (summer) to 26 percent (winter). Overlap between pronghorn and cattle varied from 8 percent (winter) to 25 percent (spring), suggesting that non-competitive coexistence (indirect competition) between pronghorn, wild horses, and cattle was possible at this level of dietary overlap. It is important to remember that even if species have the same diets, as long as there are adequate resource supplies there will be no competition. Only when resources are limited does direct competition occur.

Animal sizes vary and forage requirements change with the size of the animal. Similarly, different classes of livestock and different species of wildlife have varying requirements depending on size and maturity. Animal unit equivalents (AUEs) have been calculated for various kinds and sizes of animals. **Table 3.10-1** shows the most commonly used animal unit equivalents of various animal species in relation to a mature horse.

Table 3.10-1. Commonly used Animal Unit Equivalents

Class of Animal	Animal Unit Equivalent (AUE)
Cow, 1000 lb, dry	0.92
Cow, 1000 lb, with calf	1.00
Bull, mature	1.35
Cattle, 1 year old	0.60
Cattle, 2 years old	0.80
Horse, mature	***1.25***
Sheep, mature	0.20
Lamb, 1 year old	0.15
Goat, mature	0.15
Kid, 1 year old	0.10
Antelope, mature	0.20
Bison, mature	1.00
Deer, white-tailed, mature	0.15
Deer, mule, mature	0.20
Elk, mature	0.60
Sheep, bighorn, mature	0.20

■ HUMAN ENVIRONMENT

3.11 VISUAL RESOURCES

3.11.1 Visual Resources Characteristics

As described in **Section 3.1.1 Geology**, the CD-C project area is part of a semiarid desert dominated by patches and thickets of sagebrush. Along larger drainages, grasses, greasewood, brush, lichens, cottonwood, and other plants accompany the sagebrush stands. Colors of gray, brown, and olive characterize the vegetation, with grasses and forbs changing to shades of brown as they cure in the summer and fall. Soils and rock strata are shades of red, gray, and brown.

The project area is wholly within the Intermountain Semi-Desert Province of Southwestern Wyoming. North of Wamsutter, the project area lies within and comprises a large part of the Great Divide Basin section as a whole. The rest of the project area is almost entirely within the northeastern part of the Washakie Basin subsection of the Green River Basin section (Reiners and Thurston 1996). Rolling plains cover the Great Divide Basin part of the project area. The landscape is generally unbroken, so visual contrast draws attention wherever it occurs. Dune fields and playas (dry lakebeds) break up the sagebrush plain north of I-80. Elsewhere, cuestas (rims), occasional escarpments, and eroded streambeds create some visual contrast.

West of the Red Desert Road (BLM 3207) is a feature that USGS maps label the Red Desert Basin; this area possesses a pebbly soil with a distinctive reddishness that shows through the scattered sagebrush. The sand dunes of the northern part of the project area are part of a widespread dunes complex; dunes in the project area are mostly vegetated in contrast to the active, mostly bare dunes at Killpecker Creek, which is north of Rock Springs and far to the west of the project area.

The Chain Lakes Basin is part of a large playa complex that coincides with the Chain Lakes Wildlife Habitat Management Area in the northeastern part of the project area. Panoramic views of this area to the north of Chain Lakes Rim show these seasonal wetlands, which dry out to white alkaline flats. The occasional springs of Battle Springs Flat, west of Chain Lakes, support considerable greenery.

The extended Delaney Rim-Wamsutter Rim cuesta-and-valley complex divides the northern Great Divide Basin section of the project area from the Washakie Basin in the south. Panoramas of the central and northern portion of the project area present themselves from Delaney Rim, and the rim complex itself is the most prominent geologic feature visible from I-80 as the highway crosses the Great Divide Basin.

Eroded streambeds occur in the southern part of the project area; a key example is the deeply entrenched gully system in the lower reach of Muddy Creek. Little Robbers Gulch Reservoir, an agricultural pond far to the south within the project area, is a “social” recreation site (undeveloped and unmanaged) where usage fluctuates with the water level. Flat Top Mountain in the far south of the project area includes North Flat Top peak, the high point in the project area. This feature, Little Robbers Gulch, and The Bluffs are prominent geologic features visible from Wyoming Highway (WY) 789, the major north-south road through the southern part of the project area.

Cultural modification in the project area includes open disturbance, disturbed areas that are undergoing reclamation but do not yet blend into the landscape, and many structures. Visible in many parts of the project area are infrastructure (roads, power lines, and buried pipeline corridors), ranch improvements (homesteads, shearing sheds, fencing, and water impoundments) and oil and gas development (active drill sites and production and transportation facilities).

Oil and gas development, ongoing since the 1950s, comprises more than 4,400 natural gas wells in the project area. This surface disturbance is currently 49,218 acres (4.6 percent of the project area) of which 8,472 acres (0.8 percent) remain unvegetated and in use over the long term for facilities such as roads, well-production facilities, and pipeline facilities. The most common type of disturbance—more than 26,000 acres, or 2.4 percent—is from pipelines crossing the project area. An additional 10,958 acres have been disturbed for development other than oil and gas; this includes mainly federal, state, and county highways and roads, plus agricultural improvements.

The potentially affected scenic quality in the project area is low to moderate overall. Cultural modification due to oil and gas development has negatively affected scenic quality in seven of 15 identified landscape-rating units that are contained wholly or in part within the project area. This is generally because oil and gas development disturbs existing vegetation and introduces structures, with unnatural forms, lines, colors, and textures that contrast with the natural landscape character. In one of the seven landscape rating units found in the project area, the contrast introduced by existing oil and gas development is seen, attracts attention, and "in places is fairly dominant visually" (BLM 2011a).

I-80 bisects the project area from east to west. Because of high traffic volumes, I-80 is the vantage point from which potentially the most viewers see the project area. Views from I-80 are mainly of the Great Divide Basin portion of the project area, with the isolated mountains, uplands, and rims (among them Delaney Rim, as noted above) in the middle-ground, background, and skyline. Foreground and middle-ground views from the highway often contain residential, commercial, or industrial structures. Through travelers and trucks are the predominant users of I-80, and high prevailing speeds mean that motorists see any given part of the landscape for a short time.

Historically, WY 789 from Creston Junction to Baggs, Wyoming and Craig, Colorado, offered opportunities for pleasure driving and recreational access in the southern part of the project area. In the past five years, truck traffic on WY 789, mostly attributed to gas-field and interstate pipeline development, has grown almost twice as fast as other types of traffic. The Wyoming Department of Transportation (WYDOT) (**Section 3.16 Transportation**) now rates the traffic stream on WY 789 at less than "free-flowing." Such traffic characteristics may discourage use of WY 789 for pleasure driving and sightseeing.

The principal county road through the project area—the Wamsutter–Dad/Wamsutter–Crooks Gap Road South (Carbon County Road [CCR] 701/Sweetwater County Road [SCR] 23S)—is now primarily a natural gas industry access road. This two-lane gravel road may be busier than any other road serving the project area except I-80. It receives high levels of heavy and overweight vehicle use, with truck traffic often moving at high speed and creating considerable dust (**Section 3.16 Transportation**). These characteristics now discourage use of this road for casual recreational use except as an access to other interior roads.

As described in **Section 3.16 Transportation**, almost all of the 33 other interior roads of the project area were originally intended for agricultural use, with consumptive wildlife recreation also being a common use that is traditionally related to agricultural landscapes and lifestyles. In recent years, the many interior roads have seen increasing use for natural gas industry access. Only three of 27 interior roads owned by BLM possess right-of-way agreements for all of the private lands that the roads cross. These are Road 3207 (Red Desert Road), Road 3316 (Robbers Gulch Road) and Road 3321 (Little Robber Road). Therefore, recreation is a historical and current use of the other 24 interior roads but is subject to private landowner decisions about access.

Because of the extensive road network, all land within the project area is in the foreground or middle ground of major or other roads (BLM 2011a). Increasing use by oil and gas workers lowers the level of sensitivity of many interior roads because of the low to moderate concern for scenic quality of most users in the context of low to moderate total use (BLM 2011a). For VRM sensitivity ratings, foreground and middle ground are treated alike and represent a distance of up to 3 to 5 miles (BLM 2011a).

The Overland Trail corridor through the project area is an exception because the trail corridor is identified as a special management area in the RFO's RMP. The corridor has high sensitivity to scenic quality by definition because of its special area status and because of the interest it attracts as part of the most important historic trail in southern Wyoming (BLM 2011a). The trail corridor is described in **Section 3.14 Cultural and Historical Resources**.

3.11.2 Visual Resources Management System

Visual resources in the project area fall under the BLM's visual resource management (VRM) system. Guidance to manage visual resources is found in BLM Land Use Planning Handbook H-1601-1, Appendix C (BLM 2005c). Land use planning decisions mandate BLM to manage visual resource values in accordance with VRM objectives, which directly correspond to the assignment of all land to a VRM class. The BLM designates VRM classes for all land by inventorying the visual resources and by taking into account management considerations for other land uses. VRM classes may differ from VRM inventory classes because of management priorities for land use (BLM Land Use Planning Handbook H-1601-1, Appendix C, Page 11).

The BLM VRM classification system recognizes four VRM classes (Classes I through IV) based on scenic quality, visual sensitivity levels, and viewer distance zones. Each VRM classification has a management objective, as described below:

Class I. The objective of Class I is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activities. The level of change to the characteristic landscape should be very low and should not attract attention.

Class II. The objective of Class II is to retain the existing character of the landscape. The level of change to the landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes to the landscape must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III. The objective of Class III is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate. Management activities may attract the attention of the casual observer but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV. The objective of Class IV is to provide for management activities that require major modifications to the existing character of the landscape. The level of change to the landscape can be high. The management activities may dominate the view and may be the major focus of viewer attention. Every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of the basic visual elements of form, line, color, and texture.

3.11.3 Visual Resources Management Class Designations

VRM classes for the project area were established by the Rawlins RMP issued in December 2008. During preparation of the Approved RMP, a protest was lodged concerning visual resource values within the RFO. As a result, the BLM-preferred VRM decisions in the Proposed RMP/Final EIS were remanded, in accordance with guidance in the BLM Land Use Planning Handbook, H-1601-1.

Map 3.11-1 compares oil and gas development extant in the project area as of 2009 to the VRM classification set by the 1990 Great Divide Resource Management Plan (GDRMP) (BLM 1990). The 1990 GDRMP remained in effect as the RFO undertook the process of amending the RMP. Map 3.11-1 illustrates why there is a potential for conflict in jointly managing oil and gas development and visual resources in the RFO. The potential was identified by BLM in the GDRMP FEIS:

> The widespread development of petroleum, natural gas, and coal in the RMPPA is creating direct, negative visual impacts within the RMPPA. Currently, visual mitigation of this activity is preventing mineral development activities from exceeding the established VRM objectives within these areas. The trend toward continued expansion of natural resource development is creating areas of potential conflict between this activity and the established VRM class objectives . . . Utilities are also having

> an increasing visual impact in the RMPPA. Even buried fiber-optic lines leave obvious visual effects. …Although visual sensitivity is clearly not the highest priority for many residents and visitors, as increasing numbers of sightseers and persons seeking various types of recreational opportunities pass through the RMPPA, an awareness of scenic values and the existing scenic quality grows for some residents and visitors.

The RFO is in the process of updating the classification of its visual resources. However, until that process is complete, the RFO must, under the remand, use the VRM classification described in the No Action Alternative (Alternative 1) of the Proposed RMP/FEIS. **Map 3.11-1** reflects that classification scheme as it applies to the project area. The classification shown on Map 3.11-1 is simply the classification carried forward from the 1990 GDRMP.

As **Map 3.11-1** shows, the project area has mixed land-ownership. This means that some state and private land within a given VRM classification may not be subject to BLM administration, which applies only where the federal government owns the surface or the oil and gas beneath the surface. This distinction is reflected in the analysis of the land within the project area as presented in **Table 3.11-1**. About 60 percent of the total project area is VRM Class III; the remainder is VRM Class IV. However, BLM's authority to manage visual resources is limited to an estimated 62 percent of the total land area in VRM Class III and 55 percent of the total land area in VRM Class IV. The remainder of the land in each class is exempt from BLM VRM management objectives because the surface and minerals are private or state owned.

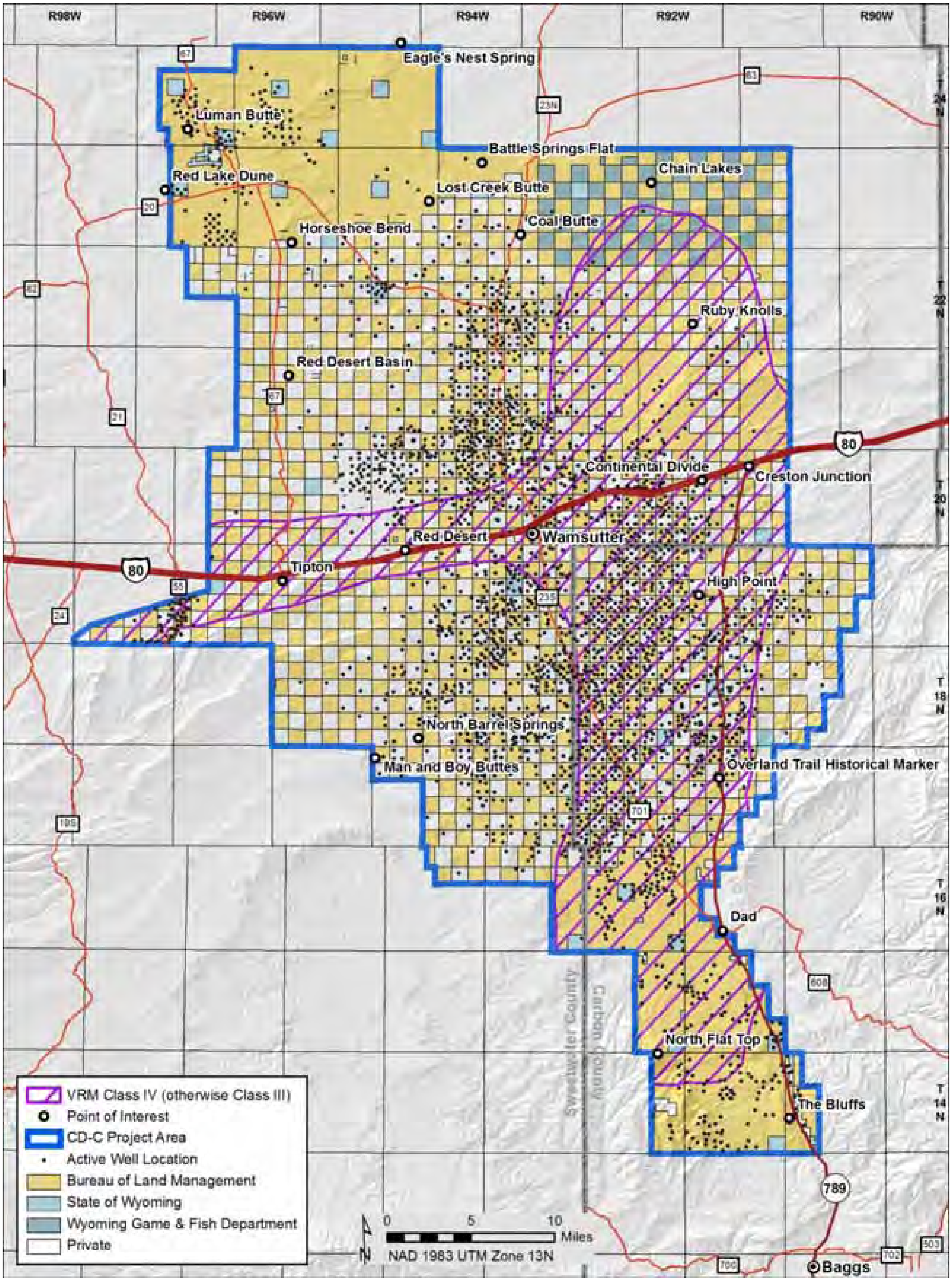
Table 3.11-1. Total and BLM-administered land area in the project area by VRM Class

VRM Class Designation	Land Area (thousands of acres)	VRM Class Share of Total Land Area	BLM-Administered Land (thousands of acres)	Share of BLM-Administered Land within Class
Class III	639	60%	393	62%
Class IV	431	40%	237	55%

3.11.4 Visual Resource Inventory of February 2011

The RFO began the process of updating its VRM objectives with a formal visual resource inventory (VRI) prepared in compliance with BLM Manual 8400, Visual Resource Management, and BLM Manual 8410, Visual Resource Inventory. The results of the completed inventory were published in February of 2011 (BLM 2011a). The publication of the updated VRI completes the first step of the process called for by the administrative remand described in Section 3.11.3 above. Using the updated inventory as a baseline, further steps remain to be completed to amend the RMP and to update the VRM classifications of BLM-administered lands in the RFO.

Information from the published VRI (BLM 2011a) has been used in this section to describe and characterize the affected visual resource environment of the CD-C project area as it exists now. However, the evaluations found in the inventory are not to be considered a VRM classification now or even, perhaps, the VRM classification that may be enacted in the future. No re-classification may occur until the RFO completes the entire RMP amendment process. Until then, as noted in Section 3.11.3, the RFO must use the 1990 VRM classifications.



Map 3.11-1. Current VRM Classification of land within the CD-C project area with comparison to existing well development

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.11.5 Visual Resources Management RMP Amendment

As noted in **Section 3.11.**3, the BLM completed the RFO RMP revision in December 2008, but a protest was lodged concerning visual resource values within the RMP planning area, which includes the CD-C project area. To resolve the protest issue, the RFO is conducting additional planning, beginning with the update of the RFO visual resource inventory described in **Section 3.11.4**.[10]

In April of 2012 BLM published a formal Notice of Intent (NOI) (Federal Register 2012a) to prepare an amendment to the VRM sections of the RFO RMP along with the required environmental assessment (EA) and began the amendment process with a 30-day public scoping period that ended May 11, 2012. The BLM intends to finalize the EA and VRM amendment by the end of 2013.

3.12 RECREATION

3.12.1 Recreation Resources

The main recreation resource of the project area is the public land managed by the BLM and the WGFD. This section discusses their use primarily for hunting and secondarily for pleasure driving to view wildlife, especially wild horses. No developed recreation sites exist within the CD-C project area. Dispersed recreational activity occurs wherever resources and access afford the opportunity. There is one undeveloped recreation site near the southern boundary of the project area, Little Robbers Gulch Reservoir, which has been historically used as a group hunting camp and fishing hole.

The project area is entirely within the Western Extensive Recreation Management Area (ERMA), a management classification of the RFO established by the Rawlins RMP. For the Western ERMA, the Rawlins RMP directs management to consider three recreation objectives: (1) provide for the health and safety of visitors, (2) prevent or mitigate resource damage resulting from recreation uses, and (3) *coordinate* with other programs to minimize conflicts and adverse impacts on recreational opportunities [emphasis supplied].

The project area is not part of any of the Special Recreation Management Areas (SRMAs) otherwise designated by the Rawlins RMP. This means that none of the areas with a high priority for recreation management in the RFO are to be found in the project area. The only feature in the project area that has a recreational aspect, and for which there is an explicit management directive in the Rawlins RMP with implications for recreational use, is the undeveloped recreation site at Little Robbers Gulch Reservoir.

One prescribed management action is targeted towards undeveloped recreation sites, such as Little Robbers Gulch Reservoir: the action opens a recreation site and its surrounding quarter-mile area to future oil and gas leasing with a “no surface occupancy” (NSO) stipulation. This means development of minerals directly under the restricted area may be undertaken by locating the necessary facilities outside of the restricted area. Although this primarily agricultural reservoir historically has been used as a hunters’ camp and fishing hole, it has recently been used less than in the past because of fluctuation in the water level.

BLM considers most of the project area to be Front Country, where improved roads are generally within 1/2 mile of recreation activity. This character prevails because of numerous improved roads in the Western ERMA that have been developed for oil and gas. Front Country is the second-most abundant class of recreation lands in the RFO according to the Rawlins RMP (BLM 2008a). Management affecting the Front Country recreation settings in the project area is guided by the objectives and actions

[10] This additional planning will not include the decision area for the Chokecherry/Sierra Madre wind energy project because a VRM amendment to the Rawlins RMP was considered separately as part of the NEPA process associated with the review of the Chokecherry/Sierra Madre wind energy project.

enumerated in the Rawlins RMP as described above. Indirectly, the recreation setting is affected by the VRM objectives established for the project area by the Rawlins RMP because the visual quality of an area is an important physical and social attribute of a recreation setting. (The Affected Environment for Visual Resources is described in **Section 3.11** and Environmental Consequences for Visual Resources are described in **Section 4.11**.).

3.12.1.1 Wildlife Resources

The existing environment for wildlife in the project area is discussed in **Section 3.8 Wildlife**. The big game wildlife resource supports hunting, which is the main recreation use of the project area. Hunting in the project area is mainly for pronghorn, but hunters also pursue mule deer and elk. Wild-horse viewing is another wildlife recreation use in the project area.

Commercial hunting guides using BLM land in the project area do so by obtaining a Special Recreation Permit (SRP) from the RFO. Nineteen hunting guides who hold permits to hunt on the WGFD Hunt Areas that overlap the project area also hold SRPs in the RFO. The project area is likely to be a small percentage of the total area upon which these hunting guides base their commercial operations. Information for determining the amount of use by these guides in the project area is not available from BLM records.

A main hunting resource in the northern part of the project area is the Chain Lakes Wildlife Habitat Management Area (WHMA) about 32 miles northwest of Rawlins. The Chain Lakes WHMA provides winter habitat and a seasonal migration corridor for pronghorn. Agreements provide hunter access throughout the WHMA despite its location in the “checkerboard,” the area of alternating one-square-mile sections of public and private land. By agreement with the WGFD, the Rawlins RMP opens the WHMA to future oil and gas leasing but with intensive management of surface-disturbing and disruptive activities. The wildlife resources of the northern part of the project area also include a block of about 135,000 acres of contiguous public land northwest of the WHMA (WGFD 2007b).

Wildlife resources in the southern part of the project area include the WGFD Carbon County Walk-In Area #1 located six miles southeast of Creston Junction. The WGFD walk-in program allows hunters to enter private land sections in the checkerboard without prior permission. The project area contains 15 sections of Walk-In Area #1 (9,600 acres), about half of which are privately owned. The remainder is outside of the project area, where it adjoins the 25,600-acre Red Rim-Daley WHMA, also located in the checkerboard of intermingled public and private land. Ready access for recreation is also available in the southern tip of the project area where there is another large, continuous block of public land. This block of public land includes upland habitat in the Flat Top Mountain range and its larger drainages, Blue Gap Draw, Robbers Gulch, and Little Robbers Gulch. Little Robbers Gulch also contains the undeveloped recreation site used as a hunters’ camp at Little Robbers Gulch Reservoir, as described above.

3.12.1.2 Other Recreation Resources

A network of small roads and two-tracks covers the project area. Increasingly, traffic has come to be dominated by vehicles related to oil and gas field-development and maintenance, but the roads continue to be used for range management and recreation. Full public access for all uses, including recreation, is available on I-80, WY 789, and Carbon and Sweetwater County roads. The BLM interior road network comprises 27 numbered routes. However, casual use without permission is limited to three roads where the BLM possesses full right-of-way agreements. These include Road 3207 (Red Desert Road), Road 3316 (Robbers Gulch Road) and Road 3321 (Little Robber Road). Private resource roads comprising the interior network of areas with gas development are generally open to the public.

Recreational off-highway vehicle (OHV) use occurs in the project area; however, such OHV use is typically for the scouting activity that is ancillary to big game hunting rather than it being a primary recreation activity.

Non-consumptive use, which is mostly driving the roads to view wild horses or the Red Desert landscape, is much less common than hunting. The resources that support these activities are located north of I-80 and are accessed from SCR 67 (Tipton-North Road) and BLM Road 3207 (Red Desert Road). Flat Top Mountain in the project area south of I-80 also attracts some recreation because of the visual resource (sightseeing, painting and photography of the mountain and from the overlooks it provides) and by the recreational setting (OHV, snowmobiling, and non-motorized snow recreation).

The Overland Historic Trail runs east and west across the southern part of the project area. Signage calls attention to a turnout with an interpretive plaque on WY 789 about 20 miles south of Creston Junction. This minor feature may attract sightseeing visits by trail enthusiasts. However, this is the only public access to the trail corridor in the project area.

3.12.2 Recreational Use

The BLM estimates recreation usage at the field-office level, so there are no data available on recreation participation and recreation visitor days specific to the CD-C project area. Relying on experience, field-office personnel characterize recreation use in the project area as low overall and seasonal during the year, with most recreational use occurring during the fall big-game hunting seasons.

The BLM generally views the project area as serving a statewide market for undeveloped recreation, especially the market comprising residents of Carbon County and nearby counties. However, there is considerable use of the area by non-resident hunters, especially pronghorn and mule deer hunters who are 23 percent and 27 percent non-residents, respectively. The project area also occasionally attracts non-resident recreation users with special interests such as wild horses, the Red Desert landscape, and historic trails. Recreation in the project area is shown on **Map 3.12-1**.

Table 3.12-1 presents data on hunting activity that indicate the level of hunting potentially occurring within the project area. The table shows the totals for the Hunt Areas that include the project area because the WGFD does not have information on sub-areas within Hunt Areas (WGFD 2010b).

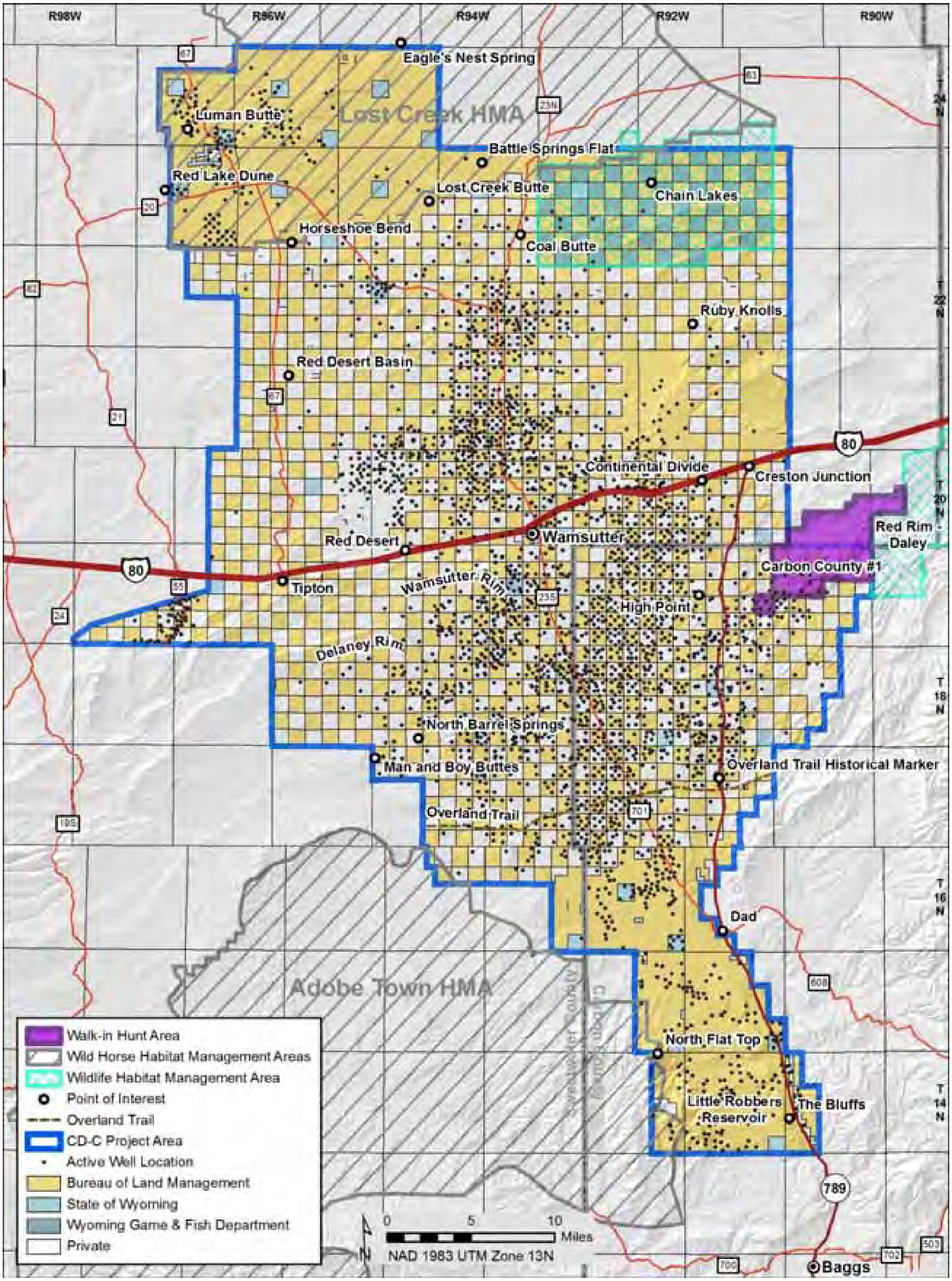
Table 3.12-1. Indicators of hunting activity by species in WGFD Hunt Areas that include the CD-C project area, 2009

Game Species	**Hunt Areas Involved** (% of Hunt Area overlapping the project area)	**Total Active Hunters**	**Average Non-Resident Hunters**	**Average Hunter Success**	**Average Days per Hunter**	**Number of BLM-Permitted Commercial Outfitters[1]**
Pronghorn Antelope	53 Baggs (2%) 55 Red Rim (28%) 57 S. Wamsutter (38%) 60 Table Rock (33%) 61 Chain Lakes (31%)	694	23%	92%	2.6	55
Mule Deer	82 Baggs (2%) 84 Atlantic Rim (19%) 98 Chain Lakes (31%) 100 S. Wamsutter (38%) 131 Steamboat (13%)	4,646	27%	45%	4.1	55
Elk	21 Baggs (2%) 100 Steamboat (14%) 108 S. Rawlins (19%) 118 Shamrock Hills (31%) 124 Powder Rim (23%)	3,057	16%	47%	5.9	55

[1] *Typical number of Special Recreation Permits for Rawlins Field Office. This number changes year to year and an exact number is not known due to the fact that other field offices hold permits for this area and little data was kept for any permit issued before 2007.*

Source: WGFD Annual Report of Big & Trophy Game Harvest 2009. Rawlins Field Office for Number of BLM-permitted Commercial Outfitters. Analysis by Lloyd Levy Consulting LLC.

An estimate based on map analysis is provided of the percentage of each Hunt Area that overlaps the CD-C project area. In terms of acreage, the project area contains about 28 percent of the involved Hunt Areas and 22 percent of the involved Herd Units for pronghorn (the Baggs, Bitter Creek, and Red Desert Herd Units). Similarly, the project area contains about 20 percent of both the involved Hunt Areas and Herd Units for mule deer (the Baggs, Chain Lakes, and Steamboat Herd Units) and about 18 percent of the involved Hunt Areas and 16 percent of the involved Herd Units for elk (the Sierra Madre, Shamrock, Petition, and Steamboat Herd Units). These percentages roughly indicate the project area's contribution to hunting activity based on these game populations. Additionally, the project area contains only about 2 percent of the Baggs Hunt Area, which attracts by far the most hunters of all three big-game animals among the areas overlapping the project area.



Map 3.12-1. Recreation in the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

The total number of active pronghorn hunters using the Hunt Areas that overlap the project area rose from 1,034 in 2002 to 1,955 in 2006 (up 89 percent). Following a modest drop in 2007, pronghorn hunters declined dramatically in 2008 to 620, then rose to 694 in 2009. Deer hunters in the relevant Hunt Areas rose to 4,918 in 2007—up 15 percent from 2002—then dropped slightly in 2008 (4,098) and 2009 (4,646). Elk hunters rose to 3,767 in 2007—up 7 percent from 2006 but down 6 percent from 2002—then declined again to 3,057 in 2009—down 8 percent from 2007. **Table 3.12-2** presents the total active hunters for each species from 2002 to 2009.

Table 3.12-2. Number of active hunters by species in WGFD Hunt Areas that include the CD-C project area, 2002–2009

Game Species	**Hunt Areas Involved** (% of Hunt Area overlapping the project area)	2002	2003	2004	2005	2006	2007	2008	2009
Antelope	53 Baggs (2%) 55 Red Rim (28%) 57 S. Wamsutter (38%) 60 Table Rock (33%) 61 Chain Lakes (31%)	1,034	1,113	1,221	1,499	1,955	1,697	620	694
Deer	82 Baggs (2%) 84 Atlantic Rim (19%) 98 Chain Lakes (31%) 100 S. Wamsutter (38%) 131 Steamboat (13%)	4,280	4,487	4,048	4,070	4,834	4,918	4,098	4,646
Elk	21 Baggs (2%) 100 Steamboat (14%) 108 S. Rawlins (19%) 118 Shamrock Hills (31%) 124 Powder Rim (23%)	4,027	3,928	3,278	3,356	3,505	3,767	3,105	3,057

Source: Wyoming Game and Fish. Harvest Reports (annual). Analysis by Lloyd Levy Consulting LLC.

3.12.3 Recreation Trends

Apart from long-term trends in popularity, the main factor determining the number of hunters using a particular Hunt Area is WGFD's allocation of hunting licenses in response to demand and to game-management policies that balance the demand for hunting with the supply of game. BLM personnel have observed that recreational use in the RFO area in general appears to be steady or in a slight upward trend. If favorable conditions for wildlife were sustained in the future, then hunting throughout the RFO would likely continue near current levels. A similar trend may be expected in the project area.

OHV use in the project area that occurs in connection with hunting is limited to existing roads and two-tracks by the OHV designations published in the Rawlins RMP, although travel off-road up to 300 yards is permitted to retrieve a downed game animal or to access a campsite. Despite limitations, the proliferation of authorized and unauthorized OHV routes is expanding rapidly, potentially detracting from the recreational setting.

According to a survey in the Carbon County Land Use Plan, fishing, hunting, overnight camping, and nature appreciation are the four most important outdoor recreational activities to Carbon County residents. The plan notes that important outdoor recreational activities occur at facilities or on lands that are developed or managed by other agencies, so the plan encourages coordination to allow substantive input by the county into agency planning (Carbon County Board of Commissioners and Carbon County Planning Commission 1998). The land use plan contains no specific recreation plans for land within the project area.

Recreation is mentioned in the Sweetwater County Comprehensive Plan. The plan states that Sweetwater County goals and objectives relating to public lands and resources include a goal of promoting [public land management] agency awareness of County issues and interests: "These include, but are not limited to, natural resource exploration and development, multiple-use land and resource management practices, agriculture/ranching and recreation, and adequate public access to and across public lands" (Sweetwater County 2002).

3.13 LANDS WITH WILDERNESS CHARACTERISTICS

Lands with wilderness characteristics (LWCs) are blocks of public land possessing sufficient size, naturalness, and outstanding opportunities for either solitude or primitive and unconfined recreation, as defined in BLM Manual Section 6310 (BLM 2012f), Conducting Wilderness Characteristics Inventory on BLM Lands and Section 6320 (BLM 2012g), Considering Lands with Wilderness Characteristics in the BLM Land Use Planning Process.

A roadless area of more than 5,000 acres of contiguous BLM land is generally the minimum for consideration as an LWC; smaller roadless areas of contiguous BLM land may be considered when they are adjacent to an area already formally determined to have wilderness character or potential. These BLM manual sections define current policy on LWCs, directing BLM to:

1. Continue to conduct and maintain inventories regarding the presence or absence of wilderness characteristics; and
2. Consider identified lands with wilderness characteristics in land use plans and when analyzing projects under the National Environmental Policy Act (NEPA).

The policies stated in BLM Manual Sections 6310 and 6320 do not encompass wilderness areas already designated by Congress or formally identified Wilderness Study Areas (WSAs) which are pending before Congress and are managed as wilderness until a decision is made. Within the RFO, there are five WSAs, one of which—the Adobe Town WSA—is near the southwest boundary of the CD-C project area but does not overlay the project area. There are no designated wilderness areas in the RFO.

Specifically to comply with BLM Manual Section 6320, the RFO is tiering this analysis of the Proposed Action and alternatives to the approved Rawlins RMP issued in 2008 (BLM 2008a and b). During the land use planning process leading to the approved RMP, the RFO reviewed several citizens' proposals for new WSAs. The RFO responded to these proposals by conducting inventories to determine whether the affected lands possess the wilderness characteristics of size, naturalness, or outstanding opportunities for primitive, unconfined recreation or solitude, and found two areas located adjacent to existing WSAs that possess one or more of these characteristics. However, neither of the two areas—Adobe Town Fringe and West Ferris Mountains—lies within the CD-C project area (see Rawlins RMP Draft EIS Map 2-45, Areas with Wilderness Characteristics, viewable online at <http://www.blm.gov/pgdata/etc/medialib/blm/wy/-programs/planning/rmps/rawlins/deis/maps.Par.89221.File.dat/48_Map2-45.pdf>).

Although ineligible for designation by BLM as WSAs, the Adobe Town Fringe and West Ferris Mountains areas with wilderness characteristics were considered for special, protective management under the RFO's land use planning authority and were evaluated to determine whether they were manageable as wilderness. The majority of the areas under consideration are leased for oil and gas development, in which case the RFO would not have the means to prevent impairment of any wilderness character that may be present. Therefore, "the BLM elected to manage lands with wilderness character for multiple use and not for protection of wilderness character" (Rawlins RMP ROD, p. 1-3).

The RFO continues to update the inventory of public lands for wilderness characteristics. All new information regarding LWCs would be considered by the RFO in the future along with other resource information in developing and revising land use plans and when making subsequent project-level decisions.

3.14 CULTURAL AND HISTORICAL RESOURCES

3.14.1 Cultural Chronology of the Area

Archaeological investigations in the Great Divide Basin and the Washakie Basin indicate that the area has been inhabited by people for at least 12,000 years from Paleoindian occupation to the present. The accepted cultural chronology of the Great Divide and Washakie basins is based on a model for the Wyoming Basin by Metcalf (1987) and revised by Thompson and Pastor (1995). The prehistoric chronology of the Wyoming Basin, which includes the Great Divide and the Washakie basins, is documented in **Table 3.14-1**.

Table 3.14-1. Prehistoric chronology of the Wyoming Basin

Period	Phase	Age (B.P.)
Paleoindian	--	12,000–8500
Early Archaic	Great Divide	8500–6500
Early Archaic	Opal	6500–4300
Late Archaic	Pine Spring	4300–2800
Late Archaic	Deadman Wash	2800–2000/1800
Late Prehistoric	Uinta	2000/1800–650
Late Prehistoric	Firehole	650–250

B.P. = before present
Source: Metcalf (1987), as modified by Thompson and Pastor (1995)

Paleoindian Period

The Paleoindian period is the oldest period for which there is archaeological evidence. It began ca. 12,000 years B.P. and ended around 8500 B.P. This is the transitional period from the Wisconsin ice advance during the terminal Pleistocene to the warmer and drier climatic conditions of the Holocene. A savannah-like environment with higher precipitation than occurs today was prevalent in southwestern Wyoming. Understanding paleo-environmental conditions operating at the end of the Pleistocene and into the Holocene provides insights into the articulation between human populations and the environment (Thompson and Pastor 1995). Paleoindian sites are rare in southwestern Wyoming. Fifty-one sites have been documented to contain Paleoindian cultural material in the project area. One site includes a feature (a hearth) that dates to the Late Paleoindian period at 8840 ± 90 B.P. No cultural material was found with the hearth.

Isolated surface finds of Paleoindian projectile points are not uncommon and suggest that site preservation may be a major factor affecting the number of known sites. Paleoindian lithic technology is distinctive with projectile points serving as chronological/cultural indicators within the period. Paleoindian tool assemblages include lanceolate points, gravers, and end-scrapers (Thompson and Pastor 1995). Radiocarbon analysis of a mammoth tusk at one site dates the site to 11,000 B.P.

Archaic Period

Settlement and subsistence practices in southern Wyoming remained largely unchanged from the end of the Paleoindian period through the Archaic and continued until at least the introduction of the horse or even until historic contact. Reduced precipitation and warmer temperatures occurred ca. 8500 B.P. The environmental change at the end of the Paleoindian period led to a pattern of broad-spectrum resource exploitation, which is reflected in the subsistence and settlement practices of the Archaic period. The resource exploitation became more diverse during the Archaic period. Large side- and corner-notched dart points and housepits are found during the Archaic period, and the presence of groundstone implements suggests a greater use of plant resources during this period. Faunal assemblages from Archaic components document increased use of small animals (Thompson and Pastor 1995).

Late Prehistoric Period

The Late Prehistoric period (2000-650 B.P.) is subdivided into the Uinta and the Firehole phases. Large-scale seed processing and an increase in the number of features including roasting pits is noted in the Late Prehistoric period, as is the presence of pottery and the introduction of bow-and-arrow technology. A characteristic of the Uinta phase is clusters of semi-subterranean structures dating to ca. 1500 B.P. At least two different types of structures have been identified: a more substantial cold-weather habitation and a less substantial, warm-weather structure serving more as a windbreak. The Firehole phase is distinguished from the preceding Uinta phase by a dramatic decline in radiocarbon dates, possibly related to a decline in population density.

Proto-Historic Period

The Proto-Historic period begins sometime after 300 years B.P. with the first European trade goods to reach the area, and ends with the development of the Rocky Mountain fur trade 150 years ago. The Wyoming Basin was the heart of Shoshone territory during this period, with occasional forays into the area by other groups such as the Crow and Ute (Smith 1974). The most profound influence on native cultures during this time was the introduction of the horse, enabling Native Americans to expand their range. All forms of rock art denoting horses, metal implements, and other Euro-American goods are associated with the Proto-Historic period. Metal projectile points have been recovered from both surface and subsurface contexts in southwest Wyoming.

Historic Period

Historic use of the area is limited. Steep canyons, inadequate water supply, badlands, and escarpments make the area inhospitable for settlement with only limited ranching activities present. Historic site types include linear properties such as trails, railroads, and highways and associated sites such as stage stations, rail stations, and sidings. Other historic site types include cabins, historic inscriptions, mines, cemeteries, historic cairns, ranches, corrals, stock-herding sites, post offices, small towns, debris and trash dumps, monuments, and bridges. No homesteads have been documented in the project area. The Homestead Act of 1862 gave 160 acres to anyone who could pay a $10 registration fee and pledge to live on the property and cultivate the land. The Grazing Homestead Act of 1916 allowed grazing homesteads to file for 640 acres of land. The Act was intended to help cattlemen. The federal government retained the mineral rights to the land. In 1934, the Taylor Grazing Act and associated Executive Order 6910 ordered lands withdrawn from further homesteading claims. These laws ensured the federal government would be the largest single landowner in Wyoming (Gardner and Johnson 1989). Several ranches or ranch-associated activities have been documented in the project area. Fur trapping and trading was not an important occurrence in the study area due to the lack of perennial streams.

Linear historic sites are found within the study area. The Overland Trail crosses the mid-portion of the study area trending east to west. The Cherokee Trail transects the southern portion of the study area, trending east to west. The Rawlins–Baggs Road transects the southeastern portion of the study area, trending generally north to south. The road is located south of I-80 and east of WY 789. The Lincoln Highway and the original UPRR grade transect the project area trending east-west, generally paralleling south of the I-80 corridor.

Table 3.14-2. Historic chronology of the Great Divide Basin and the Washakie Basin

Phase	Age A.D.
Proto-Historic	1720 – 1800
Early Historic	1800 – 1842
Pre-Territorial	1842 – 1868
Territorial	1868 – 1890
Expansion	1890 – 1920
Depression	1920 – 1939
Modern	1939 – Present

Source: Massey 1989

3.14.2 Summary of Extant Cultural Resources

The project area encompasses approximately 1,680 sections of land for a total area of 1.1 million acres. The State of Wyoming Cultural Records Office in Laramie provided information on the previous work conducted and sites recorded in the project area. Records at Western Archaeological Services (WAS) were also consulted. There have been 20,473 cultural resource projects conducted and 4,860 sites recorded in the project area (prior to 2007). The inventoried area is comprised of 116,322 Block acres. The site density is 0.04 sites per acre. Many of the projects have been linear Class III cultural resource inventories for roads, pipelines, powerlines, and seismic projects. Block surveys include wells, compressor stations, and general block inventories. Other project types in the project area include Class I data reviews; Class II sampling surveys, monitors, and open-trench inspections; reclamation; range improvements; test excavations; data-recovery excavations; examination of ethnographic records; and historic record research. The total amount of open-trench inspections and monitors conducted in the project area has not been consistently recorded through the years. However, open-trench inspections on 36 projects and blading monitors on 35 projects within the project area have resulted in discoveries.

In southwest Wyoming, sand deposits (sand dunes, shadows, and sand sheets), alluvial deposits along major drainages, and colluvial deposits along the lower slopes of ridges are recognized as areas of higher archaeological sensitivity. Cultural resources are also likely to be found around internally drained playa lakes.

3.14.3 Site Types

Of the total of 4,860 sites recorded prior to 2007, 2,350 were located in Sweetwater County and 2,510 in Carbon County. Site types included: prehistoric sites (4,266), historic sites (281), and prehistoric/ historic sites (313). The total percentage for site types is: prehistoric sites (88 percent), historic sites (6 percent), and sites with prehistoric and historic components (6 percent). Of the recorded cultural resources, 0.04 percent have been listed on the National Register (2 sites; 1 has been destroyed), 23 percent (1,127) are recommended eligible for nomination to the National Register of Historic Places (NRHP), 50 percent (3,443) are recommended not eligible for nomination to the NRHP, 25 percent (1,201) remain unevaluated, and 2 percent (87) have been destroyed. Cultural resources documented in the project area include prehistoric open camps, prehistoric lithic debris scatters, historic sites, and prehistoric/historic sites. The types of sites that have been previously identified or predicted to be in the project area are discussed below.

3.14.3.1 Prehistoric Sites

Prehistoric site types identified in the project area include sites dating to all time periods, burials, housepits, rock art, hunting blinds, stone circles, rock alignments, rock shelters, cairns, pottery sites, prehistoric camps, milling/vegetable-processing sites, butchering/bone-bed sites, lithic scatters, quarries, and primary and secondary procurement sites. Many of these sites have undergone data recovery and/or test excavations.

Prehistoric camps contain evidence of a broad range of activities including subsistence-related activities. Cultural remains include formal features such as fire hearths, stone rings, cairns, rock art, lithic debris, chipped stone tools, quarries, evidence of milling/vegetable-processing activities including ground stone, and pottery. Single as well as long-term occupation are represented.

Lithic scatters consist of sites containing lithic debris such as debitage or stone tools. No features or feature remnants are found at the sites. The sites are interpreted as representing short-term activities.

Quarries are sites where lithic raw material was obtained and initially processed. Primary and secondary lithic procurement areas are geologic locations where chert and quartzite cobbles have been redeposited and later used by prehistoric inhabitants for tool manufacture. Archaeological landscapes are secondary lithic procurement sites identified within the project area. Landscapes are by definition not eligible to the National Register.

Human burials, rock art (both pictographs and petroglyphs), rock alignment sites, and rock shelters have been identified as sensitive or sacred to Native Americans. Few such sites have been located in all of southwestern Wyoming. Numerous stone circle and/or cairn sites have been identified in the project area. Prehistoric cairns are usually found along ridges overlooking seasonal drainages. Three rock shelters have been documented in the project area. One site in the study area contains prehistoric and historic rock art (Romanowski 1998), where two separate panels were identified. The southeast-facing panel contains a prehistoric zoomorphic figure near the top, similar to a horse or buffalo. Also noted were vertical scratches representing claw marks. The same panel contains a historic figure near the base. The second panel faces east and contains historic and modern petroglyphs.

Housepits are found throughout the study area, and radiocarbon analysis dated two internal features to 5900 B.P.

Pottery/ceramics have been documented in the project area as well as numerous pottery sites in southwestern Wyoming and northwestern Colorado. Small sherds from unknown vessel types were recovered from most of the sites, and one nearly complete corrugated pot was collected.

Prehistoric/historic site types (313) include prehistoric camp/historic debris scatters and prehistoric lithic scatters/historic debris scatters. These multi-occupation sites exhibit mixed surface components. Generally the historic components of these mixed sites are associated with transportation or sheep-herding activities.

Numerous sites have recently been excavated in the study area, and a data synthesis was compiled for the Rawlins RMP, greatly increasing the knowledge of hunter/gatherer subsistence strategies in the area. One site excavated as a result of the CIG Uinta Basin Lateral pipeline dates between 9300–1730 B.P. (Pool 2000). Five components have been identified at the Salamander site ranging from the Early Archaic period through the Late Prehistoric period (Fleming 2004). Other excavated sites in the project area have dated to the Late Archaic period and the Late Prehistoric period.

3.14.3.2 Historic Sites

A total of 281 historic sites have been documented in the project area. Site types include historic trails, stage roads, stage stations, ranches, cairns, and debris. Eligible historic linear sites that cross portions of the project area include the Overland Trail, the Cherokee Trail, the Rawlins–Baggs Road, the Lincoln Highway, and the UPRR. The Overland Trail crosses the south-central portion of the project area, the Cherokee Trail crosses the southern portion, and the Rawlins–Baggs Road transects the southeastern portion of the project area. The Lincoln Highway and the UPRR (original grade) trend east-west through the central portion of the project area and are located within an area known as the "Southern Corridor." As part of planning for the project area, the Lincoln Highway and original grade of the UPRR were identified and evaluated. BLM has accepted the evaluation with SHPO concurrence.

Several sites are associated with the UPRR including sidings, rail camps, bridges, a culvert, and variations on the original grade. Five railroad sidings have been documented. Six railroad stations have been reported. Four bridges have been documented along the UPRR mainline. Other sites associated with the railroad include foundations, camp debris, a shed, and a dugout.

Towns and post offices played a part in the settlement of the project area. Towns were located along the UPRR and the Lincoln Highway. A post office, ranch, and stage stop were located at Dad, along the Rawlins–Baggs Road. Recorded communities along the tracks or highway include Tipton, Red Desert, Wamsutter, and Creston Junction. A "truss bridge" crossing Muddy Creek is considered eligible for nomination to the National Register.

The Cherokee Trail was used in the 1850s by members of the Cherokee Tribe moving from the Oklahoma Reservation to the California gold fields. A southern variant of the Cherokee Trail trends southwest, crossing Savory Creek, and staying south of Ketchum and Five Buttes. The trail crosses the South Fork of Cherokee Creek and then Smiley Draw, remaining south of Cherokee Creek. The road continues west, with Wild Horse Butte to the south, descending to the Muddy Creek drainage and continuing west through Blue Gap Draw. The Cherokee Trail through the project area was identified and evaluated as part of this project (Johnson 2006). As with any of the westward migratory trails of the mid-1800s, variants have been documented. Reasons for variations in routes include inaccessibility at certain times of year or members of the group may have traveled the route previously and found an easier or more direct avenue to water.

The Cherokee Trail has received a great deal of attention by writers and even the film industry. LeRoy Hafen, in his work *The Overland Mail,* contends that the pioneering efforts of the Cherokee Indians led to the eventual development of the Overland Trail. The net result of the combined effort of novelists, historians, and the media has been to create a highly romanticized trail that is still not well understood in terms of the people who used it and the location of the actual route taken by Cherokees traveling west from Oklahoma to California in 1850 (Gardner 1999).

Excerpts from a Cherokee Trail diarist found in *Cherokee Trail Diaries* (Fletcher *et al.* 1999) document stops along the southern variant of the Cherokee Trail. Mitchell (1850):

> "June 30 Sunday . . . frosty and plenty of ice We took an object west [possibly Five Buttes] at a great distance west to travel to and had great trouble in getting to it Too many bluffs & bad branches in the way In the evening we got out of the mountains & got to a bad Swamp creek runing south [This is Muddy Creek north of Baggs, WY] Supposed to be a for of elk head [Little Snake] 7 of our men were dissatisfied with the corse we were travling & left us taking a more South corse"

The Overland Trail is recommended as eligible for inclusion on the NRHP. The Overland Trail goes through the project area, traversing the checkerboard land pattern, and has been previously evaluated with BLM and SHPO concurrence (Johnson *et al.* 2005). This evaluation included the associated stage stations. Duck Lake Stage Station, Coal Gulch Stage Station, and the Washakie Stage Station were stops along the Overland Trail. Gardner *et al.* (1993) states: "Construction of stage stations at Sulphur Springs, Washakie, and Duck Lake more than likely took place in 1862." This time frame coincides with Ben Holladay beginning his Overland Stage venture to connect Denver, Colorado, with Salt Lake City, Utah. "Home" stations offered travelers more amenities than "swing" stations where a change of horses occurred and travelers' meals were offered. Robert Foote, giving testimony to Senator Cameron during a request for reimbursement for destruction caused by Native Americans, stated that "Stations from Sulphur Springs west to Fort Bridger were built from stone." (Gardner *et al.* 1993) Along with the construction of the stage stations was the stringing of the telegraph wires. Freighters as well as emigrants used these routes.

The Rawlins-to-Baggs Stage Road is an eligible freight and stage road. Mail, goods, and passengers followed the road on freight wagons and the Overland Stage. The road is first documented in 1881 and there were subsequent stage stations built along the route. Only the southern tip of the project area overlaps the Rawlins-to-Baggs Stage Road. The entire segment of the stage road through the project area has been previously determined as not contributing to the overall eligibility of the road (Rosenberg 2006).

Seven historic rock-art inscriptions have been documented in the project area. The Overland Rock contains inscriptions associated with the Overland Trail and is listed on the National Register. Three sites are documented to contain historic rock inscriptions associated with sheep ranching. Nine historic ranches are documented within the project area and several additional buildings, foundations, corrals, and fences are ranch-associated. The ranches are generally associated with raising sheep. In Wyoming, large-scale sheep ranching did not appear until the latter decades of the 1800s; by 1920, however, it was one of the pillars of the state's economic base. Ranching families promoted economic wealth with hard work and by taking chances, such as expanding across the desert of southwest Wyoming. Ranching/stock-herding sites in the area are generally sheepherder camps exhibiting hole-in-top cans and purple glass. Refuse left behind from tending herds is usually located on terrain with water as well as a good view to watch over the herds. One historic log cabin has been documented in the study area. Also reported at the cabin site are a tipi ring and two fire pits. A wild-horse trap is reported in the project area.

Historic cairns, often associated with sheep-herding, are located on ridges or high points, sometimes overlooking seasonal drainages.

Historic debris/trash sites are found distributed throughout the project area. These scatters usually include trash associated with emigration and ranching/herding activities—condensed-milk cans, food cans, baling wire, glass, and milled wood. The sites are usually found on ridge tops in areas with vegetative cover conducive for forage and bedding.

One historic mine has been reported in the project area. The Bugas Mine is a small subsurface coal mine where low-grade coal was extracted, probably between 1950 and 1964. Gardner and Johnson (1991) recorded its location on a northeast-facing slope overlooking Hansen Draw, approximately one-half mile south of the Union Pacific Railroad and 2.5 miles northeast of Wamsutter. It is accessed by a faint two-track road. The surface extent of the Bugas mine includes a 17-mile-long trench with a mine portal at the west end that is partially blocked with earth. At the east end of the trench is a broad, flat tailings pile of low-grade coal with some mica cut fragments mixed in. Some low-grade uranium ore was noted in the mica cut-bank of the trench. It is unknown if any reclamation work has been conducted at the mine since the initial recording in 1991. The site is recommended not eligible for nomination to the National Register of Historic Places.

One grave, the Divide Burial, has been documented in the project area. The grave of a male Caucasian was located during the construction of a telecommunication line. The grave was located on Union Pacific land. Analysis of the human remains and associated coffin and grave goods indicate the male was about 23 years of age and was probably a railroad worker. His remains were moved to the Rock Springs, Wyoming, cemetery.

3.14.4 Summary

Based on information derived from the data review, it is evident that prehistoric cultural resources are found along the major ephemeral drainages and along the lower benches of escarpments that dominate the terrain in the project area. Sensitive areas include drainages such as Muddy Creek, and other locales where water was or is present—natural springs, playa lakes, and the larger ephemeral washes that provide intermittent water sources. The numerous springs in the project area would be likely to contain cultural resources. Seasonal drainages flow into the project area from several escarpments such as Flat Top Mountain, North Flat Top Mountain, Baldy Butte, Pine Butte, Chain Lakes Rim, Ruby Knolls, Coal Butte, High Point, Sugarloaf, Horse Butte, Luman Butte, Horseshoe Bend, Siberia Ridge, Lost Creek Butte, Delaney Rim, Wells Bluffs, Wamsutter Rim, and Big Hill. Certain topographic settings have higher archaeological sensitivity: eolian deposits (sand dunes, shadows, and sheets), alluvial deposits along major drainages, and colluvial deposits along lower slopes of ridges.

Two areas within the study area are identified by the RFO as especially sensitive. The first consists of approximately 127 cairns along a ridge system in the southern portion of the study area, and the second consists of a dune complex that spans nine sections. A sensitivity model and treatment plan for the dune complex was compiled as part of the CD-C project.

The subsistence and settlement patterns in the project area reflect a hunter-gatherer lifeway. Information about the Paleoindian period is sparse and is not well understood. Research into the subsistence and settlement patterns used during the Archaic period indicates summer occupations in the mountains, winter occupations in the foothills, and spring and fall movements utilizing all available zones (Creasman and Thompson 1997). Subsistence patterns in the Archaic period and the Late Prehistoric period are similar in that they are based on seasonal movement throughout the basins and foothills in response to the availability of floral and faunal resources (Creasman and Thompson 1997). A broad diet is evident in extensive procurement and processing of small mammals by 450 B.P. (Shimkin 1947), or possibly earlier (Bettinger and Baumhoff 1982). Numic-speaking Shoshonean groups occupied the Wyoming Basin and continued to reside there until Euro-American expansion relegated them to reservations beginning in 1868.

Historic use of the project area was limited by terrain and lack of perennial water sources. Ranches, limited irrigation, grazing, and limited ranching activities are identified by the historic debris scatters and historic record. Sheep ranching was an important industry historically, and continues today. Historic trails and stage stations are located within the project area including the Overland Trail, the Cherokee Trail, the UPRR (original grade), the Lincoln Highway, the Rawlins-to-Baggs Road, the Wamsutter-to-Baggs Road, and the Red Wash Wagon Road. Stage stations are associated with the Overland Trail and the Rawlins-to-Baggs Road.

3.15 SOCIOECONOMICS

This section describes recent and current social and economic trends and conditions in and near the CD-C project area, the geographic area that would be primarily affected by the Proposed Action or alternatives. Information for this section was derived from a variety of published documents and from interviews with local officials and service administrators. A Baseline Socioeconomic Technical Report (STR) was prepared in 2008 (available on the BLM website for this document), which examined a wide range of socioeconomic conditions and trends in and near the project area. These trends have been monitored over time, updated, and are presented in this section of the EIS.

Natural gas development has been ongoing in the project area for more than 50 years but the pace of such development accelerated between 1999 and 2004, then remained high through 2007/2008, contributing to an economic expansion in Carbon and Sweetwater counties during that same period. Natural gas development activity in the region was subsequently curtailed in the wake of the national economic recession that began in December 2007, the repercussions of which continue at the time of this assessment (mid-2011).

Figure 3.15-1, which displays the total number of wells (which are mostly natural gas wells) in production in Carbon and Sweetwater counties between 2000 and 2010, illustrates the high levels of natural gas activity in the early to mid-years of the decade and the subsequent leveling-off of development in 2008–2009. Development began to accelerate again in Sweetwater County during 2010, but remained fairly flat in Carbon County.

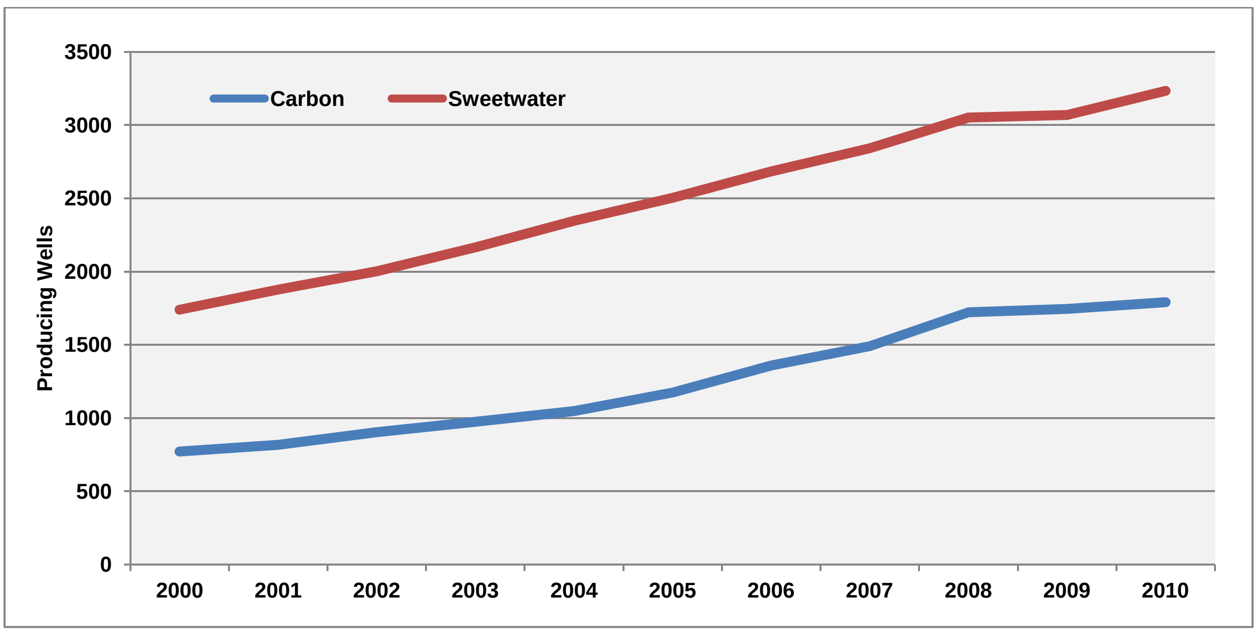


Figure 3.15-1. Producing oil and gas wells in Carbon and Sweetwater Counties, 2000–2010

Socioeconomic effects of historic and ongoing oil and gas development in the project area and the two-county area are included in this Affected Environment section, as information about these effects provides valuable insight into the potential effects of the Proposed Action and alternatives and the historic and cumulative contexts in which they would occur. The socioeconomic effects of the recent energy-related economic expansion and subsequent contraction are particularly illustrative of potential future socioeconomic effects of similar occurrences. This section also discusses the often cyclical nature of oil and gas development and the effects of those expansion and contraction cycles on socioeconomic conditions within the study area.

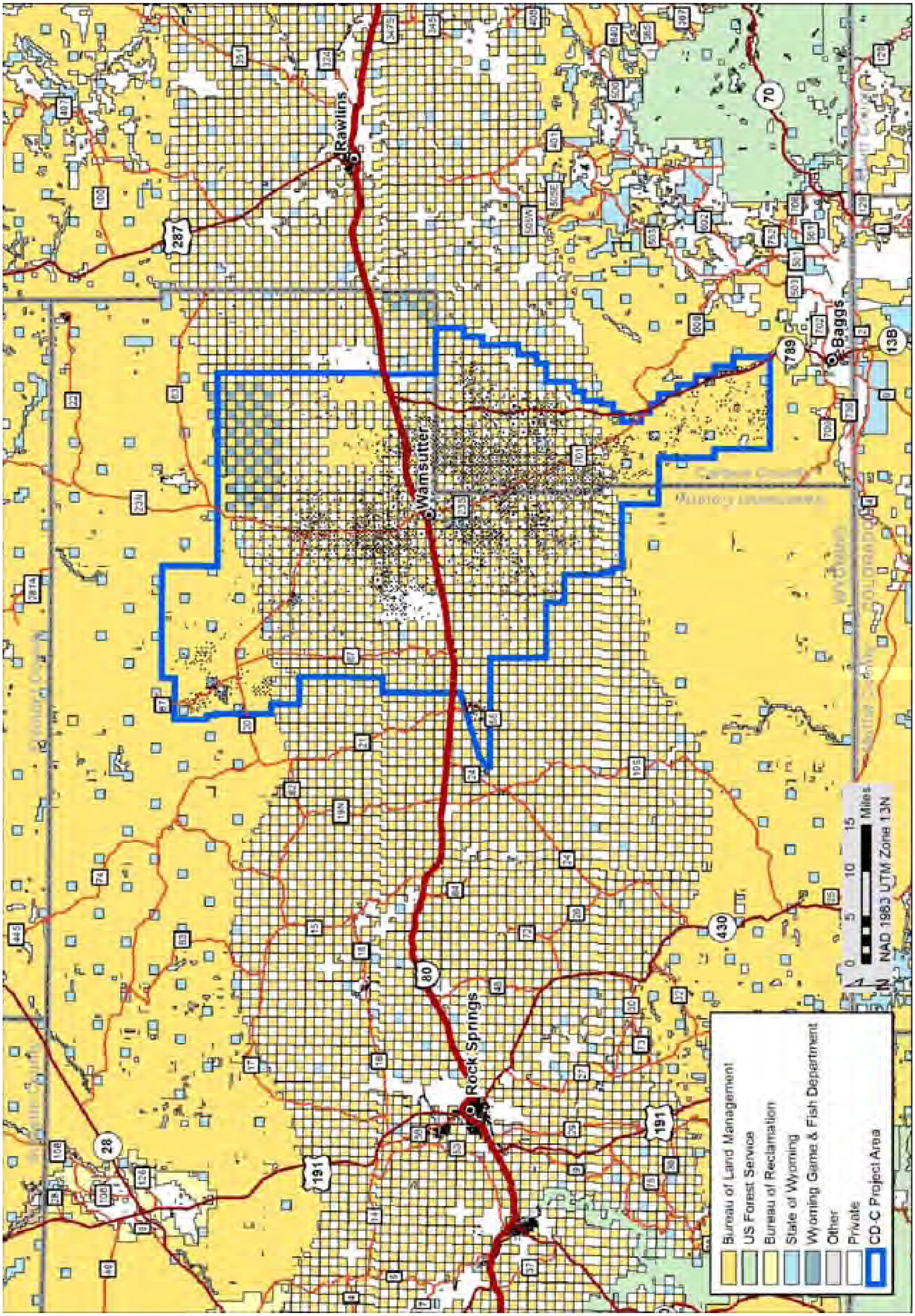
The project area is located in western Carbon and eastern Sweetwater Counties in south central Wyoming (see **Map 3.15-1**). Five communities are likely to be primarily affected by natural gas development and production in the project area: Rawlins and Baggs in Carbon County and Wamsutter, Rock Springs, and Green River in Sweetwater County. The Town of Wamsutter is near the geographic center of the project area and is the only incorporated community within the project area. Although sharing some economic and social characteristics, each community is unique.

The project area is about 40 miles across from east to west, and extends 20 to 25 miles north and up to 45 miles south of I-80, being somewhat keyhole-shaped in general form (**Map 3.15-1**). I-80 bisects the project area along an east-to-west alignment. Along I-80, the eastern boundary of the project area is about 25 miles west of Rawlins, the Carbon County seat. The western boundary of the project area is about 40 miles east of Rock Springs in Sweetwater County. Approximately 80 percent of the total project area is located in Sweetwater County, and approximately 60 percent is within the “checkerboard” of federal/fee ownership pattern created by federal land grants to the railroad to promote development of the transcontinental railroad.

The project area is sparsely populated; there are few permanently occupied residences outside of Wamsutter, although some ranch facilities and a few rural cabins and privately owned lots are occupied on a seasonal basis, the latter by the owners who park recreational vehicles (RVs) or camp. Green River, the Sweetwater County seat, lies about 50 miles west of the project area along I-80.

The Carbon County town of Baggs lies about 8 miles southeast of the project area.

Four other communities—the Carbon County towns of Dixon and Sinclair and the Sweetwater County towns of Bairoil and Superior—may also be minimally affected by the Proposed Action and alternatives. The size of these communities and their land ownership, lack of temporary housing, and/or distance from the project area indicate that substantial growth or other socioeconomic effects of the CD-C project would be unlikely.



Map 3.15-1. CD-C project area and surrounding area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.15.1 Economic Conditions

Economic conditions and trends for the study area were identified based on data from the U.S. Census Bureau, the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, the *Economic Profile System*, from Headwaters Economics, available online at: <http://headwaterseconomics.org/tools/eps-hdt> and from other federal, state, and local sources as cited in the text.

Local economic development and diversification efforts, coupled with expansion in mining, energy resources, and the local trade and services industries, brought about a period of economic stability through the 1990s with total employment fluctuating around 24,500 jobs (**Figure 3.15-2**).

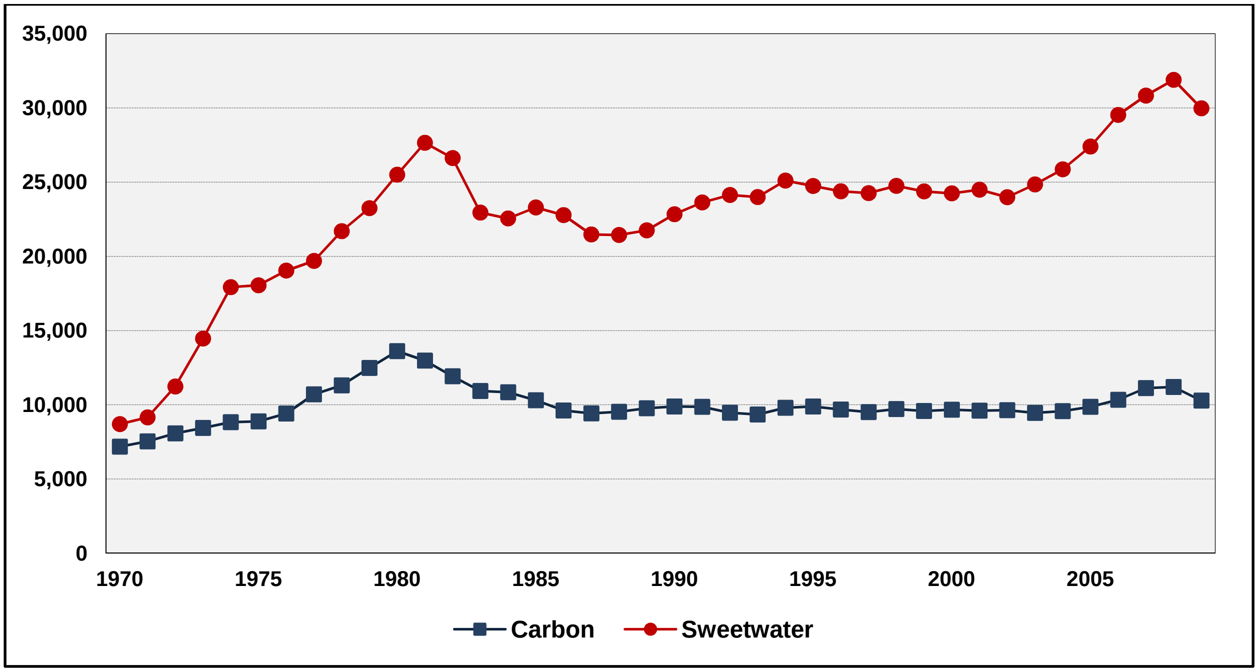


Figure 3.15-2. Total full-time and part-time employment, 1970–2009

Source: U.S. Bureau of Economic Analysis, 2011.

In 2002/03, natural gas development again became a driving economic force in Sweetwater County, prompted by national energy policy, record-high energy prices, and other factors. From the 2002 level of 23,989 jobs, over 3,400 jobs were added through 2005, with about 4,700 additional jobs added through 2008. Available data indicate a net loss of more than 2,400 wage and salary jobs in 2009, or about 7.5 percent of all such jobs, with a modest increase of approximately 500 jobs in 2010 (U.S. of Economic Analysis 2011, Wyoming Department of Employment 2011).

In Carbon County, employment also climbed dramatically in the early 1970s, primarily due to energy resource development (coal, uranium, and oil and gas). The net gain of 6,437 jobs between 1970 and 1980 represented a 90-percent increase in total employment. Like neighboring Sweetwater County, much of the gain in Carbon County was transitory as nearly 4,200 jobs were lost during the early/mid-1980s as the local coal and uranium industries both contracted. Thereafter the local economy remained relatively stable through 2004, at least in terms of employment. More than 200 new jobs were added between 2002 and 2005, and nearly another 1,500 jobs added through 2008. Approximately 1,000 wage and salary jobs were lost in Carbon County in 2009, nearly 10 percent of all jobs in existence at the beginning of the economic recession in late 2007, with a further loss of about 200 jobs in 2010. Although the recession figured in some of the job cutbacks, a substantial number of the losses were associated with the scheduled completion of a major facility upgrade at the Sinclair Refinery (U.S. Bureau of Economic Analysis 2011, Wyoming Department of Employment 2011).

Table 3.15-1 displays the current composition of the local economies in terms of covered employment. Mining, construction, and transportation/warehousing are the primary sectors in Sweetwater County's economic base. In addition to oil and gas development, the mining industry includes two active coal mines and four trona mines. Trade, hospitality services, health care, education, and public-sector employment are also important local economic sectors.

The mining sector has historically been important to Carbon County, but despite the level of recent and ongoing energy resource development in the region, the mining sector currently plays a more limited role in the Carbon County economy than that of its western neighbor. Pipeline and wind-energy facility construction, state government, health care, and the trade, accommodations, and food-service industries have also been important to the Carbon County economy.

Table 3.15-1. Full-time and part-time covered employment, by industrial sector, 2009

Industrial Sector	Carbon County		Sweetwater County	
	Number	% of Total	Number	% of Total
Private				
Agriculture, Forestry, Fishing, and Hunting	198	2.7%	13	0.1%
Mining	290	4.0%	5,446	22.3%
Utilities	75	1.0%	NR	n/a
Construction	533	7.3%	1,685	6.9%
Manufacturing	NR	n/a	1,314	5.4%
Wholesale Trade	62	0.8%	761	3.1%
Retail Trade	759	10.4%	2,408	9.9%
Transportation & Warehousing	235	3.2%	1,278	5.2%
Information	82	1.1%	219	0.9%
Finance & Insurance	149	2.0%	434	1.8%
Real Estate & Rental & Leasing	83	1.1%	439	1.8%
Professional & Technical Services	136	1.9%	532	2.2%
Management of Companies and Enterprises	NR	n/a	NR	n/a
Administrative and Waste Services	119	1.6%	418	1.7%
Educational Services	NR	n/a	45	0.2%
Health Care and Social Assistance	445	6.1%	1,019	4.2%
Arts, Entertainment, and Recreation	79	1.1%	131	0.5%
Accommodation and Food Services	859	11.8%	2,304	9.4%
Other Services, Except Public Administration	154	2.1%	600	2.5%
Subtotal private	**4,715**	**64.5%**	**19,545**	**80.0%**
Government	2,134	29.2%	4,375	17.9%
Total reported	**6,849**	**68.8%**	**19,545**	**81.7%**
Not Reported (NR) due to disclosure guidelines	457	31.2%	4,375	18.29%
TOTAL	**7,308**	**100.0%**	**23,920**	**100.0%**

Source: Wyoming Department of Employment, 2010.

Labor Market Conditions

Local labor markets are reflective of the underlying economic and demographic conditions. From 1990 through 2002, the pool of residents employed or actively seeking work remained relatively steady in Sweetwater County. Fueled by expanded economic opportunities associated primarily with natural gas development, migration, and increases in labor-force participation among residents, the local labor force has since expanded by almost 3,700 individuals, or 19 percent in five years. In Carbon County, the local labor force underwent a slow but protracted decline from 1990 through 2004, shrinking by nearly 1,200 individuals or 14 percent. This period is also characterized by steady out-migration of former residents.

Labor demand tied largely to the increase in natural gas development spawned a reversal in trends, attracting more than 700 current and immigrating individuals into the Carbon County work force between 2004 and 2008. During the same period, the resident labor force in Sweetwater County expanded by more than 3,200 individuals, approximately 14 percent (**Figure 3.15-3**). More recently, weaker labor demand brought about by the recession and associated impacts on natural gas development in the region resulted in labor force contractions.

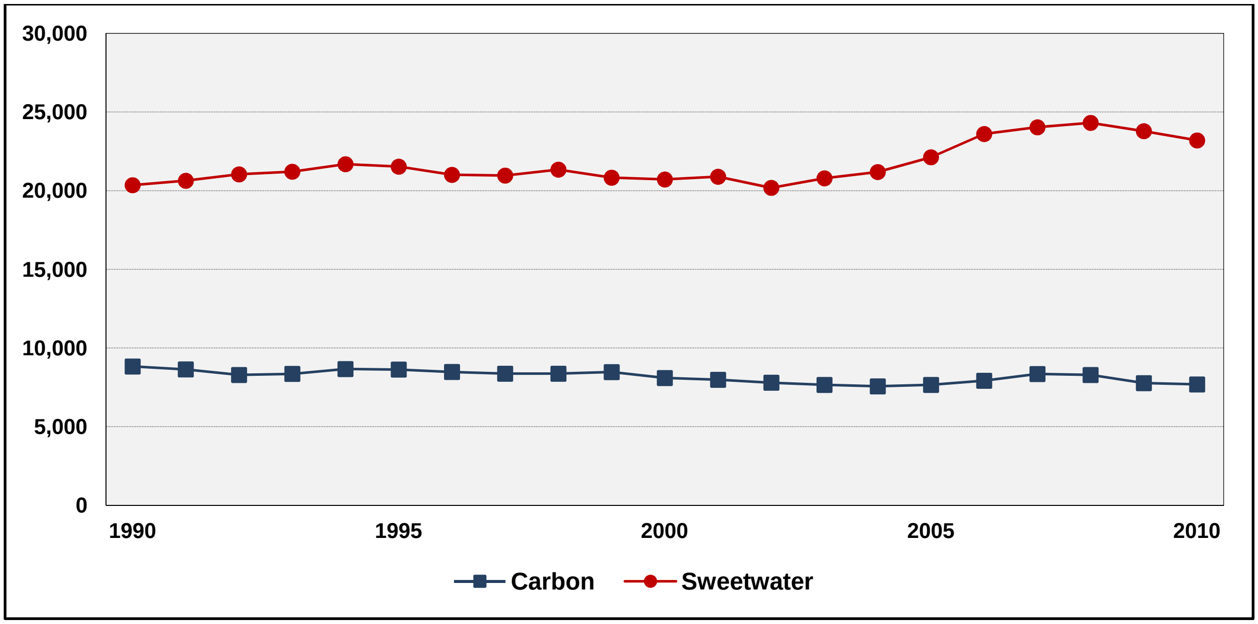


Figure 3.15-3. Local resident labor force: 1990–2010

Source: U.S. Bureau of Labor Statistics, 2011.

Unemployment in the region since 1990 had generally been between 5.0 and 6.5 percent, on par with or slightly above the statewide average (**Figure 3.15-4**). Migration and commuting play important roles in moderating local unemployment rates. Local unemployment rates dropped sharply in 2000, with a more protracted decline between 2004 and 2008. During the recent expansion, labor markets were tight across the state due to the high demand for labor associated with ongoing energy development. In Sweetwater County average annual unemployment dropped to a record low of 2.3 percent in 2007, representing fewer than 600 individuals unable to find work, or temporarily between positions. Carbon County also had record low unemployment in 2007, averaging just over 250 unemployed, representing 3.0 percent of the local labor force (U.S. Bureau of Labor Statistics 2010). The effective unemployment rate was likely even lower as the estimates of the local labor force used to calculate unemployment rates may not capture all non-resident laborers working in the area but living in motels, RV parks, and other temporary housing.

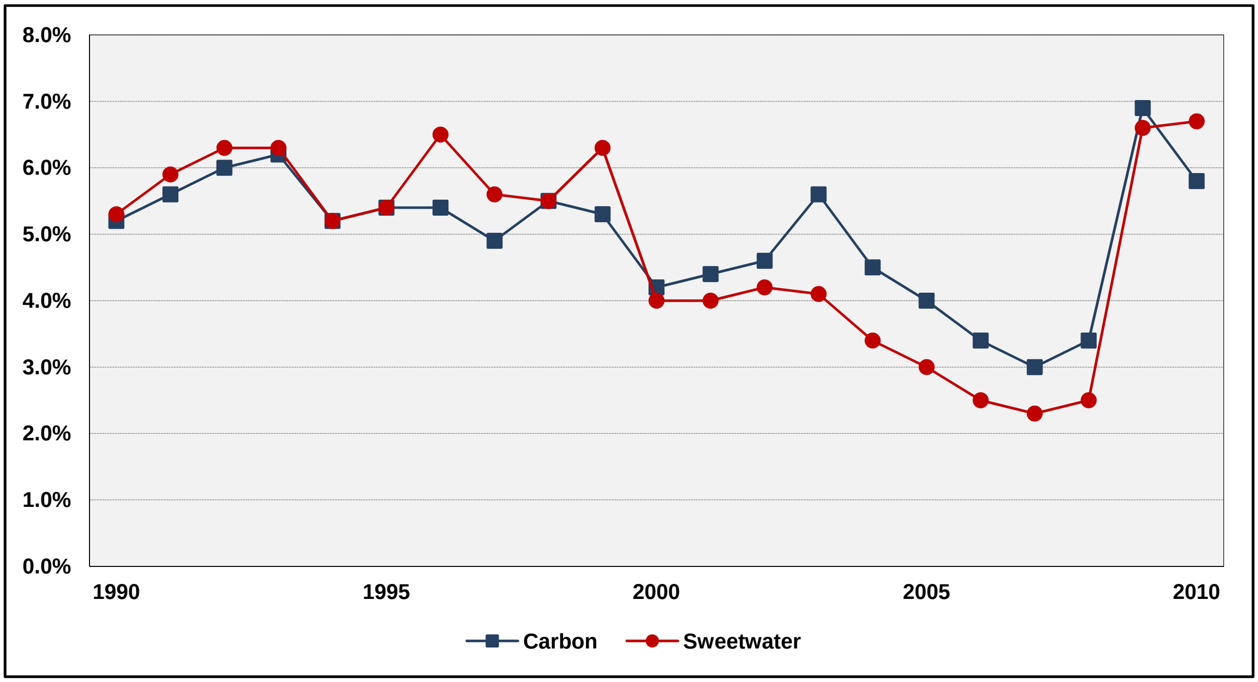


Figure 3.15-4. Local Unemployment Rates (average annual): 1990–2010

Source: U.S. Bureau of Labor Statistics, 2011.

The tight labor market was reflected in across-the-board labor shortages in Carbon and Sweetwater counties. All economic sectors appear to be affected by the high demand for workers. The labor shortage resulted in higher wages, bonuses, and per-diem payments in the natural gas industry. High wages in the natural gas industry resulted in job shifts and worker loss in other sectors of the economy, creating upward pressure on wages for employees across the private and public sectors. Even with the increase in wages, local and state government and private businesses were frequently short-staffed and experienced high employee turnover during 2007 and 2008 (Derragon 2008, Rader 2007, Spicer 2007). Shortages of affordable housing in Carbon and Sweetwater counties (discussed in **Section 3.15.5**) impeded recruitment of non-local workers, who frequently had difficulty competing for housing with higher-paid gas-industry workers. Natural gas service companies were required to develop or contract for temporary housing for employees, many of whom were rotated in and out of the area on a temporary basis.

Employers in other sectors of the economy were in some cases constrained from expanding their business because of labor shortages. Some retail and service businesses had to limit business hours and, in at least one case, temporarily ceased operating because of their inability to attract or retain employees.

A slowdown in the pace of natural gas development, combined with the effects of the recession and the housing mortgage crisis, resulted in substantial economic dislocation and job losses in the region. Unemployment and unemployment rates more than doubled between 2008 and early 2010, peaking at 7.3 percent and 564 unemployed in Carbon County. Peak unemployment in Sweetwater County topped 2,000 individuals in early 2010, representing 8.8 percent of the labor force. More recently, local unemployment has declined, to 5.3 percent and 392 unemployed in Carbon County and 5.6 percent and 1,345 unemployed in Sweetwater County in March 2011 (U.S. Bureau of Labor Statistics 2011).

Sections 3.3 through 3.5 of the Baseline STR describe recent trends in key sectors of the Carbon and Sweetwater County economies including agriculture; minerals; and tourism, travel, and outdoor recreation. Section 3.6 of the STR discusses energy development effects on retirement migration and non-location-dependent businesses. Key findings of these sections are discussed below.

Agriculture

Farm employment has been trending downward in Carbon and Sweetwater counties since 1970. Carbon County farm employment decreased from 741 in 1970 to 564 in 2000, a 23-percent decrease over the two decades. Farm employment continues to trend downward in Carbon County, falling below 400 in 2005 and to 369 in 2009.

Sweetwater County farm employment decreased from 552 to 201, a 63.5-percent decrease in the same period (Headwaters Economics 2007a and 2007 b). Farm employment has since trended upward, to 266 in 2009.

A total of 287 individual farms and ranches, operating on nearly 2.2 million acres of land, were recorded in Carbon County in the 2007 Census of Agriculture. Both totals represent slight declines relative to the corresponding totals tallied in the 2002 Census of Agriculture. In 2007, a total of 244 farms and ranches, operating nearly 1.5 million acres of land, were tallied in Sweetwater County (National Agricultural Statistics Service 2009).

In 2008, local ranches and farms in the two counties reported total cash receipts of $60.5 million in agricultural products, with livestock sales the primary source of agricultural revenue in both counties. Gross annual agricultural sales in Carbon County in 2008 were nearly four times the level in Sweetwater County during that year. Cash receipts from livestock and crop sales in Carbon County declined by approximately 20 percent over the past five years, but increased slightly in Sweetwater County (U.S. Bureau of Economic Analysis 2010).

Minerals

Mining employment in both counties reflect the period of intensive energy and minerals development in the late 1970s and early 1980s and the ensuing slowdown as world energy prices fell. Current and historical mining activity in the study area includes trona mining in Sweetwater County, and coal, uranium mining and oil and natural gas production in both counties. Mining employment in Carbon County peaked at 3,563 in 1980, declined to a low of 180 in 2003 and subsequently increased to 621 in 2008. Sweetwater County mining employment declined from its peak of 7,811 in 1981 to a 2000 low of 3,736,[11] climbing to 6,717 in 2008 (U.S. Bureau of Economic Analysis 2010). Recession related job losses in mining from 2008 to 2010 are estimated at about 200 in Carbon County and 500 to 600 in Sweetwater County (Wyoming Department of Employment, 2011).

Assessing recent mining-sector employment in the study area is complicated by the nature of employment practices in the natural gas industry. Acute labor and housing shortages within the study area during the boom years, coupled with the mobile nature of many natural gas drilling and service company operations, hampered the reporting and tracking of natural gas industry employees. Shortages of local labor resulted in many workers relocating to the study area on a temporary basis, working at job sites located in several counties while staying in temporary lodging near the work site, and then returning home for extended periods. Consequently their employment may not be recorded in the county where they are actually working, or if their employer is located outside the study area, these workers may not be recorded within the affected counties at all.

Oil and natural gas exploration and production have been important but volatile elements of the Carbon and Sweetwater County economies for well over 30 years. According to the Wyoming Oil and Gas Conservation Commission (WOGCC), Carbon County natural gas production increased from 75,851 million cubic feet (MMcf) in 1995 to 128,395 MMcf in 2009, or 69 percent. Production then declined by 4 percent, to 122,755 MMcf, in 2010. Carbon County oil production approached 1.82 million barrels (bbls) in 2009, about 38 percent higher than the 1995 level of 1.3 million bbls, but then declined to 1.59

[11] Mining employment for 2001 through 2004 was not reported by the U.S. Bureau of Economic Analysis due to disclosure restrictions. Mining employment may have fallen even lower in 2001; however the current natural gas expansion began in 2002.

million bbls in 2010. During 2007, there were 1,620 total producing oil and gas wells in Carbon County, and the county produced 5.9 percent of total gas produced in Wyoming and 3.4 percent of total oil. By 2010, the number of producing wells had climbed to 1,791, with another 425 wells idle. Annual oil production had declined to about 1.6 million bbls. The production declines from 2009 to 2010 occurred in part due to the sharp decline in new wells completed in 2009 (WOGCC 2011b).

Annual natural gas production in Sweetwater County decreased from 238,000 MMcf in 1995 to 192,000 MMcf in 2000, but subsequently increased to 235,316 MMcf in 2007. Sweetwater County production accounted for about 12 percent of all natural gas produced in Wyoming and about 11 percent of all oil during 2007. The county had 3,234 producing oil and gas wells in 2010, compared to 3,089 in 2007. Total production of 240,144 MMcf of natural gas and 5.35 million bbls of oil occurred in Sweetwater County in 2010 (WOGCC 2011b).

The Sweetwater County economy is affected by oil and gas activity occurring beyond its borders. Over the last decade, Rock Springs has emerged as a natural gas service center for southwestern Wyoming. A number of oil and gas service companies that service the entire region have established major service centers in the Rock Springs area. Halliburton, Schlumberger, and BJ Services have all established major yards in the Rock Springs area and, according to the Sweetwater Economic Development Authority, employed a total of 1,360 employees in early 2007 (SWEDA 2007a).

Historically, natural gas sales prices in Wyoming were substantially lower than prices received for gas in other markets. This “price differential,” resulting from constraints in natural gas transmission capacity to markets outside of Wyoming, was usually expressed as the difference between average Wyoming sales prices, e.g., prices at the Opal Hub, Cheyenne Hub, or some combination of the two, and those at Louisiana’s Henry Hub. The Henry Hub is one of several reference pricing points for natural gas. Between January 2000 and December 2007, the price differential between Wyoming gas and national averages ranged from just a few cents to $5.00 during the summer of 2007 (Wyoming Pipeline Authority 2008). The price differential effect fluctuated based on such factors as gas supply in Wyoming and weather and other demand factors.

This price differential is important for state and local government because it affects revenues from ad valorem and severance taxes and royalty payments and also affects gas company development decisions. Extension of the Rockies Express Pipeline to Midwestern markets in 2008 and 2009 saw some moderation of the price differential, and the completion of the Bison pipeline in northeastern Wyoming in early 2011 also had an effect. Further narrowing of the price differential is expected as additional gas transmission capacity comes online: the Ruby pipeline, which was completed in mid-2011 and transports gas from the Opal hub to Oregon; and two expansions of the Kern River pipeline, also originating in southwestern Wyoming, which were completed in April 2010 and October 2011 (Kern River 2012, Ruby Pipeline LLC 2011, Wyoming Pipeline Authority 2010).

Travel and Tourism, Including Outdoor Recreation

Travel and tourism in the region, including non-residents engaged in outdoor recreation locally, generate important contributions in the local economy. In addition to the economic benefits, outdoor recreation, including hunting and fishing, is also an important contributor to the quality of life of many local residents.

Much of the tourism and travel in Carbon and Sweetwater counties is traffic passing through the region on I-80 which supports the lodging, dining, and entertainment sectors. These sectors also benefit from energy workers residing in the area on a temporary basis. An economic analysis of travel in Wyoming in 2006 estimated annual tourism and travel spending by non-residents of $166.7 million and $142.6 million in Sweetwater and Carbon counties, respectively. That spending supported an estimated 2,020 jobs in Sweetwater County and 1,560 jobs in Carbon County (Dean Runyan Associates 2007). Travel and tourism were also affected adversely by the economic recession. In 2009 estimated annual travel spending by non-residents in Sweetwater County was more than $22 million lower than in 2006, with a corresponding decline of 330 travel/tourism-related jobs. In Carbon County, the corresponding changes were $12.6 million in lower spending and a loss of 300 jobs (Dean Runyan 2010).

Analysis of the seasonal variations in employment in the accommodations and food service sectors, and the comparative growth in spending in recent years, indicate that a noteworthy portion of those totals reflect travel in the I-80 corridor and the impacts of energy workers residing temporarily in the communities, rather than more traditional destination-type tourism.[12] Local observations about the tourism and recreation economy in Carbon and Sweetwater counties help illuminate the findings of the Dean Runyon studies. Sweetwater and Carbon counties do not have major tourism attractions such as Yellowstone and Grand Teton National Parks that attract large numbers of destination visitors. Rather, the visitor economy in Carbon and Sweetwater counties is based on outdoor recreation, including hunting and fishing by non-residents, and non-local participation in local events such as historic/cultural celebrations, competitions, conventions, and conferences (Radar 2007, Spicer 2008).

The strong pace of natural gas development in Carbon and Sweetwater counties between 2000 and 2008 had both beneficial and adverse effects on tourism and recreation-related businesses. In addition to the general across-the-board increase in business, the beneficial effects of the gas expansion included increases in customers and occupancy rates during the traditional winter and spring off-seasons, which increased the year-round profitability of businesses catering to travelers. High demand also resulted in an increase in the number of lodging and dining establishments, which in turn increased the lodging and dining base for tourism and recreation visitors. High occupancy rates for lodging establishments also resulted in a dramatic increase in lodging tax revenues; lodging tax revenues increased from $110,000 to $362,000 between fiscal year 2002 and fiscal year 2008 in Rawlins, and from $254,000 to $615,000 in Rock Springs during the same period. Local tourism and recreation organizations have used these revenues to develop promotional materials and to promote events that bring visitors to the area and increase the average length of stay. Reductions in lodging tax revenues in the ensuing two years, to $278,000 (-23 percent) in Carbon County and $422,000 (-31 percent) in Sweetwater County, provide another measure of the recessionary effects on natural gas development and tourism in the area (Wyoming Dept. of Administration and Information, various years).

Adverse effects of natural gas and other energy development on the travel and tourism industry included the high energy-worker occupancy rates in lodging establishments, particularly during summer months, which reduced lodging availability for recreationists, event attendees, and travelers on I-80. Travel and tourism businesses, like most businesses in the study area, reported difficulty in recruiting and retaining employees during the boom years (Radar 2007, Spicer 2008).

Energy Development Effects on Retirement Migration and Non-Location-Dependent Businesses

Many communities view local economic diversification as a goal to help achieve economic stability. Recently, some groups and organizations have highlighted the importance of retirees and other sources of non-labor income, service and professional occupations, and non-location-dependent businesses as key to economic diversification in western communities. A number of recent studies espouse the potential role of amenity values, including those on public lands, in attracting retirement migration and non-location-dependent businesses to rural communities in the West and serving as a foundation of overall economic development strategy for rural western communities. Public comments during the scoping for this EIS and on other natural-resource-development actions in the region have expressed concern about the potential effects of energy development on the amenity values of public lands and the resultant

[12] "Travel" for the purposes of that analysis includes both business and pleasure travel by residents and non-residents that was more than 50 miles from the traveler's home. In the study area this would include spending by all travelers on I-80, as well as that by non-resident workers employed in the area on an extended basis but staying in local motels, hotels, and campgrounds. Although not explicitly addressed in the Runyan Report, the spending estimates likely capture some spending by non-local hunters and anglers.

detrimental effects on retirement migration, non-location-specific business attraction, and tourism/recreation visitation. Adverse effects on other sectors of the economy such as recreation and grazing, effects on environmental amenities, and general boom conditions such as scarcity and high cost of housing and labor shortages are also viewed as having the potential to dampen economic diversity in communities within the study area.

Section 3.6 of the Baseline STR examines retiree migration, non-location-specific business attraction, and tourism/recreation in Carbon and Sweetwater counties using an analytical framework combining comparative cross-sectional and time series analysis involving 198 rural counties in six western states.[13,14] Among the findings of this analysis are the following:

<u>Retirees</u>

- Per-capita personal income growth in Carbon and Sweetwater Counties outpaced that of the 198 rural western counties, climbing to 119 percent of the average in Carbon County in 2005; and from 126 percent to 146 percent of the overall average between 1990 and 2005.
- Dividends, interest, and rent (DIR) and personal current transfers (PCT)[15] are two measures of non-earned income typically correlated with retirees. The growth in per-capita DIR in Carbon and Sweetwater Counties between 1990 and 2005 substantially exceeded the rural western county average and the growth in PCT generally paralleled the rural average during that period. The latter is noteworthy given the high labor force participation in Sweetwater County and the large non-working population in Carbon County associated with the Wyoming State Penitentiary, suggesting that energy development did not prompt any relatively disproportionate out-migration of retirees or deter in-migration of new retirees.
- Anecdotal information and census data suggest that absent energy development, relatively few retirees would choose to relocate to the study area parts of Carbon and Sweetwater County from outside these counties. Some retirees move from smaller communities and ranches within these counties to Rawlins, Rock Springs, or Green River, and some retirees have accompanied family members relocating for employment purposes, but most of the growth in the retirement sector in these communities appears to be associated with the aging of the resident workforce (Ducker 2007, Archer, 2007).

These trends suggest little or no adverse effects of energy development with respect to influencing retirement income or migration within the study area when compared to all rural counties.

<u>Non-Location-Dependent Businesses</u>

- Carbon County has experienced more rapid growth in the number of non-farm proprietors and such proprietors account for a larger share of employment when compared to the peer group of all rural counties. Because of the presence of large trona and coal mines, soda-ash and fertilizer manufacturing plants, and large electric-power generating plants, Sweetwater County has had relatively fewer proprietors and has seen lower growth in the number of non-farm proprietors, a substantially lower share of employment accounted for by such proprietors. Also, the recent location of large oil and gas service companies in Rock Springs would contribute to the latter.
- Average annual income for non-farm proprietors in Carbon County, historically lower than the peer group, is now on par. However, the average income for non-farm proprietors in Sweetwater County is more than twice the average for all rural counties, and even higher than the averages for the urban and resort counties. The differences may indicate a higher tendency for part-time proprietors in rural

[13] There are 249 counties in the six states. Of these, 198 were considered rural for the analysis; 43 were excluded as urban counties and eight were excluded as winter-resort communities that are fundamentally atypical from other counties in the region.

[14] This analysis has not been revised since the original STR.

[15] Personal current transfers (PCT) include unemployment, income maintenance, and retirement receipts.

areas as compared to Sweetwater County, or differences in the industries and activities in which non-farm proprietors are active in Sweetwater County.

While the non-farm proprietor data reveal differences between Carbon and Sweetwater counties as compared to the peer group, they are inconclusive with respect to whether or not energy development stimulates or adversely affects the recruitment or operations of location-independent non-farm proprietors.

Influence of Environmental Amenities

The project area is located some distance from the major population centers in both counties and has been the site of ongoing oil and gas development for over 40 years. Much of the project area has been affected by development, adversely affecting some outdoor amenities including wildlife and wildlife habitat, scenic vistas, and areas that provide opportunities for solitude.

Although no major regional scenic and recreation attractions are located within the project area, scoping comments indicate that several features within the area are important to some residents and non-residents alike, including a sage-grouse lek complex southeast of Creston, a small portion of the Red Lake Dunes Citizens' Proposed Wilderness located in the northwestern part of the project area, and the Chain Lakes WHMA located in the northeast portion of the project area. The importance of these and other environmental amenities located within and adjacent to the project area for attraction of retirees and non-location-dependent businesses to communities in the study area is not known. However, given the number of more widely known scenic and recreation attractions within the region, the distance to major communities, and the historic level of gas development activity and disturbance, the importance is likely low. It is not known if existing development within the project area adds to the existing cumulative effects on environmental amenities within the region and to the way the region is viewed by potentially relocating retirees and non-location-dependent businesses.

3.15.2 Population and Demographics

Figure 3.15-5 displays population statistics for Carbon and Sweetwater counties between 1970 and 2010. These statistics show the population effects of the mining and energy expansion, which began in the early 1970s, peaked in the early 1980s in both counties, and then began to decline. Carbon County population increased 69 percent between 1970 and 1982 and Sweetwater County population increased 149 percent during that period. Sweetwater County experienced a brief resurgence of the boom in the mid-1980s during construction of the Exxon La Barge gas-sweetening plant, expansion of the Jim Bridger power plant, construction of the Chevron Phosphate plant east of Rock Springs, and expansion of Western Wyoming College.

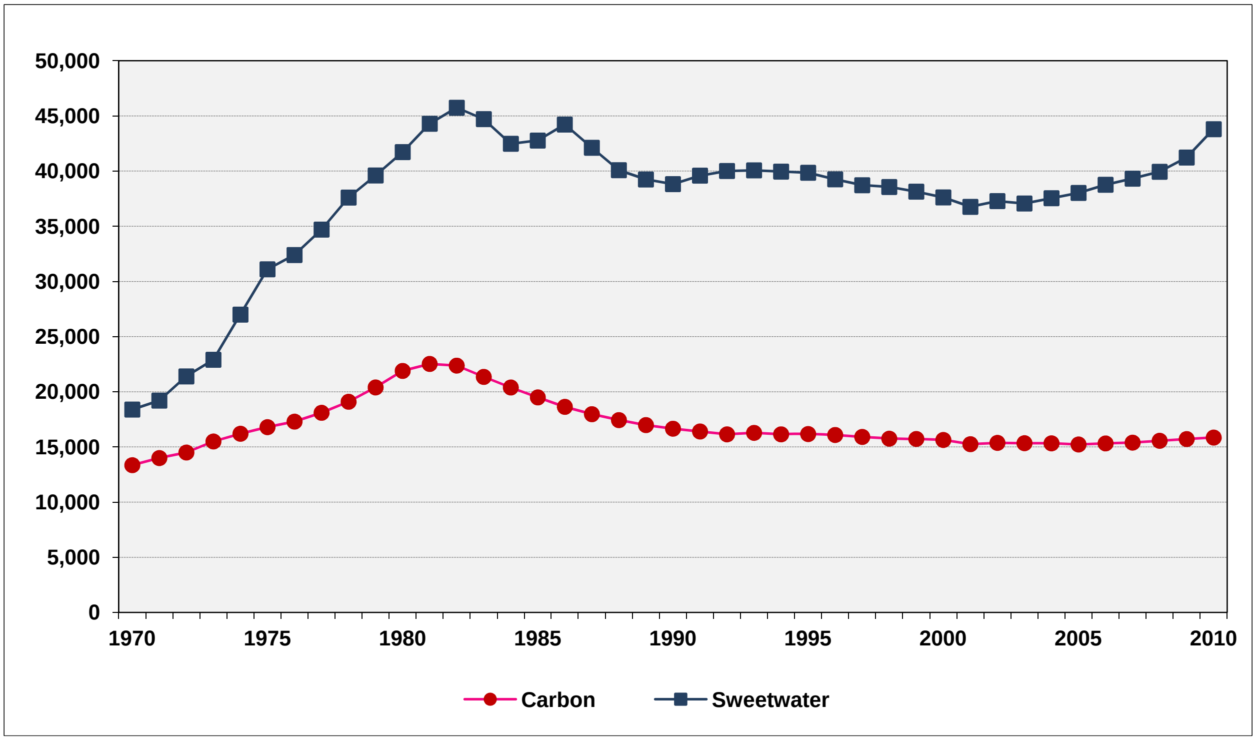


Figure 3.15-5. Population, Carbon and Sweetwater Counties: 1970–2010

Compiled from Wyoming Department of Administration and Information, Division of Economic Analysis and U.S. Census Bureau reports. 1970, 1980, 1990, 2000 and 2010 populations are Census data; other years are population estimates produced by U.S. Census Bureau.

Source: U.S. Census Bureau, 2010xx; U.S. Census Bureau, 2011xx and above.

Sweetwater County's population climbed moderately in the 1990s in conjunction with a number of construction projects and ongoing maintenance of mining and energy facilities. The county's recent natural gas-related growth surge began in 2004, though population in 2010 was still about 4 percent below the 1982 peak, according to 2010 Census counts. Carbon County continued its downward trend for much of the 1990s, and has fluctuated between 15,000 and 16,000 over the past decade.

Table 3.15-2 displays recent population estimates for selected communities in Carbon and Sweetwater counties. As shown, most of the communities within the study area experienced substantial growth during the past decade. Although Rawlins grew by 9 percent between 2005 and 2010, the net gain over the last decade was 3 percent as a result of population loss earlier in the decade.

Table 3.15-2. Population of selected Carbon and Sweetwater County communities: 2000–2010

	2000		2005	2006	2007	2008	2009	2010	Change 2000-2010	% Chg
Carbon County										
Rawlins	8,969		8,503	8,534	8,651	8,723	8,791	9,259	290	3%
Sinclair	421		399	399	403	404	406	433	12	3%
Baggs	348		347	363	388	403	423	440	92	26%
Dixon	79		79	79	81	81	82	97	18	23%
Balance of County	5,822		5,723	5,790	5,874	5,953	6,018	5,626	-196	-3%
County total	**15,639**		**15,051**	**15,165**	**15,397**	**15,564**	**15,720**	**15,855**	**216**	**1%**
Sweetwater County										
Rock Springs	18,589		18,474	18,956	19,629	20,160	20,905	23,036	4,447	24%
Green River	11,806		11,528	11,702	12,047	12,115	12,411	12,515	709	6%
Wamsutter	260		261	262	270	272	310	451	191	73%
Bairoil	97		95	95	97	96	98	106	9	9%
Superior	243		235	235	240	237	242	336	93	38%
Balance of County	6,618		6,738	6,767	7,037	7,062	7,260	7,362	744	11%
County total	**37,613**		**37,331**	**38,017**	**39,320**	**39,942**	**41,226**	**43,806**	**6,193**	**16%**

Sources: U.S. Census Bureau, 2010 and 2011.

Sweetwater and Carbon County officials believe that U.S. Census population estimates do not fully reflect the population growth during the energy expansion years. The Sweetwater Economic Development Authority (SWEDA) developed population estimates for the county and its incorporated municipalities, based on residential electric accounts and an average persons-per-household estimate (2.58) obtained from the Wyoming Division of Economic Analysis. The SWEDA Sweetwater County population estimate of 48,000 for 2007 was over 20 percent higher than the 2007 Census estimate and as much as 128 percent higher for Wamsutter (SWEDA 2007b). Although they did not prepare their own estimates, Rawlins and Baggs officials also believed that the U.S. Census Bureau estimates during the 2006–2008 period substantially underestimated population in their communities, based on increases in utility hook-ups and building permits (Derragon 2008, Corners 2007).

The components of population-change statistics show a net out-migration of approximately 400 residents from Carbon County between 2000 and 2009, with a net in-migration of approximately 300 residents to Sweetwater County during the same period (U.S. Census Bureau 2010). These statistics may not fully capture the many temporary workers in both counties that accompanied the surge in natural gas development.

Based on the 2010 Census, residents of Carbon County tended to be somewhat older than those in Sweetwater County, but were similar in age to the population of the State of Wyoming and the United States overall. In Carbon County, nearly one of eight residents was 65 years or older, as compared to about one in 12 in Sweetwater County. The median age has stayed about the same in the last ten years in Carbon County (38.9 years), while the median age in Sweetwater County has dropped from 34.2 to 32.8 (U.S. Census Bureau 2011).

The largest shares of population in both counties are working age adults aged 18 to 64 years. In Carbon County, the number of persons aged 18 to 64 increased just slightly between 2000 and 2010, accounting for 63.5 percent of all residents in 2010. In Sweetwater County, the number of persons aged 18 to 64 increased by more than 4,500 individuals (19.2 percent) from 2000 to 2010. The number of young persons under age 17 and the number of persons 65 years and older in Sweetwater County also increased. Increases in the number of working-age persons in these counties can be correlated to recent increases in jobs, particularly in the mining sector, which attracts a high portion of working adults. Also consistent with this pattern is the number of natural gas-related jobs attracting younger male workers who are unmarried or married but not accompanied by school-age children. In addition, the number of mining-sector jobs has increased noticeably in Sweetwater compared to Carbon County, which is also reflected in the major increase in working-age adults in Sweetwater County as compared to Carbon County.

The racial and ethnic compositions of the local populations reflect the influences of historical settlement patterns and economic factors, including substantial labor migration in response to the relative abundance of economic opportunity. According to the 2010 Census, Carbon County's resident population was 79.8 percent white and not Hispanic or Latino, with 20.2 percent of the population being made up of persons of other races, multiple races, and/or of Hispanic or Latino ethnicity. The minority population in Carbon County increased from 17.6 percent in 2000 to 20.2 percent in 2010. Sweetwater County has a larger share of the population that is white and not Hispanic or Latino, with 80.9 percent of the population as non-Hispanic white and 19.1 percent of the population being made up of persons of other races, multiple races, and/or Hispanic or Latino ethnicity. Though the percentage share of racial and ethnic minorities in these two counties is higher than for the State of Wyoming as a whole, it is much lower than that for the United States. The minority population in Sweetwater County has increased from 13.1 percent in 2000 to 19.1 percent in 2010. The largest racial and ethnic minority group in both counties is Hispanic and Latino, making up 16.8 percent of the Carbon County population and 15.3 percent of the Sweetwater County population.

The Economic Analysis Division of the Wyoming Department of Administration and Information (WEAD) prepares population forecasts for Wyoming and its counties and municipalities. The current forecasts, which pre-date the results of the 2010 Census, anticipated Carbon County's population increasing by about 5 percent over the next ten years, from 16,350 in 2011 to 17,230 in 2020 and then decreasing slightly to 17,140 by 2025. The forecasts show Sweetwater County population trending upward, increasing from 42,420 in 2011 to 47,220 in 2025—an increase of 11 percent during the 15-year period (WEAD 2008).

3.15.3 Housing

This section provides information about conventional and temporary housing resources in the study area. A shortage of housing during the boom period, particularly affordable housing, is a key issue routinely cited by the local officials, service administrators, and local residents interviewed for this assessment.

Table 3.15-3 displays housing information from the 2010 census.

Table 3.15-3. 2010 Census housing status by county and community

	Carbon County	Rawlins	Baggs	Sweetwater County	Rock Springs	Green River	Wamsutter
Total Housing Units							
2000	8,307	3,860	197	15,921	8,359	4,426	148
2010	8,576	3,960	223	18,735	10,070	5,002	286
Change (%)	3.0%	3.0%	13.0%	18.0%	20.0%	13.0%	93.0%
Occupancy Data, 2010							
Total Occupied Units	6,388	3,443	183	16,475	8,762	4,642	189
Home-owner Occupied Units	4,552	2,346	122	11,872	5,952	3,454	98
Renter-Occupied Units	1,836	1,097	61	4,603	2,810	1,188	91
Total Vacant Units	2,188	517	40	2,260	1,308	360	97
Home-owner Vacancy Rate	3.4%	3.0%	2.4%	2.8%	3.2%	2.5%	3.8%
Rental Vacancy Rate	16.5%	16.6%	17.1%	16.8%	19.1%	11.0%	17.1%
Vacant for Seasonal Use	1,070	36	6	295	79	35	31

Source: U.S. Census Bureau, Census 2000; US Census Bureau, 2010.

3.15.3.1 Carbon County

According to 2010 Census housing counts, total Carbon County housing units increased from 8,307 units to 8,576 units, or about 3 percent over the decade. The number of total housing units increased between 2000 and 2010 in every community in the study area except Dixon, which lost three units.

Carbon County's housing stock expanded dramatically in the late 1970s and early 1980s in conjunction with the previous economic expansion. Given the subsequent contraction, few permits for new residential construction were issued until a brief surge in residential permits occurred in the mid to late 1990s. Strong housing demand associated with the more recent local economic expansion prompted considerable new residential construction over the past decade, particularly between 2004 and 2008. According to the Wyoming Housing Database Partnership (WHDP), Carbon County issued 334 residential building permits during the five years 2004 through 2008. Building permit applications fell sharply in Carbon County during 2009 to 24 units, just 36 percent of the annual average for the previous five years, and to 18 in 2010 (WHDP 2011 and U.S. Census Bureau 2011). It is likely that the recession resulted in the cancellation of construction of some units that had been planned and for which building permits had been issued.

In recent years, several large, temporary living facilities were built for workers near the gas fields in Carbon County. A temporary living facility was developed along WY 789 north of Dad for Devon Energy which currently houses about 80 workers and can be expanded to house a total of 150 workers. A second camp has been developed along WY 789 for Nabors Drilling and a third camp was also proposed.

City of Rawlins

The 2010 Census tallied 3,960 total housing units in Rawlins in 2010, a 3 percent increase over the housing inventory in 2000. The net change understates the amount of traditional housing development that occurred in the city because it reflects both demolitions (Mika 2007) and decreases in the number of mobile homes during the past decade. Of the 2010 total of 3,443 occupied units, about 59 percent were owner-occupied and the remaining 41 percent were renter-occupied.

Information about housing conditions in Rawlins during the recent natural gas expansion was obtained from the 2007 Rawlins Housing Assessment (Kirkham & Associates LLC 2007). The housing assessment was intended to assist city officials, community leaders, and developers in planning for infrastructure and housing development in response to the growth that was occurring and anticipated at that time.

Between 2001 and 2007, 106 single-family residential building permits and no multi-family permits were issued in Rawlins. Rawlins has 11 apartment complexes with a total of 439 units. The newest of these is an 85-unit complex built in 1997. The 2007 Housing Assessment estimated that the city needed 170 additional multi-family units, of which 100 should be rent-assisted.

At the time of the 2007 housing study, Rawlins had 19 mobile-home parks. In recent years, three mobile-home parks with a total of 146 pads were converted to lot ownership where the mobile-home owner also owns the lot. The 2007 Housing Assessment projected demand for three new mobile-home parks in Rawlins by 2010. During 2010 Rawlins had 16 mobile home parks with 639 pads (MHPS 2010).

Housing availability in Rawlins has been volatile in recent years. The 2007 Housing Assessment estimated rental housing vacancies at less than 1 percent in December 2006. According to that assessment, there were virtually no apartment vacancies in mid 2007 and most complexes had waiting lists. Rental housing and apartment vacancies increased during 2008 and early 2009 due in part to the reduction in the construction work force at the Sinclair refinery (Mika 2009). The WHDP estimated overall vacancy rates at 16 percent during the second half of 2009 (WHDP 2010).

According to the Carbon County Visitors Council (CCVC) Rawlins has 23 motels with a total of over 1,252 rooms (CCVC 2010). Some motels offer weekly or monthly rates and typically host energy industry and construction workers. Rawlins also has 3 recreational vehicle parks with a total of 303 pads, although one RV park is not winterized (Stolns 2010). The CCVC conducted an informal telephone survey of motels and RV parks during August 2010. The CCVC reported that the newer, nationally affiliated motels in Rawlins averaged 95 to 98 percent occupancy, while the older and smaller motels, which were more likely to accommodate construction and gas-field workers on a weekly or monthly basis, averaged 75 to 80 percent occupancy. Local RV parks averaged 80 to 85 percent occupancy (CCVC 2010).

Baggs

Total housing units in Baggs grew from 197 to 233 units between 2000 and 2010, an increase of 13 percent. During that period, Baggs approved a 16-lot subdivision and a 6-lot subdivision. Most housing in the Baggs area is manufactured housing and mobile homes (Corners 2007). There is little available rental housing and rents have increased substantially in recent years.

In the Baggs area, temporary housing resources include two motels with a total of 64 rooms and a 26-space mobile home park equipped to accommodate RVs and mobile homes. Within the park there are several mobile homes for rent, but these are rarely vacant. There are also two RV parks on WY 789 north of town (CCVC 2010).

3.15.3.2 Sweetwater County

According to the 2010 Census, total housing units in Sweetwater County increased from 15,921 to 18,735, an 18 percent increase over the preceding decade. Much of that growth occurred between 2004 and 2008, when Sweetwater County issued 2,150 building permits (WEAD 2011). Sweetwater County issued a total of 2,651 building permits from 2001 to 2010. Of those, 70 percent were issued during the 2003 to 2008 period. Building permits fell from the 2008 level of 321 to 160 in 2009, but have increased to 213 in 2010. (Kot 2011).

As with Carbon County, the effects of the natural gas-related economic expansion and contraction are evident in the housing statistics. The WHDP estimated rental housing vacancy rates below 1 percent in Sweetwater County in December 2006. The tight housing market was reflected in rising rents; the average apartment-rental rate rising from $512 in the second quarter of 2005 to $684 in the second quarter of 2006, an increase of almost 34 percent in one year. Average rental rates of detached single-family homes increased approximately 21 percent during the same period while the average monthly rent for mobile homes increased almost 13 percent and the average monthly rent for a mobile home lot rose by 11 percent. As elsewhere in southwestern Wyoming, the shortage and high cost of rental housing was a constraining factor on employee relocation and on the ability of people on low or fixed incomes to acquire and retain rental housing.

During 2009 and 2010, rental vacancy rates in Sweetwater County rose to between 5 and 7 percent. Average monthly apartment rental costs fell from the second quarter 2009 high of $779 to $691 per month in the second quarter of 2010, a decrease of 11 percent. Monthly rates for rental housing fell by almost 18 percent between fourth quarter 2008 and fourth quarter 2010 (WHDP 2010).

During the height of the boom, ESS Support Services, under contract to BP, developed a 250-bed temporary living facility with food service, housekeeping, and recreation facilities just north of Wamsutter. The Wamsutter Base Camp was open to both BP employees and gas-field contractors. The facility was permitted for 500 beds, providing flexibility to expand as demand emerged (Van Rensburg 2007). As yet another reflection of the curtailment in development activity during the recession, that facility has now been closed and removed from the site.

City of Rock Springs

Rock Springs has seen dramatic changes in housing conditions in recent years, driven primarily by the increase in demand associated with natural gas development. The 2010 Census counted 10,070 housing units in Rock Springs, 20 percent more than the 2000 Census count of 8,359 units.

The City of Rock Springs issued a Final Housing Plan (Housing Plan) in September 2007 to inform the community about anticipated housing needs and potential housing development opportunities in the city (City of Rock Springs Housing and Community Development 2007). The Housing Plan identified 1,560 acres of land used for residential purposes and 8,899 housing units located within the city during January of 2007. **Table 3.15-4** displays the distribution of housing, by unit type, within the city at that time. Single-family units were the predominant form of housing with 60 percent of all housing being single-family detached units.

Table 3.15-4. Rock Springs total housing units by housing type: January 2007

Housing Unit Type	# Housing Units	Percent of Total
Detached single-family	5,319	60
Attached single-family	886	10
Mobile homes	1,447	16
Apartments	1,247	14
Total	8,899	100

Source: City of Rock Springs Housing and Community Development 2007.

The number of housing units in Rock Springs grew by about 8 percent, or 685 units, between 2004 and January 2007 according to the Housing Plan. This generally coincides with the period of intensified natural gas development in the region.

The City approved 33 new subdivisions between January 2004 and May of 2007. Of those, 25 subdivisions were for residential development with the potential to create over 2,000 residential lots. A January 2007 inventory conducted for the Housing Plan identified 705 vacant residential lots, but noted that not all of these lots were available for sale and development.

Residential development in Rock Springs continued during 2008 through early 2011, despite the economic slowdown. A total of 1,235 residential occupancy permits were issued by the city between January 2007 and April 15, 2011. Of the total occupancy permits issued, 40 percent were for single-family homes, 36 percent for apartments and 19 percent for duplexes. Rock Springs approved 14 residential subdivisions with a combined capacity for 399 units between January 2007 and April 15, 2011 and the Planning Department estimates that that there were 134 vacant residential lots within city limits as of April 15, 2011 (McCarron 2011).

The average price of an improved residential property (a lot with a house) in Rock Springs during 2006 was $175,500, about 28 percent higher than the 2004 average of $137,500. The average price for unimproved residential property (a vacant building lot) increased from $48,958 in 2004 to $160,989 in 2006, or 229 percent. According to the Housing Plan, these increases can largely be attributed to a shortage in available housing inventory and strong housing demand from an incoming workforce. In 2010, the average sales price for residential properties was $174,257, virtually the same as 2006 (SWEDA 2011).

Although not establishing an affordable housing threshold, the Housing Plan suggested that given the relatively high per-capita personal incomes in Rock Springs ($38,039 in 2005), many local workers in Rock Springs could have afforded an average-priced home, if it were available.[16] In addition, given the relatively large number of two-income households (43 percent in 2000), many households with members earning below-average incomes could have also afforded the average-priced home, if it were available.

The Housing Plan forecasted future demand for housing units for purchase based on the plan’s population projections for the 2007–2017 period, the 2000 average household size of 2.48 persons per household, and various assumptions concerning housing preferences. The Housing Plan forecasted demand for 1,539 new housing sales units and 1,100 new rental units by 2017. The Housing Plan also forecasted increased demand for senior housing, housing for persons with disabilities, and low-income households. This demand was based on a Rock Springs population forecast of 27,113 persons by 2017, contrasted with the WEAD forecast of 21,474 persons by 2017 (Rocks Springs’ 2010 population was 23,036 according to the 2010 Census).

Rock Springs has a total of 1,638 motel rooms (Sweetwater County Joint Travel and Tourism Board 2009)

Green River

The U.S. Census Bureau counted 5,002 housing units in Green River in 2010, 13 percent more than the 2000 census count of 4,426 units. A total of 159 of the total housing units were constructed between 2000 and May of 2007. As of June 2011, there were only 39 available residential lots within Green River. However, two subdivisions with a total of 224 units were nearing final approval at that time (Brown 2011).

Green River has a total of 256 motel rooms (Sweetwater County Joint Travel and Tourism Board 2009).

Wamsutter

According to the 2010 census, the housing inventory in Wamsutter has nearly doubled over the past decade, growing from 148 units in 2000 to 286 units in 2010, an increase of 93 percent. Wamsutter had no available rental units during the summer of 2007 and very few vacancies during the summer of 2010. Temporary housing resources in Wamsutter include seven mobile home/RV parks with a total of 160 spaces. Some drilling and gas-service contractors have put dormitory units in these mobile home parks. There are two motels in Wamsutter, one with 24 units, the other with 4 units, with a new 120-unit motel in the planning stages (Colson 2007 and 2010).

3.15.4 Community Infrastructure and Services

This section describes community infrastructure and services likely to be directly affected by the Proposed Action and alternatives. The following inventory identifies key public facilities and services

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[16] Housing affordability and the ability to qualify for home mortgages are subject to other criteria in addition to earnings.

including law enforcement, emergency response (fire suppression and ambulance), hospitals, solid-waste disposal, and water and wastewater systems (schools are addressed in a following section). These are the services and facilities that have been and would be most immediately affected by energy development in the project area and elsewhere in the study area. However, all county and municipal services are affected by the demands associated with population growth.

The experiences of the past decade illustrate both the benefits and the challenges that oil and gas development present for local government service delivery, particularly when that development is regional in nature. Although oil and gas development has been ongoing in southwestern Wyoming for decades, the advances in drilling in and producing from tight sands and other unconventional formations led to a surge in development throughout southwestern Wyoming as well as nearby regions of Wyoming, Colorado, and Utah during the early to middle years of the last decade.

Because oil and gas development typically involves multiple companies operating in multiple fields across a region, growth in development activity, employment and, consequently, community population and service demand occurs in a decentralized manner. Communities are uncertain regarding the magnitude of growth and service demand that they may be facing, which hampers planning efforts. And although large-scale oil and gas development generates substantial increases in state and local government revenues, much of that revenue does not accrue until after the growth and increase in service demand has been ongoing for sometime, and in the case of Wyoming, key revenue sources such as ad valorem taxes on production are not available to municipalities, where much of the service demand occurs. These factors, coupled with the previously described housing shortages and competition for labor, contributed to challenging times for most of the local governments within the CD-C study area during the energy expansion period of the last decade.

Then, when the sub-prime mortgage crisis, the ensuing global recession and other factors resulted in falling natural gas prices in the latter part of the decade, industry activity and employment experienced a corresponding decrease. Although a reduction in transient workers provided a respite from growth and service demand, the corresponding drop in natural gas-related revenues presented a fiscal hardship for communities that had added staff and begun infrastructure improvements to accommodate the growth.

Once oil and gas development reaches an equilibrium of relatively constant drilling and field development activities and once development is completed and fields are producing, host counties and nearby communities typically can prosper and use the incremental revenues to improve infrastructure and services and accommodate the relatively stable population. However, the beginning and end of development cycles and the surges and declines resulting from decreases in commodity prices and demand are particularly challenging for affected local governments.

3.15.4.1 Law Enforcement

Law enforcement services are affected by natural gas development and production activities in the project area in terms of demand for law enforcement agency response to accidents and law enforcement incidents within and on highways providing access to the project area, as well as in terms of demand for services from the workforce and population generated by drilling, field-development, and production activities. Affected law enforcement agencies include the Carbon and Sweetwater County Sheriff's Departments and the Rawlins, Baggs, Rock Springs, and Green River Police Departments.[17]

During the boom years, energy development-related effects on law enforcement agencies included difficulty in recruiting and retaining officers, due in some cases to the higher wages paid by the energy industries and by larger law enforcement agencies, and due in part to the difficulty in finding affordable housing. The time and cost to train and equip an inexperienced officer affected law enforcement agency budgets, particularly when officer turnover was high. Most law enforcement agencies reported

[17] Law enforcement services in Wamsutter are currently provided by the Sweetwater County Sheriff's Department.

substantially increased levels of certain types of offenses associated with the large, temporary, and transient component of the drilling and field-development workforce, which included a high percentage of single-status working-age males. Increases in traffic offenses, alcohol-related offenses and minor assaults were typical. All agencies report substantial increases in drug-related offenses, particularly methamphetamine (Carnes 2007, Claman 2007 and 2011, Colson 2009, Corners 2007, Jackson 2007, Lowell 2007, Morris 2007 and 2010, Reed 2007, Steffen 2007).

The Carbon and Sweetwater County Sheriff's Departments experienced increases in calls for service related to industrial accidents, vehicle accidents, crime, and traffic infractions in remote parts of their respective counties resulting from the intensification of drilling and field-development activities in previously isolated and seldom-visited areas (Claman 2007 and 2011, Colson 2007 and 2010).

Criminal detention facilities in the two counties are operated by the respective Sheriff's Departments. The Sweetwater County Detention Facility has a design capacity of 208 inmates and was designed to allow expansion on the same site while maximizing use of administrative facilities. In 2007, occupancy averaged about 110 inmates and recent (summer 2011) occupancy was slightly higher (110 to 120), in part because the detention facility has been housing inmates from other counties. The Carbon County Detention Facility, which opened in 2004, has a design capacity of 78 beds. During the summer of 2009 the facility's design capacity was exceeded a number of times. Consequently the detention facility appears to have reached its capacity sooner than the 10–15 years anticipated when it was constructed.

Law enforcement and emergency-response dispatch services within the project area are provided by the Carbon and Sweetwater County Sheriff's Departments. The Sweetwater County 911 service is administered by the Sweetwater County Emergency Management Agency, a division of the Sheriff's Department. The Rawlins, Rock Springs, and Green River police departments also provide dispatch services (Carnes 2007, Claman 2007 and 2011, Colson 2009, Corners 2007, Jackson 2007, Lowell 2007, Morris 2007 and 2010, Reed 2007, Steffen 2007).

3.15.4.2 Emergency Management and Response

Emergency management and response is coordinated in Carbon County by the Carbon County Emergency Management Agency and in Sweetwater County by the Sweetwater County Emergency Management Agency. Both of these agencies coordinate emergency management and response in their respective portions of the project area and have recently established cooperative emergency-response staging locations within the project area, which allows employees working in remote areas to meet emergency responders at predetermined areas to guide them to remote accident locations.

Fire-suppression and emergency-response services in the Carbon County part of the project area are provided by the Carbon County Fire Department (Rawlins and Baggs divisions) assisted as necessary by the Rawlins Fire Department. Fire suppression services in the Sweetwater County part of the project area are provided by the Sweetwater County Fire Department, aided by the Wamsutter Volunteer Fire Department. Rawlins, Rock Springs and Green River also operate fire departments for their communities and surrounding areas.

Ambulance service in the northern and western part of Carbon County including a portion of the project area is provided by Memorial Hospital of Carbon County. In the southwestern part of the county, ambulance services are provided by the Noyes Medical Clinic & Ambulance Service, which is located in Baggs. The Wamsutter Volunteer Ambulance Service responds to calls along I-80 and to calls within much of the central portion of the project area. Vase Emergency Medical Services provides ambulance services in Rock Springs and along I-80. Castle Rock Ambulance Service provides ambulance services in Green River (Carnes 2007, Carter 2007, Hannum 2007, Jones 2007, Kennedy 2007, Valentine 2007, Sarff 2007, Zabel 2007, Zeiger 2010).

The Rawlins Interagency Dispatch Center provides a central location for reporting all wildland fires in southern Wyoming. Additionally, the BLM RFO and RSFO maintain trained and equipped fire crews that respond to wildland fires on BLM surface and if needed will support other agencies on other federal, state, and private lands.

3.15.4.3 Hospitals and Health Care

Hospital and emergency-room services in the study area are provided by Memorial Hospital of Carbon County (MHCC) and Memorial Hospital of Sweetwater County (MHSC). MHCC is a 35-bed acute-care facility located in Rawlins and designated as a Community Trauma Hospital by the state of Wyoming. A Community Trauma Hospital must have a surgeon on staff. MHCC's emergency room is staffed 24 hours per day, seven days per week with an emergency-care physician, a registered nurse and emergency medical technicians. Currently the hospital has staffing and facility capacity to serve substantially more patients than are currently treated. During the summer of 2010, MHCC had eight active medical staff physicians, over 35 courtesy (visiting) physicians and five *locum tenens* physicians who are hired on a temporary, short-term basis to fill in when active medical staff are on leave (Jessop 2010).

MHSC is a non-profit, 99-bed, rural acute-care facility located in Rock Springs. As of 2010, MHSC had a total staff of 363 and 112 physicians, including *locum tenens* and consulting physicians (MHSC 2011). During the peak of the recent gas expansion in southwestern Wyoming, MHSC reported an average 20 percent occupancy rate during 2008 (Wyoming Healthcare Commission 2008). During that period MHSC experienced an increased use of hospital emergency rooms for non-emergency care and increased uncollected debt attributed to the large number of workers who did not have health insurance and an increase in charity-care cases. The increase in emergency-room visits was largely attributed to non-local workers who did not have primary-care physicians in the area (Hawk 2007).

There are medical clinics in Rawlins and Baggs and a number of clinics in the Rock Springs/Green River area. Carbon County had 13 licensed practicing physicians during 2007 (the most recent year for which physician data were published) or 0.85 physicians per thousand population, substantially below the Wyoming and national averages of 1.94 and 2.81 per thousand, respectively. Sweetwater County had 39 physicians, or 1.01 per thousand, also below the Wyoming and national averages (Wyoming Healthcare Commission 2008). A lack of affordable housing in the community during the height of the natural gas boom added to the difficulty of recruiting physicians and staff. (Carter 2007, Hawk 2007, Jones 2007).

3.15.4.4 Solid Waste Management

In 2006 the Wyoming legislature passed a law requiring all operating landfills to prepare Integrated Solid Waste Management (ISWM) plans to be submitted to the WDEQ by July 1, 2009. All entities in communities affected by the Proposed Action and alternatives participated in the ISWM planning process. Three special districts—Baggs Solid Waste and Sweetwater County Solid Waste Disposal Districts (SCSWDD) # 1 and #2—are funded in part by mill levies on property within each district.

Rawlins operates its own landfill, which has a remaining life of several years at the current fill rates. The City is currently seeking to obtain an additional section of land from the BLM to expand the landfill. Rawlins, along with Casper, Douglas, and other east-central Wyoming communities, is a member of the East Central Solid Waste Management Area As of February 2011, Rawlins ceased the disposal of municipal solid waste at the Rawlins landfill and began transporting its solid waste to the Casper Regional Landfill. Construction waste will continue to be accepted at the Rawlins Landfill through year 2016 when a permit extension will be considered. The need for cover material to continue current landfill usage is an ongoing concern for the landfill operation. Disposal fees are designed to cover costs and some construction waste is recycled (City of Rawlins 2011, Stolns 2007 and 2009).

The Baggs Solid Waste Disposal District operates the Baggs landfill, which has considerable capacity at its existing site, but has recently opted to transport baled municipal solid waste and recycled materials to the Casper Regional Landfill. Construction and demolition waste and animal carcasses will still be accepted at the Baggs landfill (Good 2011).

SCSWDD #1 oversees a landfill in Rock Springs, and monitors closed landfills in Reliance, Superior, and Point of Rocks (SCSWDD#1 2007). The district is completing a permit process that will provide the Rock Springs landfill with an estimated 30 years of remaining life at current fill rates and the district owns an adjacent 320 acres, which could provide additional capacity when permitted (Herman 2011, Sugano 2007). SCSWDD #1 is part of the I-80 Solid Waste Management Planning Area along with SCSWDD #2 (Wamsutter/Bairoil), Baggs, Farson, Eden and Green River. The Rock Springs landfill is in the process of becoming a regional landfill. The emerging plan will include the development and operation of transfer stations in some other municipalities and transportation of solid waste to the Rock Springs landfill. Currently the Sweetwater County communities of Farson and Eden transfer their waste to the Rock Springs landfill.

Green River intends to close its currently operating landfill in approximately four or five years and begin transferring solid waste to the Rock Springs landfill (Herman 2010, Nelson 2007).

SCSWDD #2 serves eastern Sweetwater County from the eastern border of the County to Point of Rocks, including the towns of Bairoil and Wamsutter. District #2's landfill fill rates more than doubled during the boom years and the district's landfill, located just south of Wamsutter, was within several months of its maximum capacity. The district received authorization from DEQ to expand the existing landfill vertically, which provided it five to eight additional years of use at current fill rates. The district has applied for permits to develop a new landfill adjacent to the existing landfill on the remaining 20 acres of the district's 40-acre site, which will give the district an additional 25 years of capacity at current fill rates (Rigano 2007 and 2011, Pilch 2011).

Disposal of solid waste from energy development has been of concern to community landfills and solid waste districts in the past. Currently, most solid waste from energy development and operations throughout the I-80 Solid Waste Management Planning Area is transferred to the Rock Springs landfill for disposal. Disposal of waste from drilling reserve pits is a concern for some solid waste districts (Herman 2011).

3.15.4.5 Water Treatment, Storage, and Distribution

Rawlins Water System

The Rawlins water system, which also provides treated water for the town of Sinclair, was developed in the 1970s with a target capacity to serve about 17,000 residents. The system includes an 8-million-gallon-per-day (MGD) treatment plant, which registered a 2006 peak daily usage of 4.45 MGD. Consequently, the water-treatment plant could serve nearly double the current population at current usage rates. The system includes four storage tanks, with a combined capacity of 6 million gallons for the city and a single 0.8-million-gallon tank for Sinclair. There also is a raw-water storage reservoir that feeds the treatment plant. Rawlins has ample water rights in the North Platte River watershed and in springs and wells to serve both current and anticipated future water needs (Stolns 2008).

Baggs Water System

The Baggs wastewater treatment system is comprised of a four-cell aerated lagoon, which has been in use since 2006. The site includes a location for adding a fifth cell in the future. The system has capacity to treat about 100,000 gallons per day (Corners 2008, O'Neil 2007). Recent wastewater system improvements have included replacement of the pumps at the lagoon, nearly all of the vitrified clay pipes in the collection system, and some damaged PVC wastewater collection mains, as well as up-sizing all mains and installing two additional lift stations (Christopher 2011).

Rock Springs Water System

The Green River/Rock Springs/Sweetwater County Joint Powers Water Board supplies water to Rock Springs. The water storage and distribution system could serve a population of about 35,000. Each year the Rock Springs Public Services Department replaces and improves a portion of the water distribution system in the older parts of the city. Water main extensions to neighborhoods on the perimeter of the city are sized to accommodate additional growth (Walker 2007 and 2011).

Green River Water System

Green River obtains treated water from the Green River/Rock Springs/Sweetwater County Joint Powers Water Board treatment plant, located in Green River. Although the system requires certain distribution and treatment improvements, there is capacity to accommodate additional users (Nelson 2007, Michael 2011).

Wamsutter Water System

Wamsutter recently completed a series of improvements to the town's water system; a 400,000-gallon water-storage tank north of town (funded in part by $1,213,000 from capital facilities sales tax revenues), construction of a water main connecting the industrial park to the town's water system (funded by $954,716 from the capital facilities sales tax), and installation of water meters (funded by a $538,000 loan from the Wyoming State Revolving Loan Fund). A new well intended to be Wamsutter's main water source came online in November of 2007; the Town is completing a water-treatment project and has received funding to study the siting of a new water source for the town. The town's water system improvements are designed to accommodate a target population of 1,200 (Colson 2007 and 2010).

3.15.4.6 Wastewater Collection and Treatment

Rawlins Wastewater System

The wastewater system for Rawlins was designed for a target population of 17,000; recent usage is about half of maximum capacity. The system has three aerated lagoons, two settling lagoons, and two storage lagoons. In order to achieve maximum capacity several lagoons would need to be cleaned and restructured. It is possible that the wastewater treatment system would need to be upgraded to tertiary treatment if substantial growth were to occur. There are currently over 65 miles of wastewater collection lines within the city and recent expansions have extended the collection system to serve additional land along I-80 (Stolns 2007, 2008 and 2010).

Baggs Wastewater System

The Baggs wastewater treatment system includes a four-cell aerated lagoon system and all cells have been in use since 2006. The site includes a location for a fifth cell, but it has not yet been constructed. The system has capacity to treat about 100,000 gallons per day (Corners 2008, O'Neil 2007). Recent wastewater system improvements have included replacement of the pumps at the lagoon, replacement of nearly all of the vitrified clay pipes in the collection system, replacing some damaged PVC wastewater collection mains and up-sizing all mains and installing two additional lift stations (Christopher 2011).

Rock Springs Wastewater System

The Rock Springs wastewater treatment plant capacity was expanded to 4.2 MGD in 2007. During 2010, the plant processed 2.3 to 2.45 MGD and served a population of about 25,000. The expanded plant has planned treatment capacity for a population of about 50,000 and was designed to accommodate a second plant on the same site, if required (Gaviotos 2007, Conner 2010). Work is currently underway to convert the treatment plant back to an anaerobic system. The Rock Springs Public Services Department replaces and upgrades portions of the wastewater collection system each year in older parts of the city and designs collection system extensions to growth areas of the city to accommodate future growth (Walker 2007 and 2011).

Green River Wastewater System

The Green River wastewater treatment plant has a 1.5-MGD treatment capacity and treated about 1.0 MGD during 2007. Although the plan has capacity to accommodate additional growth, a recent wastewater master-plan study identified a number of areas in the wastewater-collection system requiring improvement to accommodate new growth and more effectively move wastewater to the treatment plant Michael 2011, Nelson 2007).

Wamsutter Wastewater System

Wamsutter recently completed construction of a wastewater-collection main to connect the industrial park and other system improvements to the wastewater system, and conducted a capacity analysis of its wastewater lagoon system to determine short- and long-term needs. The analysis was funded by a $16,500 grant from BP America. The current system is designed to serve a population of about 1,200 and Town staff believes that at peak, the system served about 850. The Town intends to expand and improve the wastewater system to accommodate a population of 2,500. (Carnes 2007, Colson 2007 and 2010).

3.15.5 Local Government Fiscal Conditions

Natural gas development in the project area would affect certain local, state, and federal government revenues and expenditures. Affected revenues would include ad valorem property tax revenues of Carbon and Sweetwater counties; Carbon County School District #1, Sweetwater County School District #1 and certain special districts; sales and use tax revenues of the State of Wyoming, the two counties, and their municipalities; state severance taxes; and federal mineral royalties. The two counties and the affected school districts, special districts, and municipalities would also see increases in expenditures to serve development and associated population growth. This section describes existing conditions and trends in the local government jurisdictions that are likely to be affected by the proposed CD-C project.

3.15.5.1 County Fiscal Conditions and Trends

Ad Valorem/Property Tax Trends

Ad valorem taxes, commonly known as property taxes, constitute an important share of the revenue base of Carbon and Sweetwater Counties, and for local school districts. The basis for local property taxes in Wyoming is the assessed valuation of real and personal property, utilities, and mineral production. Driven largely by increases in mineral valuation, the ad valorem tax base has grown substantially over the past decade, despite a sharp drop from 2009 to 2010 (see **Figure 3.15-6**). Sweetwater County total assessed valuation exceeded $2.1 billion in 2010; nearly $900 million lower than in 2009 but still nearly double the $1.1 billion recorded in 2000. Assessed valuation also climbed dramatically in Carbon County over the past decade, from $337 million in 2000 to nearly $800 million in 2010. The net change in Carbon County included jumps of more than $200 million from 2005 to 2006 and from 2008 to 2009, but a sharp decline of more than $450 million from 2009 to 2010.

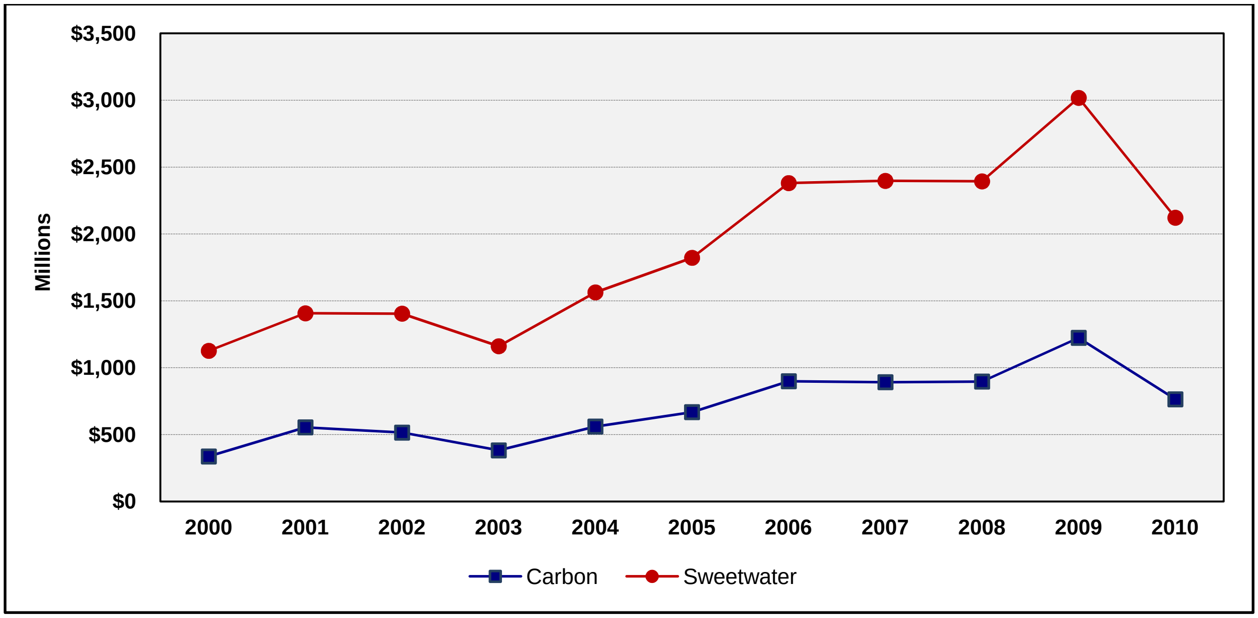


Figure 3.15-6. Total assessed value, Carbon and Sweetwater Counties, 2000–2010

Source: Wyoming Department of Revenue, 2003–2010.

Valuation on oil and gas production has accounted for most of the changes in assessed value, more than quadrupling between 2000 and 2009 in Carbon County and tripling in Sweetwater County. That growth reflected both rising energy prices and increased production. As a result of that growth, the assessed value on minerals currently accounts for approximately 80 percent of the total valuation in both counties. However, as is readily apparent locally, these valuations are subject to substantial year-to-year volatility due to the volatility in global energy prices. Between 2009 and 2010, the assessed value of mineral production in these counties declined by nearly 50 percent in Carbon County and over 40 percent in Sweetwater County.

Sales and Use Tax Conditions and Trends

Another key source of revenue for counties and incorporated communities are sales and use taxes imposed by the state and, when approved by the local electorate, the counties themselves. The state sales and use tax of 4 percent is collected based on the point of sale, a share of which is redistributed back to local governments. The share returned to counties and incorporated municipalities (a statutorily prescribed amount, currently 31 percent of statewide total receipts) is on a population-based formula, irrespective of where the sales were generated. Counties can elect to impose a 1-percent general-purpose local tax and a 1-percent specific-purpose tax for capital improvements. Carbon and Sweetwater Counties currently each impose the general-purpose 1-percent levy and Carbon County imposes the 1-percent special-purpose option tax. The state collects these taxes and distributes the local share based on the above-referenced formula.

Figure 3.15-7 and **Tables 3.15-5** and **3.15-6** summarize the sales, use, and lodging tax distributions by the state to the two counties in recent years. The reported distributions include both the full distribution of local-option taxes and the respective county's proportional share of the state taxes. The tables also show the total amount of sales and use tax receipts collected from each of the counties for activities occurring within their respective boundaries, providing a comprehensive measure of the changes in taxable sales activity over the period.

Figure 3.15-7 displays the general pattern of growth and then decline in recent years in response to the level of natural gas development and related capital investment, for example, in compression and pipeline transmission capacity. Declines of approximately 30 percent occurred in each county between 2009 and

2010; the absolute declines amounting to more than $39 million in Sweetwater County and more than $8 million in Carbon County.

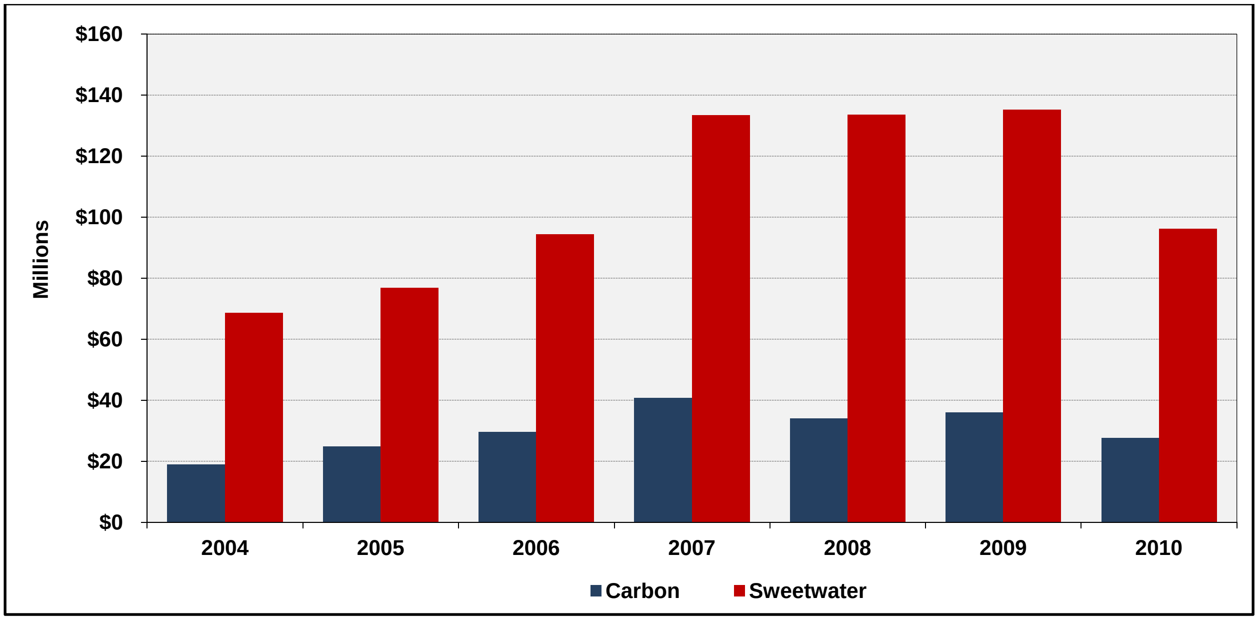


Figure 3.15-7. Annual sales and use tax distributions to Carbon and Sweetwater Counties, fiscal years 2004–2010

Source: Wyoming Department of Revenue, Annual Reports.

As shown above and in **Table 3.15-5**, total sales and use tax revenues distributed to Carbon County, largely reflecting the increase in natural gas development activity, more than doubled from 2004 to 2007, then declined to just over $34 million in 2008 as a 1-percent specific-purpose local-option tax expired. Continuing natural gas development activity, along with construction activities at the Sinclair refinery supported a modest increase in receipts to $36 million in 2009. Completion of the major construction activities at the refinery and the effects of the recession on the statewide and local economies took hold in 2010, resulting in a decline of more than $8 million. The significance of the local-option taxes is readily apparent, generating more than $13.0 million in sales and use tax revenues for Carbon County in 2007. The total local-option tax receipts declined to $9.0 million in 2010.

Table 3.15-5. Annual sales, use, and lodging taxes generated by sales in Carbon County, by levy

Tax Levy	Fiscal Year				
	2006	2007	2008	2009	2010
General-purpose local sales	$4,481,031	$5,466,724	$ 5,625,450	$6,293,772	$3,955,550
General-purpose local use	409,374	1,368,627	1,077,816	717,474	596,977
Specific-purpose local sales	4,450,047	4,879,915	50,200	454,429	3,924,130
Specific-purpose local use	407,808	1,306,446	- 21,491	87,900	598,009
State sales	17,924,890	21,867,275	22,502,258	25,175,135	15,822,251
State use	1,637,544	5,475,415	4,311,431	2,871,311	2,387,907
Lodging	307,846	405,083	472,174	432,060	377,233
Total revenue generated	**$29,618,540**	**$40,769,485**	**$34,017,838**	**$36,032,081**	**$27,662,057**

Sources: Wyoming Department of Revenue, Annual Reports, and Wyoming Department of Administration and Information, Wyoming Sales, Use, and Lodging Tax Report, Annual Series 2002–2010.

Sweetwater County sales and use taxes generated by local activity have increased sharply over time. Much of the growth reflects the effects of economic expansion through 2009, although locally levied specific-purpose local-option taxes have generated more than $20 million annually from 2007 to 2009. Sales and use tax revenues declined by $39 million between 2009 and 2010, a 29 percent decline. The high level of sales and use tax attributable to the mining sector in Sweetwater County reflects the trona and coal-mining base within the county as well as oil and gas development (**Table 3.15-6**).

Table 3.15-6. Annual sales, use and lodging tax generated by sales in Sweetwater County, by levy

TAX LEVY	Fiscal Year				
	2006	2007	2008	2009	2010
General-purpose local sales	$15,520,807	$ 18,621,968	$ 17,756,577	$ 18,886,147	$14,120,339
General-purpose local use	2,813,858	3,571,329	4,385,679	3,561,457	2,915,227
Specific-purpose local sales	1,789,959	18,217,172	17,688,132	18,781,477	8,969,716
Specific-purpose local use	310,554	3,551,219	4,431,882	3,604,861	1,579,204
State sales	62,122,000	74,528,846	71,058,754	75,549,214	56,495,696
State use	11,255,462	14,285,373	17,543,373	14,247,199	11,661,191
Lodging	551,209	691,139	742,203	704,232	516,051
Total revenue generated	**$94,363,849**	**$133,467,046**	**$133,606,600**	**$135,334,587**	**$96,257,424**

Source: Wyoming Department of Revenue, Annual Reports; and Department of Administration and Information, Wyoming Sales, Use, and Lodging Tax Report, Annual Series, 2002–2010.

The mining industry is a major generator of state and local sales and use tax revenues in Carbon County and changes in mining activity, including new oil and gas development, translate into differences in tax receipts. The receipts yield fiscal benefits statewide through various redistribution formulas.

Sales and use tax collections reported by the mining industry for the five years immediately preceding the recent economic recession exceeded $145 million, representing approximately 25 to 30 percent of the total annual revenues generated by the state sales and use tax levies in the two counties during that period (**Table 3.15-7)**. These revenues are derived largely from oil and gas development, and of that total, approximately 51 percent accrued to the state coffers or was distributed to other communities.

Table 3.15-7. Annual sales and use tax collections by the mining industry in Carbon and Sweetwater Counties, 2006–2010

	Fiscal Year				
	2006	2007	2008	2009	2010
Sales and Use Taxes Collected by the Mining Industry in Carbon County					
Total state sales and use (from Table 3.15-5 above)	$19,562,434	$27,342,690	$26,813,689	$28,046,446	$18,210,158
State sales and use tax reported by mining	5,006,293	8,172,047	7,570,549	8,017,405	3,540,632
Percent by mining	25.6%	29.9%	28.2%	28.6%	19.4%
Sales and Use Taxes Collected by the Mining Industry in Sweetwater County					
Total state sales and use (from Table 3.15-6 above)	$73,377,462	$88,814,219	$88,602,127	$89,796,413	$68,156,887
State sales and use tax reported by mining	19,534,344	26,514,528	25,192,508	25,948,033	15,644,884
Percent by mining	26.6%	29.9%	28.4%	28.9%	23.0%

Sources: Wyoming Department of Revenue, Annual Reports, and Wyoming Department of Administration and Information, Sales and Use Tax Distribution Reports, Annual Series 2002–2010.

3.15.5.2 County Revenues and Expenditures

Property, sales, and use taxes combine to account for the major share of county revenues. However, counties have many other revenue sources, ranging from fees for services to federal payment-in-lieu-of-taxes, and distributions of severance tax and mineral royalties from the state. Historically, Carbon County also has received various grants to address capital needs, but the amount and timing of such grants is highly variable.

Table 3.15-8 shows total fund revenues and expenditures in several broad categories for Carbon County's general fund over the past three fiscal years. As shown, property tax receipts increased by $2.7 million from 2009 to 2010 in response to increases in assessed valuation, driven primarily by mineral valuation. Budgeted expenditures for selected departments that tend to be sensitive to growth increased from 2008 to 2009 and were budgeted to increase again in 2010. However, as described elsewhere, the economic downturn and reduction in the pace of development had noticeable adverse effects on revenues; actual revenues from sources other than property taxes were 40 percent below the budgeted sums. Consequently, the County's total general fund revenue was 22 percent below budget, requiring substantial reductions in operating outlays, deferral of planned capital outlays, and use of reserve funds. While the recession may have resulted in some reductions in service demand, the severity of the cutbacks resulted in diminished levels of service for county residents.

Table 3.15-8. General fund revenues and expenditures, Carbon County

	FY2008 Actual	2009	2010 Original	2010 Adjusted Actual	Change 2010 Original vs. Adjusted
General Fund Revenue					
Property tax revenue	$ 9,603,868	$ 9,700,506	$12,472,882	$12,472,882	0%
Other revenue	11,999,836	12,156,935	15,976,118	9,593,391	-40%
Total revenue	**$21,603,704**	**$21,857,441**	**$28,449,000**	**$22,066,273**	**-22%**
General Fund Expenditures					
Select departments					
• Criminal justice	$ 1,507,178	$ 1,674,792	$ 1,743,346	$ 1,691,878	-3%
• Sheriff	1,467,007	1,704,024	2,139,065	1,654,892	-23%
• Jail	1,749,921	1,913,701	3,032,959	2,583,053	-15%
• Road and bridge	2,310,140	3,393,772	3,253,057	2,015,528	-38%
Select departments subtotal	**$ 7,034,246**	**$ 8,686,289**	**$10,168,427**	**$ 7,945,351**	**-22%**
All other departments	13,414,088	13,277,770	31,176,149	12,826,271	-59%
Total General Fund Expenditures	**$20,448,334**	**$21,964,059**	**$41,344,576**	**$20,771,622**	**-50%**

[1] *Other includes all other departments, budgeted capital outlays and closing balances/reserves. The 2010 original budgeted expenditures included anticipated receipts of a $10 million grant.*

Source: Carbon County, County Budget, FY 2008-10.

Table 3.15-9 shows similar general-fund budget data for Sweetwater County. There too, the effects of the recession are apparent in declines in revenues and general fund expenditures from fiscal year 2008 to 2009. Sweetwater County realized a net increase in tax revenues between 2009 and 2010, primarily derived from property taxes on mineral production which more than offset declines in sales and use tax receipts. Due to the lags between production and taxation on mineral valuation, a substantial reduction in property tax revenues and further reductions in sales and use taxes are anticipated for the 2011 budget year.

Table 3.15-9. General fund revenues and expenditures, Sweetwater County (in millions)

	FY2008	FY2009	FY2010
General fund revenue			
Property tax revenue	$18.54	$19.25	$28.51
Other revenue, excluding transfers	24.73	20.94	18.97
Total revenue	**$43.27**	**$40.19**	**$47.48**
General Fund Expenditures			
• General government	$27.79	$17.25	$18.52
• Public safety	11.16	10.21	14.38
• Road and bridge	5.50	4.43	4.41
• Other miscellaneous	0.21	0.22	1.30
• Capital outlay	0.00	7.32	5.57
Total expenditures	**$44.66**	**$39.43**	**$44.18**
• Changes in reserves	($1.39)	$0.76	$3.17

Source: Sweetwater County, Sweetwater County Budget Audit Reports, FY 2009 and 2010.

Figure 3.15-8 summarizes the total annual general fund revenues for Carbon and Sweetwater Counties for fiscal years 2004 through 2010, illustrating the volatility in tax revenues associated with natural-resource development. Because the timing and magnitude of the changes are often not foreseeable and can come about relatively quickly, the year-to-year changes in revenues, coupled with the subsequent implications for budgeted expenditures, pose important challenges for local government The challenges can be particularly acute with respect to planning and funding large-scale capital improvement projects and to expanding current services during periods of rapid growth.

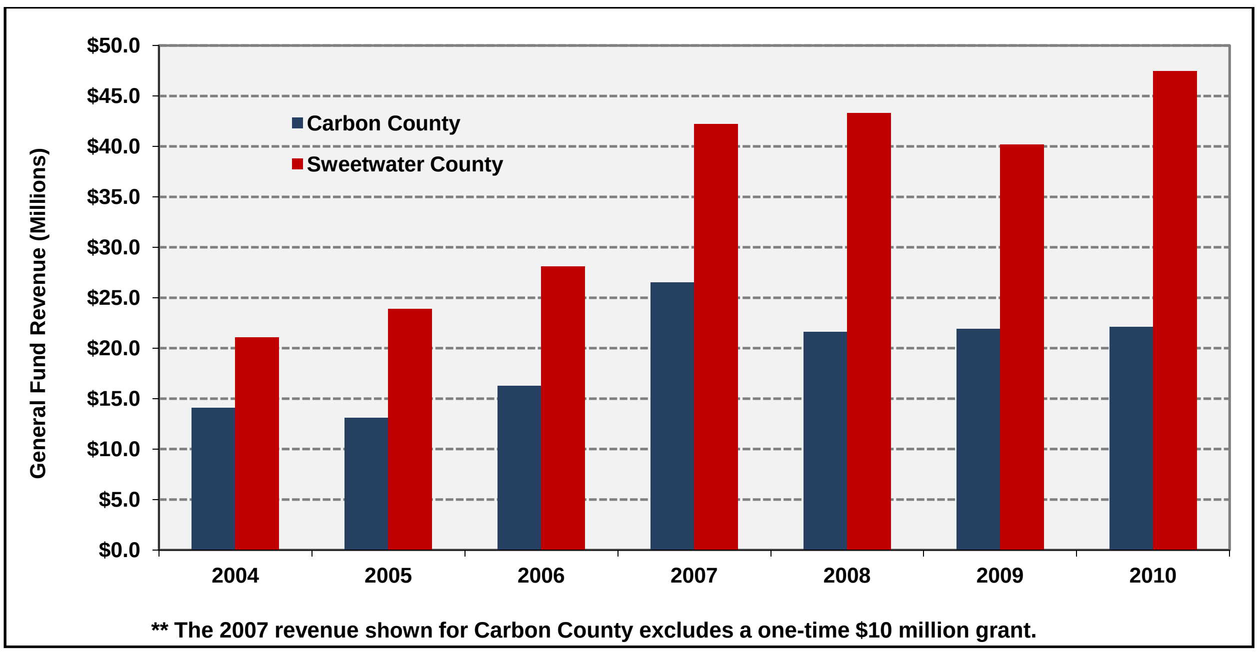


Figure 3.15-8. General fund revenues for Carbon and Sweetwater Counties, 2004–2010

3.15.5.3 Municipal Fiscal Conditions and Trends

Property Taxes

Property taxes are a less significant, but still important revenue source, for municipalities than for counties. Unlike county-wide valuations that rely heavily on mineral valuation, municipal valuations are more heavily based on the real estate. The dependency on real estate reduces the volatility in year-to-year valuations for municipalities, as compared to that for counties. Because of the latter factor, trends in assessed valuation are important indicators of local economic growth.

As shown in **Table 3.15-10**, Green River, Rawlins, and Rock Springs have relatively large ad valorem tax bases, while the three smaller communities have much smaller property tax bases. The most significant trends disclosed by these data include the strong growth in valuations among the three large communities, and the recent declines in Wamsutter's property tax base following its peak of $5.4 million in 2006. Rock Springs saw a 136-percent increase in assessed value between 2003 and 2010 due to its emergence as a regional service center for natural gas development, resulting in an assessed value nearly four times that of Rawlins and over twice that of Green River.

Table 3.15-10. Total assessed value, affected cities and towns

	Fiscal Years					Change 2006-10
	2006	2007	2008	2009	2010	
Green River	$ 55,080,205	$64,197,337	$75,527,179	$76,962,206	$76,067,639	38.1%
Rawlins	31,466,624	40,026,026	46,593,587	51,449,273	50,599,959	60.8%
Rock Springs	119,965,719	146,505,485	179,056,974	194,302,844	191,988,774	60.0%
Baggs	1,253,046	1,740,673	2,061,521	3,363,378	2,733,582	118.2%
Wamsutter	5,438,372	1,804,230	2,791,829	3,988,816	3,942,481	-27.5%

Source: Wyoming State Board of Equalization, 2009 and 2010, and Wyoming Taxpayers Association, 2007 to 2008.

Sales and Use Tax Distributions

Sales and use taxes are typically the single largest source of general-fund revenue for municipalities. That pattern applies to the affected municipalities in the project area. **Table 3.15-11** shows the annual sales and use tax distributions reported by the state to each of the six potentially affected communities from 2005 through 2010. The comparative distributions among the communities generally reflect their relative sizes, as well as differences in the level of economic activity and growth associated with the natural gas industry.

Table 3.15-11. Total annual sales and use tax distributions, cities and towns

	Fiscal Year						Change
City/Town	2005	2006	2007	2008	2009	2010	2009-10
Green River	$10,177,818	$12,668,279	$15,299,399	$15,252,520	$15,458,494	$11,728,814	-24%
Rawlins	5,252,016	6,336,901	8,594,271	8,417,212	8,808,209	5,695,922	-35%
Rock Springs	16,429,886	20,471,622	24,239,596	24,165,324	24,491,659	18,582,542	-24%
Baggs	205,710	245,475	332,090	325,249	340,357	220,096	-35%
Wamsutter	228,118	282,659	338,173	337,136	126,988	259,250	104%

Source: Wyoming Department of Revenue, Sales and Use Tax Distribution Reports.

As shown above, the local municipalities experienced substantial declines in sales and use tax distributions as the economic recession continued. In Rock Springs the total distribution dropped by $5.9 million, or 24 percent. Rawlins experienced a larger decline, in relative terms, of 35 percent. The unforeseen magnitude of these declines necessitated mid-year revisions in budgets, which translated to responses such as staff layoffs, deferral of planned hiring, cutbacks in services and programs, and cancellation or deferral of capital-improvement spending.

Municipal Revenue and Expenditures

Summaries of municipal general-fund revenues and expenditures were developed from budget documents of the selected cities and towns. These summary budgets are presented in **Tables 3.15-12** through **3.15-15**. Although the organization of funds and level of detail provided in the municipal budgets varies among the communities, the summary budgets attempt to present comparable information for each municipality by assigning all revenues and expenditures to one of a broadly defined set of categories. Two conventions should be noted. First, the income category of "taxes" includes sales and use taxes returned to the municipalities by the state. Several of the source-document budgets listed such payments as "intergovernmental revenue." Conversely, some "taxes" such as severance tax and mineral royalties are included in the summaries as "intergovernmental" even though some local budgets classified them under the "tax" heading. Second, in preparing the expenditure summaries, multiple departments are grouped into six categories with descriptive titles that do not necessarily mean only the department with a similar name. For example "public works" in the table could include the Public Works department, but also Streets, Engineering, Shops, Building Maintenance, and other physical facility and plant construction and maintenance activities.

City of Rawlins

Table 3.15-12 summarizes general-fund budget data for three years of recent budgets for the City of Rawlins. General fund revenues and expenses will effectively equalize over the long term, but there may be variances in any one year due to inter-fund transfers, contributions to or from reserves, and varying year-end cash balances. In Rawlins, budgeted revenue was anticipated to increase modestly over the three-year period, with approximately half of the total revenue from taxes. On the expenditure side, public safety accounts for the largest share of outlays.

Table 3.15-12. General fund revenue and expenditures, City of Rawlins

	2007-08 Actual	2008-09 Budget	2009-10 Preliminary Budget	Change 2007-08 to 2009-10
General Fund Revenue				
Taxes	$ 7,454,450	$ 7,468,667	$ 8,348,500	12.0%
Franchises	359,000	394,000	430,000	19.8%
Intergovernmental	2,969,635	2,547,347	2,380,139	-19.9%
Charges for services	1,053,513	1,077,050	1,030,200	-2.2%
Police and court	354,700	387,400	390,900	10.2%
Other revenue	119,500	82,900	71,140	-40.5%
Transfers in	425,850	483,610	687,497	61.4%
Beginning balance	2,638,736	3,820,237	3,593,656	36.2%
Total Revenue	**$15,375,384**	**$16,261,211**	**$16,932,032**	**10.1%**
General Fund Expenditures				
Administration	$ 2,511,368	$ 2,652,215	$ 3,097,286	23.3%
Courts	287,597	289,915	284,631	-1.0%
Public safety	4,666,059	5,059,741	5,234,031	12.2%
Public works	2,482,836	2,426,548	2,937,439	18.3%
Parks & recreation	1,623,278	1,291,187	1,314,228	-19.0%
Miscellaneous	617,235	842,476	1,037,273	68.1%
Capital improvements	1,060,242	1,473,192	274,349	-74.1%
Ending balance	2,026,769	2,225,937	2,752,795	35.8%
Total Expenditures	**$15,275,384**	**$16,261,211**	**$16,932,032**	**10.8%**

Source: City of Rawlins, Budget Worksheet, FY2009-10.
Note: Taxes include state-rebated sales and use tax.

Revenue shortfalls beginning in 2009 and continuing through 2010 necessitated amending the use of reserves, and cutbacks of more than $1.1 million in city spending to address the resulting deficit. The cutbacks included a reduction of 16 positions through attrition or layoffs.

The proposed budget for 2010-2011 calls for another $1.1 million reduction in expenditures, with periodic reviews to monitor revenues, particularly sales and use tax proceeds. If necessary, the city may draw on its reserve account to preserve essential services.

City of Rock Springs

The City of Rock Springs has an annual general-fund budget more than twice that of Rawlins, with taxes again the largest single contributor to revenue (see **Table 3.15-13**). The City's anticipated general revenues exhibit substantial year-to-year revenue variability due to transfers and unexpected changes in local economic activity.

The City's total budgeted general-fund expenditures decreased by 28 percent over the past 3 years. Sharp cutbacks in the budgets for public works and parks and recreation accounted for most of the reduction, while the budget for administration increased by about $2.1 million.

Table 3.15-13. General fund revenue and expenditures, City of Rock Springs

	2008-2009 Actual	2009-2010 Actual	2010-2011 Budget	Change 2010-2011
General Fund Revenue				
Taxes	$ 3,647,055	$ 3,762,761	$ 2,932,782	-22%
Intergovernmental	34,175,579	35,645,049	31,573,137	-11%
Charges for services	1,388,822	1,350,393	1,377,425	2%
Fines and forfeitures	518,009	572,146	518,250	-9%
All other, including transfers	3,234,759	5,638,559	1,833,039	-67%
Total revenue	**$42,964,224**	**$46,968,908**	**$38,234,633**	-19%
General Fund Expenditures				
Administration	$ 8,163,156	$ 8,571,182	$10,309,818	26%
Municipal Court	398,800	430,351	439,101	10%
Parks & Recreation	20,605,894	10,613,992	8,578,928	-58%
Public Safety	13,297,227	12,802,508	12,376,084	-7%
Public Works	11,484,602	11,956,730	7,343,680	-36%
Total expenditures	**$53,949,679**	**$44,374,763**	**$39,047,611**	**-28%**

Note: Taxes include state-rebated sales and use tax.
Sources: City of Rock Springs, Final Budget 2008–2009, 2009-2010, and 2010-2011.

City of Green River

As indicated in **Table 3.15-14**, Green River's general-fund revenues have declined by 27 percent over the last three years, with reductions in taxes comprising the majority of the decline. During the same period, total general fund expenditures increased by about 9 percent; the increase funded through the use of reserves.

Table 3.15-14. Revenue and expenditures, City of Green River

	2008–2009 Actual	2009–2010 Budget	2010–2011 Budget	Growth 2008-10
General Fund Revenue				
Taxes	$ 17,290,036	$ 12,612,606	$ 11,858,377	-31%
Intergovernmental	2,788,802	3,325,009	2,927,386	5%
Charges for services	492,437	426,700	449,150	-9%
Other & Miscellaneous	1,387,866	829,200	711,200	-49%
Total revenue	**$ 21,959,141**	**$ 17,193,515**	**$ 15,946,113**	**-27%**
General Fund Expenditures				
Administration	$ 3,010,274	$ 3,464,791	$ 3,284,419	9%
Courts	5,119,193	5,555,267	5,526,219	8%
Public safety	2,450,853	2,746,938	2,830,292	15%
Public works	727,121	844,111	974,537	34%
Parks & recreation	4,364,043	4,878,946	4,918,062	13%
Total expenditures	**$ 15,671,484**	**$ 17,490,053**	**$ 17,533,529**	**9%**

Notes: Taxes include state-rebated sales and use tax.
Source: City of Green River, Annual Budgets Fiscal Year 2008, 2009 and 2010.

3.15.6 Schools

Three school districts could be affected by the CD-C project:

- Carbon County School District #1 (CCSD #1)
- Sweetwater County School District #1 (SCSD #1)
- Sweetwater County School District #2 (SCSD #2)

Figure 3.15-9 displays 1991–2010 fall enrollment statistics for the three affected school districts. All three districts had substantial enrollment declines through the 1990s and the first several years of the following decade. Thereafter all three districts experienced enrollment gains in concert with population growth associated with the increased pace of natural resource development. Enrollment gains continued in CCSD #1 and SCSD #2 through 2007 and 2008, respectively, but stabilized somewhat in subsequent years. Enrollment in SCSD #1 has grown steadily over the past seven years, gaining more than 960 students since 2003. Fall 2010 enrollment counts, covering kindergarten through grade 12, were 1,810 for CCSD #1, 2,635 for SCSD #2, and 5,159 for SCSD #1.

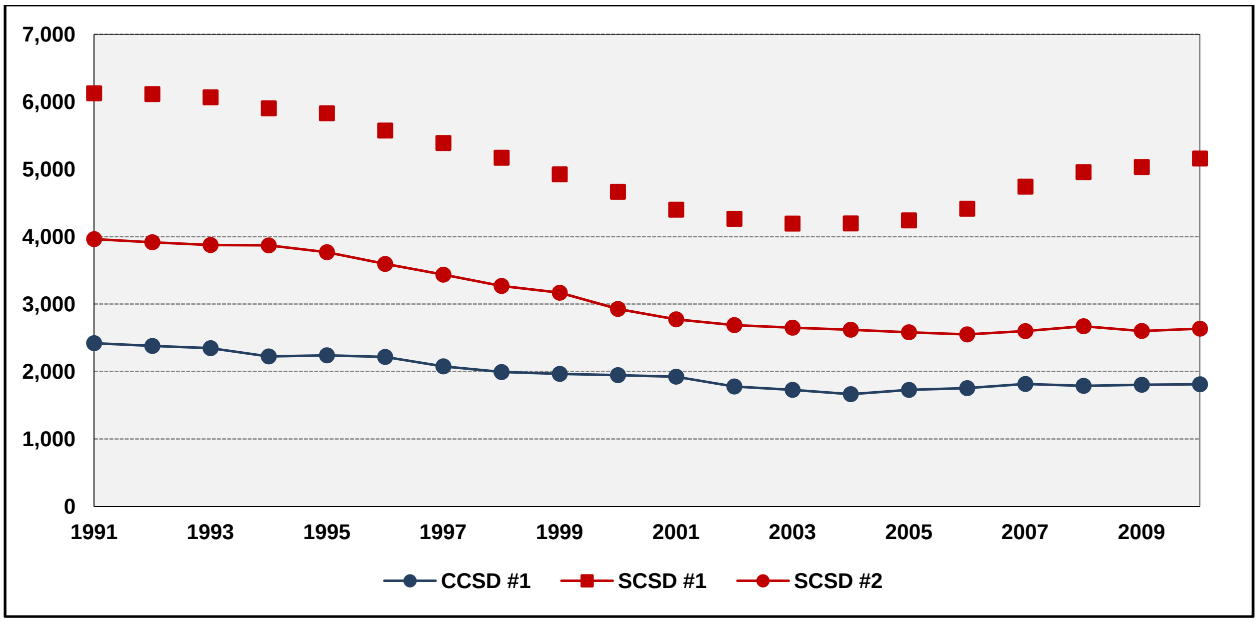


Figure 3.15-9. Fall enrollment, Carbon County School District #1 and Sweetwater County School Districts #1 and #2, 1991–2010

Source: Wyoming Department of Education 2010, 2011.

The differences in enrollment levels are reflected in their respective annual operating budgets and level of staffing (see **Table 3.15-15**). The pupil/teacher ratios for all three districts are slightly above the statewide median.

Table 3.15-15. School district revenue, staffing, and enrollment, 2009

	Fiscal Year 2009		
	CCSD #1	SCSD #1	SCSD #2
Total Revenue	$19,717,769	$84,586,170	$52,736,915
Staff (FTE)			
• Teachers	137.9	356.5	200.4
• Others	139.6	483	264.9
Total	277.5	839.5	465.3
Enrollment	1,727	4,955	2,669
Pupil/Teacher Ratio	12.5	13.9	13.3

Source: Wyoming Department of Education 2009.

All districts have historically had difficulty finding affordable housing for teachers. The districts have also occasionally had difficulty in recruiting and retaining maintenance and custodial staff and bus drivers during periods of economic expansion when labor shortage and the high wages paid in the energy industry put the districts at a competitive disadvantage for labor (Grube 2007, Sanders 2007, Sorenson 2007).

3.15.6.1 Carbon County School District #1

CCSD #1 serves Rawlins, Sinclair, and the Little Snake River Valley (LSRV), including the communities of Baggs and Dixon and the Sweetwater County community of Bairoil. Currently CCSD #1 operates two elementary schools, a middle school, a high school, and a cooperative high school in Rawlins; elementary schools in Sinclair and Bairoil; and a K–12 comprehensive school in Baggs that serves the entire LSRV. Additionally the district operates a fine-arts center, a swimming pool, and a sports complex in Rawlins.

The Rawlins Elementary School opened in early 2011. It currently has two learning communities, (grades 2–3 and grades 4–5). The school is designed to allow the addition of a K–1 community. Currently, kindergarten and first-grade students are housed in the adjacent Highland Hills Elementary School, which is at capacity. Rawlins Elementary could accommodate an additional 100 students over the 2010–2011 school year enrollment. The Rawlins Middle School can accommodate an additional 50 to 75 students. The Rawlins High School was designed to accommodate 1,100 to 1,200 students and fall enrollment was 455 students. The high school is an aging and outsized facility that is inefficient to operate. The Wyoming School Facilities Commission has authorized construction of a new 500-student high school, but the district believes it will need capacity for 600 students given pending energy projects in the area. Sinclair elementary is approaching capacity and the Little Snake River K–12 school could accommodate an additional 40 or more students (Terhune 2011).

3.15.6.2 Sweetwater County School District #1

SCSD #1 serves eastern and central Sweetwater County, including the communities of Rock Springs, Farson, Eden, Superior, and Wamsutter. SCSD #1 has seven elementary schools, one junior high school, and two high schools (one traditional and one alternative) in Rock Springs. The district opened the new Pilot Butte Elementary, a 5–6 grade school, in the fall of 2011. SCSD #1 also operates a K–12 school in Farson; and a K–8 school in Wamsutter. The district closed eight schools between 1991 and 2003 due to declining enrollments.

SCSD #1 has proposed to build an additional 5–6 grade school and a new junior high school. Longer-term plans include replacing the high school. School construction plans are subject to approval by the Wyoming School Facilities Department.

With new and planned facilities, SCSD #1 should be able to accommodate an additional 60 students per grade in the elementary schools. The new junior high school will have additional capacity, but the high school is currently near capacity with anticipated increases in enrollment in the coming years. The district has a plan to relocate a portion of the school to a satellite facility. The Wamsutter K–8 school currently has enrollment of about 8 to 12 students per classroom and could accommodate up to 23 students per classroom (Lopiccolo 2011).

3.15.6.3 Sweetwater County School District #2

SCSD #2 serves the western half of Sweetwater County including the communities of Green River, Granger, and McKinnon. SCSD #2 operates a high school (grades 9–12), an alternative high school (grades 10–12), a middle school (grades 7–8), and an intermediate school (grades 5–6). The District also maintains four K–4 elementary schools within the city limits and three rural elementary schools. The district has closed two elementary schools since 1990 due to declining enrollment.

It is estimated that the four Green River K–4 elementary schools could accommodate a combined total of an additional 110 students and the 5–6 elementary school could accommodate an additional 20 students. There is some capacity to absorb new students in the middle school. The high school has a design capacity of 1,200 to 1,500 students and currently serves about 700 students (Little-Kaumo 2011).

3.15.7 Social Conditions and Trends

This section describes relevant social conditions and trends within in and near the CD-C project area. Specific social conditions associated with other users of the project area (grazing operators and recreationists) are also examined. Information for this section was obtained from over 60 interviews with community officials, local government staff, business persons, and ranchers; from review of scoping comments and newspaper articles; and from other secondary sources as cited.

Section 2 of the Baseline STR describes the human geography of the study area, discusses human settlement of the area, characterizes the communities, and describes the economic influences that have helped shaped the region and the individual communities. Although these communities share elements of a common heritage and regional geography, each has its own distinct economic, demographic and social setting.

3.15.7.1 Common Social Elements and Trends

Over the past decade, the communities in the study area experienced an economic expansion fueled by energy development in the project area and elsewhere in the bi-county region and in much of southwest Wyoming, and then a rapid contraction resulting from the sub-prime mortgage crisis, the ensuing global recession, and falling energy prices. The social effects of the recent expansion and contraction provide valuable insights into potential effects of the Proposed Action and alternatives on social conditions in the area.

The recent expansion was the latest in a series of regional economic expansion and contraction cycles dating back to the construction of the transcontinental railroad but more recently associated with mineral and energy development. The larger communities in the study area have a somewhat economically diverse population resulting from the influences of the ranching, energy, mining, and transportation industries and federal and state government offices and facilities. Wamsutter, Baggs and the other smaller communities are much less diverse economically. Wamsutter, although formerly a railroad and wool-shipping center, has recently become dependent on the energy industry and I-80 commerce. Of the communities in the study area, Baggs and the LSRV remain most closely tied to the ranching and outdoor recreation (principally hunting) industries, although a number of residents of Baggs and the LSRV are employed by or provide services to the energy industry and Devon Energy operates a field office in Baggs.

Even during the current (mid-2011) economic contraction there are reduced levels of energy development activity and in- and out-migration associated with the energy and mining sectors. Communities in the study area are familiar with energy industries and with the relatively constant stream of newcomers to these communities. However, during the recent expansion, which began in 2002/2003 in Sweetwater County and 2004/2005 in Carbon County, economic and population growth occurred at levels not seen for more than two decades in these two counties. Local communities are in agreement that federal and state population statistics did not reflect the magnitude of growth and there were no reliable estimates of the number of energy workers who stayed in communities on a temporary basis.

As a result of the economic and population growth and the presence of relatively large numbers of temporary and transient, predominantly male workers in these communities, social conditions in affected communities were changing at a relatively rapid pace. Many of the “boom-town” phenomena (e.g. housing shortages and escalating housing costs, workforce shortages, elevated rates of certain types of crime) reported by researchers in the late 1970s and early 1980s once again emerged. Social settings within the study area such as stores, restaurants, bars, and post offices were increasingly crowded and from a local resident’s perspective, filled with strangers. Traffic on major streets and thoroughfares in Rock Springs and Rawlins was often congested (relative to past years), housing prices increased substantially, and local retail and service establishments had difficulty obtaining and keeping employees.

There were enthusiastic supporters of the boom and just-as-ardent detractors in all communities. But even some of the supporters lamented the change in social conditions, e.g., “feeling the need to lock their houses and take the keys out of their cars, entering a supermarket or restaurant and not seeing a familiar face, having to wait for two stoplight cycles to cross an intersection.” For many, these inconveniences were offset by the robust economy and the increase in employment and shopping options. Others, including those who did not benefit from energy development and those on fixed incomes, were less likely to be enthusiastic about the boom.

Many residents of Carbon and Sweetwater counties value clean air and water, wildlife, wildlife habitat, and access to and the health of public lands (Blevins *et al.* 2004, Carbon County Board of Commissioners and Carbon County Planning Commission 1998, Markert 2008). A key concern for many residents is the effect of energy development on public lands, particularly lands with high resource values.

Two groups have been directly affected by natural gas development in the project area: ranchers/grazing permittees and recreation users of the area.

3.15.7.2 Ranchers/Grazing Permittees

Information for this section was obtained in the spring of 2008 from individual and group interviews with grazing permittees, the Rawlins-based UW Cooperative Extension Area Educator for Range Management, and the RFO Range Resources Specialist assigned to the CD-C EIS. As discussed in **Section 3.18 Range Resources**, 47 allotments are permitted for grazing within the project area. Many of these allotments extend beyond the boundaries of the project area. The active allotments are permitted for about 199,000 animal unit months (AUMs) of grazing per year used mostly by cattle, although sheep are grazed on 11 allotments.

Many of the affected livestock operations that use the project area are locally owned, multi-generational family ranches. A combination of long-term drought, high fuel and feed prices, unfavorable market conditions, and the high level of existing natural gas development within the allotments has resulted in challenging times for grazing permittees, causing some to substantially alter their methods of operation and even consider relinquishing their allotments.

In the most active natural gas fields within the project area, the predominant land use has changed from grazing/dispersed recreation to industrial. The project area contains roads with some of the highest traffic volumes in Carbon and Sweetwater counties, including high volumes of heavy-truck traffic. The high traffic volumes within the project area produce substantial amounts of dust on all but the major roads, which have been treated with magnesium chloride.

Natural gas development can affect grazing operations in several ways. Effects include livestock injury/mortality, reduced rates of weight gain in livestock, increased maintenance of range improvements, and required changes in livestock management practices.

Heavy traffic during the drilling and field-development phase often results in conflict with livestock operations. Vehicle/livestock collisions are not uncommon and, although some natural gas companies compensate permittees for livestock mortality, accidents are not reported in many cases. Responsibility is difficult to assign in areas used by multiple gas companies, and some service companies are less willing to compensate livestock owners. Companies are, in general, unwilling to compensate grazing permittees unless a driver accepts or is assigned responsibility for the accident. Gas-field traffic is of particular concern during lambing and calving periods, when animals sometimes use the roads to give birth and newborn animals are less able to move out of the way of oncoming traffic. In addition to animal losses from accidents, livestock lose weight if they are frequently startled by traffic. Some permittees have stopped trailing their herds along WY 789, the Wamsutter–Dad Road, and other major county and BLM roads within the project area because of the high volumes of industrial traffic, resulting in higher costs to move livestock by truck from pastures on one side of the road to the other.

High levels of gas-field traffic can increase damages to range improvements such as fences and cattle guards, resulting in scattering of livestock from pastures and introduction of other livestock and wild horses into pastures. During severe winters, when natural gas company contractors clear snow for some distance on either side of road surfaces to remove heavy snow accumulations, damage to cattle guards and sections of fence often occurs. As a result, some permittees are unable to use some pastures in the spring, which has disrupted grazing patterns and resulted in unbudgeted costs to relocate livestock. Although in most cases gas companies compensate grazing permittees for repairing fences and cattle guards, there are sometimes disputes over the amount of compensation, the quality of the replacement fences and structures, and the timeliness of compensation. It is again difficult to assign responsibility for damage in areas where multiple gas and service companies are active; grazing permittees lose the use of the pastures while awaiting repairs, which at times requires an extended period to locate and schedule contractors.

Another concern for livestock grazing permittees is that some gas companies do not notify them in advance of starting new development within a federal grazing allotment. Consequently, affected grazing permittees do not have advance opportunity to relocate herds to avoid conflict with development. Although required by regulation, some drilling contractors do not adequately fence drilling facilities such as reserve pits, resulting in livestock injury or mortality.

New and improved roads are at times beneficial for grazing permittees in that they allow better access to pastures and livestock. However, new and improved roads also facilitate higher travel speeds for gas-field traffic, increasing the risk of vehicle/livestock accidents. New and improved roads also allow more public access into grazing allotments, increasing the potential for vandalism and disruption of grazing in formerly remote areas. Some grazing permittees report reductions in vandalism in areas that are actively being developed, however, which they attribute to the greater human presence.

An oft-cited effect of high levels of natural gas development is the reduction in forage associated with surface disturbance and infestation of noxious and invasive species when reclamation is delayed or unsuccessful. In areas where development is concentrated, reductions in forage can be substantial. Although a portion of disturbance for well pads, pipelines, roads, and other ancillary facilities is required to be reclaimed within a short period of time, a combination of the prolonged drought and ineffective reclamation methods has resulted in drill pads, pipeline and road corridors, lay-down areas, and pads for ancillary facilities remaining unreclaimed or in a weed-infested state for years. In addition to the direct reductions in forage associated with unreclaimed or weed-infested areas, a substantially larger area is often removed from productive use as a result of wind-blown dust from unreclaimed areas and roads which accumulates on plants, reducing palatability and accelerating wear on livestock teeth. The location of well pads, gathering lines, and roads may also alter surface-water flow patterns, resulting in erosion and loss of vegetative cover and forage.

The combination of high levels of gas-development activity, reduced forage, and drought conditions requires substantially higher levels of livestock management for grazing permittees, as they are required to more frequently monitor livestock condition and movements, relocate livestock more frequently, and round up livestock that have wandered from pastures when fences and cattle guards are down. Sheepherders have been required to avoid grazing and trailing their flocks through certain areas and to find new trails to avoid halogeton infestations, which can be toxic to sheep. Some grazing permittees who formerly wintered cattle on allotments within the project area have had to truck their herds to other areas or other states, in part because of periodic drought years but also in part to avoid natural gas activity during winter months when herd management is more difficult.

Higher levels of livestock management result in higher fuel outlays and labor costs. Fuel costs for grazing permittees in the project area can be substantial given the distance to the allotments from communities and home ranches. Securing ranch hands in Carbon and Sweetwater counties during the boom years was complicated by the regional labor shortage and competition for workers. Some grazing permittees had difficulty competing for workers with the traditionally higher wages paid by the energy industry. More active livestock management, including frequent movement of livestock from pasture to pasture or between allotments to avoid disruptive activity can reduce weight gain in cattle.

All of the above factors result in higher cost, lower production, and reduced profitability for grazing permittees. In addition, although their allotments are less productive because of activity, disturbance, weed infestations and drought, their allotment lease fees are not reduced. The reduced profitability is likely to change the nature of some CD-C area ranching operations and may result in others leaving the ranching business. Grazing permittees interviewed for this assessment reported reductions in herd size, potential selling off of herds, and potential relinquishment of BLM leases.

The ranching economy in Carbon and Sweetwater counties is substantially smaller than the energy economy, but reductions in ranching operations would result in adverse changes in economic diversity in these two counties. Reductions in ranching operations would also have social and cultural implications for the study area. Ranching is an important element of the heritage and culture of Carbon and Sweetwater counties and the State of Wyoming as a whole.

3.15.7.3 Recreation Users of the Area

Substantial changes in the recreation setting within the project area have already occurred. As noted elsewhere in this assessment, an average of about 239 wells/year were drilled within the project area during the 2000-2010 period and there were over 3738 producing wells in the area at the end of 2010.

As discussed in **Section 3.12 Recreation**, hunting—primarily by locals—is the dominant recreation use of lands within the project area. Some pleasure driving to view wild horses or the Red Desert landscape occurs near the specific resources and settings of interest. As noted in Section 3.12, the BLM makes estimates of recreation usage at the field-office level only, so there are no available data on recreation participation and recreation visitor days that are specific to the CD-C project area. Similarly, the WGFD's Hunt Areas extend beyond the boundaries of the project area and the WGFD does not collect statistics for sub areas; it is therefore not possible to assign hunter activities specifically to the CD-C project area. Consequently, data are not available to support the estimation of economic effects of hunting or other recreation activities within the project area. Recreation use in the project area is low overall and seasonal, with most occurring in the fall during the big game hunting seasons. The BLM generally considers the project area to be a recreation resource that attracts some non-residents who have special interests (e.g., wild horses, historic trails, and the Red Desert) but is visited mainly by Wyoming residents, especially those living nearby.

A combination of local residents, residents from elsewhere in Wyoming, and non-residents has historically hunted within the project area, although as noted above, locals are the dominant users and the level of hunting use is relatively low. Adverse effects of existing natural gas development on hunting have resulted from development activity, traffic, and changes in wildlife distribution and abundance. Although the current presence of relatively widely spaced wells is not a deterrent for all hunters, safety issues associated with hunting around natural gas facilities and the change in the recreational setting are believed to be deterrents for many non-local and out-of-state hunters for whom a natural setting is a part of the overall hunting experience. Displacement of hunters from the project area could result in increasing hunting pressure in other areas. There is increasing concern among hunting and wildlife advocacy groups that development in wide expanses of wildlife habitat and migration corridors will have an adverse effect on wildlife populations within an area, which could result in a shift in hunting activity away from the project area.

Some local and non-local groups and individuals value specific areas within and adjacent to the project area including a sage-grouse lek complex southeast of Creston, the Red Lakes Dunes Citizens' Proposed Wilderness and the Chain Lakes WHMA. At the time of this assessment, one well has been drilled in the Chain Lakes WHMA and several wells have been drilled near the part of the Red Lakes Dunes Citizens' Proposed Wilderness and the sage-grouse lek east of Creston.

A growing concern is the increasing amount of big-game poaching occurring in remote areas now accessible on roads improved for natural gas development and an increasing amount of both personal and industrial litter along highways and county, BLM, and private roads. These effects represent a loss in environmental amenity values for local residents, recreational users, and non-users alike.

Cumulative effects of energy development on recreation use of the area is discussed in **Chapter 5** of this EIS, but there is increasing concern among local public officials and residents regarding the direct and indirect effects of the intensive level of current and ongoing energy-related development, including oil and gas development, pipeline construction, and wind energy and transmission line development across southwest Wyoming on the availability and quality of outdoor recreation opportunities and experiences. The potential for adverse effects arise in conjunction with changes in recreational setting, visual character, noise, dust, increased presence of other humans, changes in vegetation, water quality, and presence of wildlife.

3.15.8 Environmental Justice

Environmental justice is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 1998). EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, published in the Federal Register in 1994, tasks "each Federal agency [to] make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Implementation of EO 12898 for NEPA by agency directive involves the following steps (BLM 2002):

- Identification of the presence of minority and low-income populations and Indian Tribes in areas that may be affected by the action under consideration.
- Determination of whether the action under consideration would have adverse human health, environmental, or other effects on any population.
- Determination of whether such environmental, human health, or other effects would be disproportionately high and adverse on minority or low-income populations or Indian Tribes.

- Providing opportunities for effective community participation in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of public meetings, crucial documents, and notices (CEQ 1998).

The BLM standard for identifying a low-income population is the poverty level used by the U.S. Census Bureau. The standard for identifying minority populations is either: 1) the minority population of the affected area exceeds 50 percent, or 2) the minority population percentage of the affected area is “meaningfully greater” than the minority population percentage in the general population or other appropriate unit of geographic analysis. For environmental justice compliance, the relevant minority population is the total minority population comprising all persons of a minority racial identity plus persons of Hispanic-origin and Latinos (BLM 2002).

The minority and low-income status of populations within the socioeconomic study area are described in the following section.

3.15.8.1 Racial and Ethnic Minority Populations

The overwhelming majority of the project area is extremely rural and sparsely settled due to the “checkerboard” pattern of alternating sections of public and private land ownership. There are few permanently occupied residences within the project area outside of the town of Wamsutter, although some ranch facilities and a few rural cabins and privately-owned lots are occupied on a seasonal basis. There are no American Indian Reservations, Colonies, or Tribal trust lands in or near the project area.

Table 3.15-16 compares the percentage of minority residents in the project area, based on data from the 2010 Census, with that for two counties in which it is located, the state of Wyoming and the nation as a whole. The percentages of minorities in Carbon County and Sweetwater County are higher, but not meaningfully higher, than the statewide average. Minorities were an estimated 18.7 percent of the population in an area that encompasses the project area, essentially the same as the local county averages (Carbon County at 20.2 percent and Sweetwater County as 19.1 percent), slightly higher than the statewide average, but considerably lower than the national average. The Hispanic or Latino population is the single largest minority group, locally as well as across the state.

Table 3.15-16. Percentage of minorities in the State of Wyoming, Carbon County, Sweetwater County, the CD-C project area, and selected communities

	Percentage of Total Population				
	(A)	(B)	(C)	(D)	(E)
Geographic Area	White and not Hispanic or Latino	Total Racial Minorities and not Hispanic or Latino [1]	Hispanic or Latino Ethnicity	Total Racial and Ethnic Minorities (B) + (C)	Difference in Percent Minority Population Above/Below the State Average
United States	62.3%	19.5%	18.2%	37.7%	23.6%
Wyoming	85.9%	5.2%	8.9%	14.1%	0.0%
Carbon County	79.8%	3.4%	16.8%	20.2%	6.0%
Sweetwater County	80.9%	3.8	15.3%	19.1%	5.0%
Rawlins	71.5%	4.2%	24.3%	28.5%	14.3%
Rock Springs	79.1%	4.5%	16.4%	20.9%	6.8%
Wamsutter	74.7%	5.6%	19.7%	25.3%	11.1%
CD-C project area estimate [2]	81.3%	3.3%	15.4%	18.7%	4.6%

[1] *Racial minorities includes all persons identifying themselves as a non-white race, including "Black or African American," "American Indian and Alaska Native," "Asian," "Native Hawaiian and Other Pacific Islander," "Some other race alone," and "Two or more races." Ethnic minorities include persons who identify themselves as Hispanic or Latino.*

[2] *The project area estimate is based on data for several rural census tracts in western Carbon County and eastern Sweetwater Counties, including the town of Wamsutter, but excluding Baggs.*

Source: U.S. Census Bureau, 2010.

When expressed as a share of the total population, the Hispanic population has grown across these two counties over the past decade, climbing from 13.8 percent to 16.8 percent of the Carbon County population and from 9.4 percent to 15.3 percent of the Sweetwater County population. The analysis area does not exactly match the project area boundaries, but has similar demographic characteristics to the project area.

Wamsutter had a 2010 census population of 451, 25.3 percent of whom were identified as racial or ethnic minorities. The town exists in large part due to the substantial presence of the energy industry and ongoing oil and gas development activity has been largely responsible for the recent population growth. Thus, the relatively high share of minorities and the increase in minority population in recent years is indicative of growth attracted by economic opportunity, rather than the presence of a minority population rising to the BLM standards for consideration from an environmental justice perspective.

3.15.8.2 Persons in Poverty

Table 3.15-17 summarizes the prevalence of poverty in the project area and two host counties that encompass the project area. For the analysis of low-income population for the year 2000, the local area that includes the project area is slightly larger than that for the analysis of minority populations because the level of aggregation of income data available from the U.S. Census Bureau is larger than that for racial and ethnic characteristics.

Based upon 2000 Census data, persons with incomes below the poverty level represent 10.6 percent of the population in the analysis area that includes the project area, 1.8 percent lower than the 11.4 percent of the population with incomes below the poverty level for the State of Wyoming. In comparison county-wide poverty in Carbon County was slightly above the national average, while that in Sweetwater County was approximately 25 percent lower. In part the latter reflects the strong industrial base of Sweetwater

County, while the former is influenced by the location of a relatively large inmate population at the Wyoming State Penitentiary in Rawlins.

Detailed poverty data are not yet available from the 2010 Census. However, poverty estimates prepared by the Census Bureau for 2009 indicate a reduction in poverty rates in Wyoming and Carbon and Sweetwater counties, as compared to those for 2000. Meanwhile, poverty rates rose at the national level for the same two points in time. The median household income for Carbon and Sweetwater counties also exceeded the national average, with that for Sweetwater ranking among the top 5 percent within the nation. Estimates for 2009 are not available for Wamsutter, but the relatively high rates of employment—much of it in energy-related jobs—that characterize the community are thought to be unlikely to result in poverty rates substantially higher than the statewide or national averages.

Table 3.15-17. Poverty levels in the United States, State of Wyoming, Carbon County, and Sweetwater County, 2000 and 2009

Geographic Area	Share of Population Below Poverty Level 2000	Share of Population Below Poverty Level 2009	Median Household Income 2009
United States	12.4%	14.3%	$50,221
Wyoming	11.4%	10.2%	$54,400
Carbon County	12.9%	11.7%	$50,353
Sweetwater County	7.8%	7.3%	$69,297
CD-C project area estimate	10.6%	Not Available	Not Available

Source: U.S. Census Bureau, 2002 and U.S. Census Bureau, 2010.

The communities of Rawlins, Rock Springs, Green River, Baggs, Sinclair, and other small settlements are outside the project area, spatially separated from the project by topography. Consequently, these communities are not considered likely to be affected from an environmental justice perspective.

The foregoing analysis supports the finding that the low-income population in the project area does not rise to the BLM standards for consideration from an environmental justice perspective.

3.16 TRANSPORTATION AND ACCESS

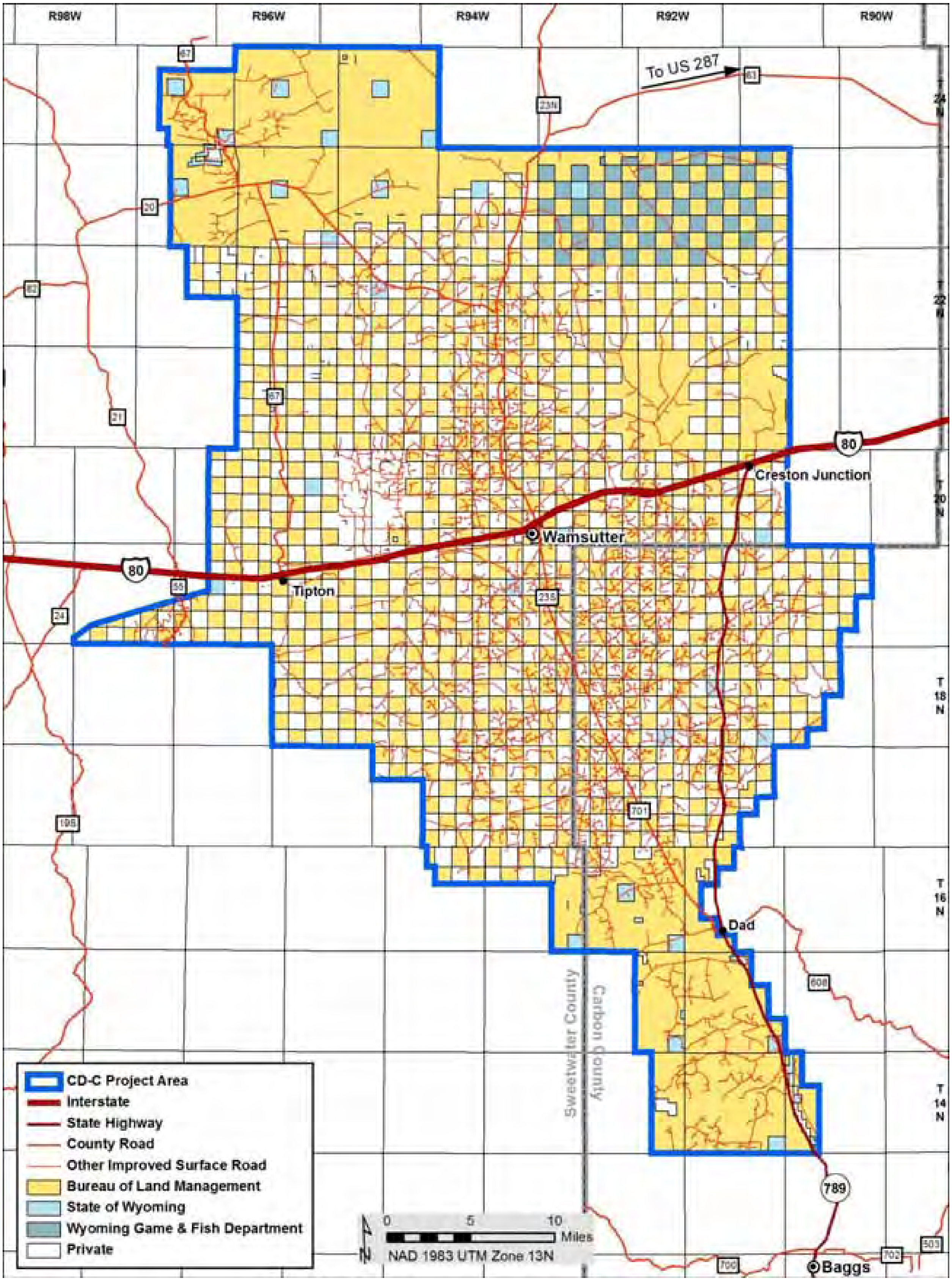
The primary transportation access to and within the CD-C project area is via highway, although the Union Pacific mainline railroad across southern Wyoming passes through the project area on a generally east-west route. General aviation and commercial service-capable airports are located in Rock Springs and Rawlins, with several other general aviation and private airfields in the surrounding region.

Interstate Highway 80 (I-80) and WY 789 provide primary highway access to the project area. Most traffic destined for the project area originates in Rock Springs, Rawlins, Wamsutter, or Baggs, making I-80 and WY 789 the most direct and commonly used highway access routes. Highway access routes are shown in **Map 3.16-1**. I-80 bisects the project area and provides access to a number of county and BLM roads that in turn access both the north and south parts of the project area. WY 789 provides access to the existing gas fields to the east and west of the highway and has seen substantial increases in traffic during the last several years attributable to natural gas development and interstate pipeline construction. Although it is possible to reach the project area from US 287 to the east, this route is seldom used because of the distance and the connecting roads; these roads are not as direct and are not maintained for gas-field traffic. US 287 provides access to I-80 for gas-field traffic coming from Casper and other points of origin north of the project area.

Access within the project area is provided by an established network of Sweetwater and Carbon County numbered and maintained roads, improved and unimproved BLM roads, and private roads. The BLM categorizes roads based on existing use or anticipated traffic volumes, seasonal or year-round use, design vehicle (types of vehicles most frequently using the road), soil types, weather conditions, topography, construction costs, compatibility with other resource values, and safety (USDOI and USDA 2006). BLM road types include the following:

- *Collector roads* serve large land areas and are the major access routes into development areas with high average daily traffic rates. They are usually double-lane, graded, drained and surfaced, with a 20- to- 24-foot travelway. They usually connect with public highways or other arterials to form an integrated network of primary travel routes and are operated for long-term land and resource management purposes and constant service. The locations and standards are often determined by a demand for maximum mobility and travel efficiency rather than a specific resource management service.
- *Local roads* provide access to large areas and for various uses. They collect traffic from resource or local roads or terminal facilities and are connected to arterial roads or public highways. The location and standards for these roads are based on both long-term resource needs and travel efficiency. Local collector roads may be single-lane or double-lane with travelways 12 to 24 feet in width and ‘intervisible turnouts,’ where approaching drivers have a clear view of the section of road between the two turnouts and can pull off to the side to let the approaching driver pass. They are normally graded, drained, and surfaced and are capable of carrying highway loads. They may be operated for either constant or intermittent service, depending on land use and resource management objectives for the area being served.
- *Resource roads* are low-volume, single-lane roads. They normally have a 12- to14-foot travelway with intervisible turnouts, as appropriate. They are usually used for dry weather, but may be surfaced, drained, and maintained for all-weather use. These roads connect terminal facilities, such as a well site, to collector, local, arterial, or other higher-class roads. They serve low average annual daily traffic (AADT) and are located on the basis of the specific resource activity need rather than travel efficiency.

Within the project area, an existing network of collector and local roads has been developed or improved to accommodate the already high level of natural gas development and operations-related travel, which is the dominant use of these roads. In several cases Carbon and Sweetwater county roads serve the function of collector roads and have been improved by the respective county to accommodate that use. Within the project area, Sweetwater County Road (SCR) 23S/Carbon County Road (CCR) 701—known as the Wamsutter/Dad Road—serves as a collector road for the portion of the field south of I-80; SCR 23N, SCR 67, and BLM Road 3207 serve as collector roads for the part of the field located north of I-80.



Map 3.16-1. Highway and county road access to and within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

The Operators have in some cases improved local roads on BLM and private lands to accommodate their level of use and they provide ongoing maintenance for those roads and for resource roads that they have constructed on BLM and private lands.

3.16.1 Current Government-Industry Transportation Planning Efforts for the Project Area

Currently, a transportation plan (TP) and transportation planning committee (TPC) are in place for the Continental Divide portion of the project area; there is no TP or TPC for the Creston portion of the project area.

The BLM, the WYDOT, Carbon and Sweetwater Counties, and a number of companies operating within the Continental Divide/Wamsutter II Oil and Gas project area developed a Memorandum of Understanding (BLM MOU NO. WY 951-99-06-102) to establish a process for dealing with road issues. The MOU was intended to:

> "…establish a process through which governmental agencies, oil and gas companies, private landowners and other interested parties can meet together to discuss road-related concerns resulting from project development, to identify potential solutions to problems, and to develop implementation strategies for transportation. The primary focus of this MOU centers on issues related to transportation planning including road use, development, maintenance and reclamation."

The MOU and the recommendations of the Transportation Planning Technical Support Document for the Continental Divide/Wamsutter II Natural Gas Project (BLM 1999a) resulted in the formation of a TPC for the CD/WII project area. Since the signing of the MOU in late 1998 and early 1999, the TPC has held semi-annual meetings to address transportation issues. Recently the scope of these meetings has been expanded to include operators in other areas of the RFO and cover other issues such as reclamation.

3.16.2 Highway Access to the Project Area

As noted above, two highways provide access to the project area: I-80 and WY 789 (see **Map 3.16-1**). I-80 bisects the project area horizontally and provides access to a number of county and BLM roads that in turn access both the north and south parts of the project area. WY 789 provides access to the existing gas fields to the east and west of the highway and has seen substantial increases in traffic during the last several years attributable to natural gas development and interstate pipeline construction. US 287 travels north from Rawlins at some distance from the project area and at present is used for access to I-80 rather than direct access to the project area.

WYDOT limits access to state highways to every one-half mile and encourages industrial developers to use main access points where possible. WYDOT also requires roads accessing state highways to be paved to the limits of the highway right-of-way and encourages developers to gravel roads for one-half mile before their intersection with state highways to allow trucks to shed mud from tires before entering the highway. WYDOT is currently monitoring traffic volumes on WY 789 to determine whether turn-lanes are needed at major gas-field road intersections.

The underpasses associated with off-ramps at the I-80 interchanges through the project area were not designed to accommodate over-height or over-width loads. Over-height/over-width loads traveling on I-80 that need to access areas on the opposite side of the highway must travel beyond the desired off-ramp, cross the median, and return in the opposite direction to the desired off-ramp. This maneuver requires three Wyoming Highway Patrol troopers to provide traffic safety services. As many as 13 over-height vehicles required use of this maneuver on one day during 2007, the peak year for drilling activity, effectively requiring a detail of three Wyoming Highway Patrol troopers for a full day (Griesbach 2007).

WYDOT measures AADT (annual average daily traffic) and collects accident statistics on federal and state highways. **Table 3.16-1** displays AADT data for segments of I-80 that provide access to the project area for 1999 and 2009 and WYDOT's AADT forecasts for 2020 and 2030 based on extrapolations of long-term trends. Included in the 2009 AADT is an estimated project area-related AADT of 1,060 (including an AADT of 299 trucks) associated with the drilling of 244 wells in 2009 and operations activities associated with 3,738 producing wells in that year.

During the 10-year period between 1999 and 2009, increases in total AADT on the I-80 segment between Rawlins and Rock Springs (both directions) ranged from 8 percent on the east side of Rock Springs to 16 percent at the west side of Rawlins. Increases in total truck AADT during the 10-year period were more modest, ranging from 2 percent on the west side of Rawlins to 5 percent at Wamsutter.

AADT increased substantially on WY 789 from I-80 at Creston Junction south to Baggs. South of the WY 789/I-80 junction, the combined AADT traveling in both directions increased by 49 percent and truck AADT increased by 98 percent during the during the 1999 to 2009 period. Just north of Baggs at the junction of WY 789 with CCR 700, which provides access to the Creston part of the project area, overall AADT increased by 86 percent and truck AADT increased by 167 percent over the 10-year period.

As noted, US 287 connects Rawlins and I-80 with Casper and I-25. Total AADT on US 287 north from Rawlins to Lamont increased during the 1999–2009 period; total traffic at the US 287 bypass on the north side of Rawlins increased by 106 percent but truck AADT increased by a more modest 6 percent. AADT south of Lamont increased by 9 percent and truck AADT decreased by 6 percent during the 10-year period.

Although 2009 was chosen to show most-recently available traffic statistics on the affected highways, traffic increases on a particular highway segment can be more dramatic as a result of industrial activities. For example, increases on WY 789 were more substantial between 1997 and 2007, the peak development year; ranging from an increase in total AADT of 76 percent and an increase in truck AADT of 156 percent south of Creston Junction and an increase in total AADT of 199 percent and an increase in truck AADT of 225 percent north of Baggs at the junction with CCR 700. The high level of traffic in this area during 2007 was attributed in part to interstate pipeline construction traffic

WYDOT assigns level of service (LOS) ratings to highways in the state system. LOS A through LOS F are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort and convenience) that characterize the operational conditions within traffic streams and the perceptions of those conditions by motorists. LOS A represents the best, or free-flowing, travel conditions and LOS F represents the worst, or total stoppage of traffic flows. During 2008, the most recent year for which LOS ratings were calculated, I-80 through the project area operated at a LOS rating of A and WY 789 operated at a LOS rating of B, except for the intersection with Carbon County Road 700 West, which operated at a LOS rating of C. US 287/WY 220 north from Rawlins to Casper operated at LOS B or LOS C, depending on the highway segment.

WYDOT forecasts for 2030 indicate that traffic conditions on I-80 from Rawlins west to Rock Springs will remain at LOS A, except for the segment around the intersection with WY 789 at Creston Junction, which will fall to a LOS B. Conditions on WY 789 from Creston Junction south to Baggs will remain at LOS B except for the intersection with Carbon County Road 700 West, which will remain at LOS C. US 287/WY 220 north to Casper is forecast to operate at LOS C for its entire length in 2030 (Brown 2011).

As shown in **Table 3.16-1**, traffic is forecast to increase substantially on all highways providing access to the project area by 2020 and 2030, with the exception of US 287 at the Rawlins bypass, where total AADT is forecast to decline in both 2020 and 2030 and on WY 789 at the junction with CR 700, where truck traffic is forecast to decline.

Table 3.16-1. AADT on highways providing access to the CD-C project area: 1999, 2009, 2020, and 2030

Highway Segment (Both Directions)	1999		2009				Projected 2020				Projected 2030			
	All Vehicles	Trucks	All Vehicles	Trucks	1999–2009 Increase All Vehicles	1999–2009 Increase Trucks	All Vehicles	Trucks	2009–2020 Increase All Vehicles	2009–2020 Increase Trucks	All Vehicles	Trucks	2009–2030 Increase All vehicles	2009–2030 Increase Trucks
I-80														
Rawlins W. Urban Limits	11,320	6,370	13,078	6,495	16%	2%	15,342	8,992	17%	38%	17,539	10,627	34%	64%
Creston Jct.	10,670	6,170	12,225	6,368	15%	3%	14,915	8,740	22%	37%	17,142	10,320	40%	62%
Continental Divide Int.	10,650	6,170	11,973	6,443	12%	4%	14,880	8,750	24%	36%	17,130	10,354	43%	61%
Wamsutter	10,650	6,170	12,014	6,458	13%	5%	14,938	8,747	24%	35%	17,211	10,354	43%	61%
Red Desert	10,630	6,170	11,563	6,332	9%	3%	14,806	8,722	28%	38%	17,063	10,325	48%	63%
Tipton	10,590	6,170	11,493	6,287	9%	2%	14,858	8,640	29%	37%	17,132	10,224	49%	63%
Table Rock	10,650	6,170	11,693	6,314	10%	2%	15,054	8,782	29%	39%	17,365	10,43	49%	65%
Rock Springs E. Urban Limits	12,710	6,770	11,678	6,498	8%	-4%	16,715	9,374	22%	44%	18,949	11,059	39%	70%
WY 789														
Creston Jct.	850	160	1,265	316	49%	98%	1,501	377	19%	19%	1,731	426	37%	35%
Jct CCR 700 West	970	160	1801	427	86%	167%	1,874	411	4%	-4%	2,174	472	21%	11%
US 287														
Rawlins N. at US 287 Bypass	2,550	740	5,241	786	106%	6%	4,419	962	-16%	22%	5,046	1,098	-4%	40%
Jct Rte 46 Lamont	2,110	660	2,303	620	9%	-6%	2,722	862	18%	39%	3,000	978	30%	58%

Source: WYDOT 2009 VMB

3.16.3 Motor Vehicle Crash Statistics on Highways Providing Access to the Project Area

Figures 3.16-1 and **3.16-2** display data for crashes on highway segments providing access to the project area. As shown in Figure 3.16-1, crashes on I-80 between Rawlins and Rock Springs averaged between 300 and 400 per year between 1998 and 2004, decreasing to 263 in 2005 and then more than doubling to 529 in 2006 and 536 in 2008 before decreasing to 343 in 2010. An average number of 370 crashes per year were reported in the 13-year period from 1998–2010. Until recently, WYDOT calculated crash rates for highways based on a formula that considered the type of highway, number of crashes and vehicle miles on the highway.[18] The 13-year average crash rate for the segment of I-80 between Rawlins and Rock Springs was 0.83, which was lower than the 1998–2007 statewide average for crashes on all Functional Class 1–Rural Interstate highways (1.10).

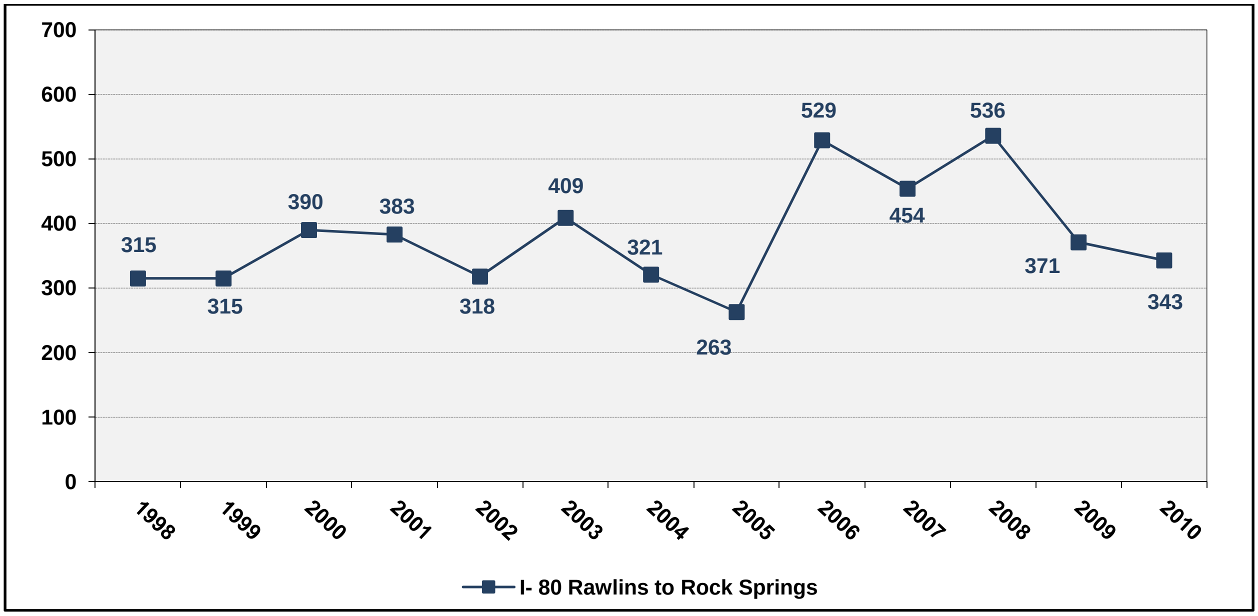


Figure 3.16-1. Annual number of crashes on I-80 between Rawlins and Rock Springs: 1998–2010

Source: WYDOT/Carpenter 2007and 2008.

Figure 3.16-2 displays annual crashes for the 1998–2010 period on WY 789 and on US 287 north of Rawlins. The number of annual crashes on WY 789 was generally 20 to 30 for the 13-year period except during 2006–2008 when the level increased to about 40 crashes. The 13-year average crash rate for WY 789 was 1.43, slightly below the 1998–2007 statewide crash rate for all Functional Class 6–Minor Arterial Highways (1.64).

The annual number of crashes on US 287 between Rawlins and Lamont ranged from 17 to 33 between 1998 and 2006, climbing to 42 in 2007 and 2008. The number of crashes then dropped to 8 in 2010. The 13-year average crash rate for the segment of US 287 between Rawlins and Lamont was 1.21, lower than the 1998–2007 statewide average for all Functional Class 02–Principal Arterial Highways (1.31).

[18] During the course of this assessment, WYDOT changed to a safety index that uses injury severity and fatal crashes as part of the weighting. Consequently the statewide crash rates for 2008 – 2010 highway functional classes were not calculated.

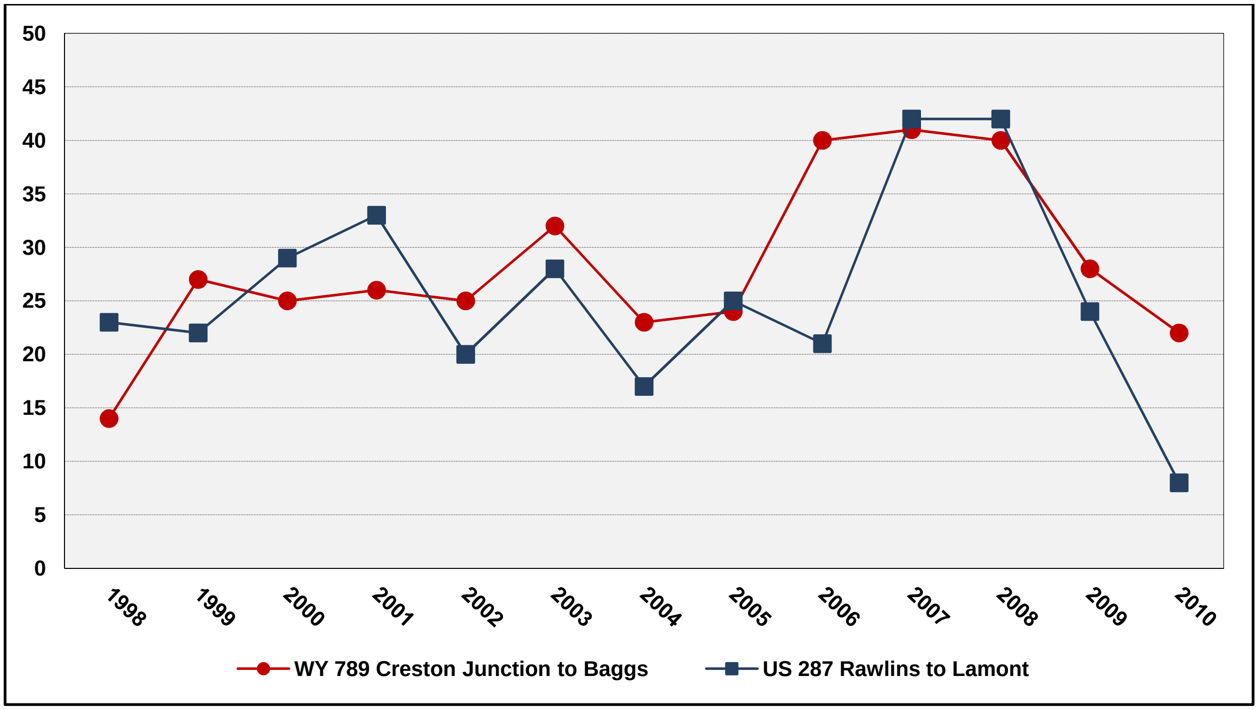


Figure 3.16-2. Annual number of crashes on WY 789 between Creston Junction and Baggs and on US 287 between Rawlins and Lamont: 1998–2010

Source: WYDOT/Carpenter 2007, 2008 and 2010

3.16.4 County Roads

Numbered and maintained Carbon and Sweetwater County roads that provide access to and within the project area are shown in **Map 3.16-1**. Other roads that are not numbered or maintained but which may fall under the definition of Public Roads as defined by U.S Revised Satute R.S. 2477—commonly known as R.S. 2477—are not specifically identified on the map. Most of the numbered and maintained county roads displayed on the map were originally developed for grazing and recreational uses but have evolved to become primarily natural gas industry access roads. This change in use, both in terms of volume and load, has resulted in substantial investments of time, equipment, materials, and funds by the counties to substantially reconstruct and maintain the affected roads.

3.16.4.1 Carbon County

Carbon County maintains about 1,000 miles of county roads. Only one Carbon County road is located within the project area: CCR 701, the Wamsutter–Dad Road.

CCR 701 (Wamsutter–Dad Road) provides access to the project area from WY 789 at Dad. Traveling north, the road becomes SCR 23S at the Sweetwater County line and provides access to the Town of Wamsutter and I-80 to the north. CCR 701 is by far the busiest road in Carbon County. The road is a 19.5-mile-long crowned-and-ditched, two-lane gravel road with a 24-foot-wide driving surface. Initially developed to serve ranching and grazing operations in the area, the road has been improved to accommodate the 24-hour/day, 365-day/year industrial level of use that it now receives. CCR 701 is in a constant state of maintenance, repair, and improvement. During 2006, the Carbon County Road and Bridge Department (CCRBD) completed a $1.2 million reconstruction of the road including 6–8 inches of gravel and one-half gallon of magnesium chloride dust-suppressant per square yard of gravel. Given the constant, high level of heavy and overweight vehicle use on CCR 701, portions of the road must be reconstructed every year. In 2008, the CCRBD applied additional gravel to the road along with one-quarter gallon of magnesium chloride per square yard of gravel. This process was repeated in 2009 along with reclamation of gravel pushed to the roadside during the preceding two years. According to the CCRBD Superintendent, the benefits of the annual gravel/magnesium chloride applications are becoming evident as the program proceeds (Nation 2007).

The lack of a nearby source of suitable gravel with the proper mixture of rock and binder, high fuel costs, and the need for water for construction, road stabilization, and dust suppression are among the challenges that the CCRBD faces in constructing and maintaining county roads. In some cases, the Operators and landowners have cooperated with the county to provide gravel and water for road reconstruction and maintenance.

Vehicle travel speed, particularly that associated with heavy trucks, is a key issue for road maintenance and safety on county roads. During 2007, the CCRBD and Sheriff's Department conducted a speed index survey on CCR 701. As a result of the survey, the Sheriff's Department established a speed limit of 45 miles per hour (mph) on the road and 30 mph for some curves. The Sheriff's department monitors speed on CCR 701 and issues summons for speed-limit violations (Morris 2007).

3.16.4.2 Sweetwater County Roads

Sweetwater County maintains about 1,200 miles of roads and 23 bridges. Sweetwater County roads providing access to and within the project area include SCR 23, 20, 67, 80, and 55. These and all Sweetwater County roads that serve oil and gas industry activities are under a continuous maintenance program that includes grading and spot gravel replacement and accounts for about 77 percent of the Sweetwater County Road and Bridge Department's (SCRBD) annual budget (Gibbons 2007, Radosevich 2007).

- **SCR 23S (Wamsutter–Crooks Gap Road South**) is an 8.2-mile, 24-foot-wide gravel and native-material road that provides access from I-80 and Wamsutter to the north and connects with CCR 701 to the south to form a continuous road to WY 789 at Dad. SCR 23S is a heavily traveled industrial road. During 2007, SCRBD conducted a traffic study at a point 0.5 miles south of the Wamsutter overpass on SCR 23S and counted a total of 11,729 vehicles during a 72-hour period, which averages about 3,910 trips/day for those three days. The SCRBD overlaid six miles of the road with gravel and magnesium chloride during 2007 and the remainder of the road in 2008.
- **SCR 23 N (Wamsutter–Crooks Gap Road North)** is a 44.5-mile, 24-foot-wide gravel and native-material road that travels north from I-80 and Wamsutter to the Sweetwater County line. The road is paved for the first half-mile north of Wamsutter. The 2007 SCRBD traffic study counted 2,792 vehicles in a 72-hour period on the road or a daily average of 931 trips for the three-day period.
- **SCR 67 (Tipton North Road)** is a 24-foot-wide gravel and native-material road that travels north from I-80 at Tipton to a point north of Luman Butte, just outside the northwest corner of the project area. This route is divided into two segments. The first segment travels 25 miles north from I-80 to SCR 20, merges with SCR 20 (Luman Road) and travels west for about one mile, and then travels about 10 miles north of SCR 20.
- **SCR 20 (Luman Road)** is a 28.3-mile, 20-foot-wide native-material road that travels west from SCR 23 at about mile 13 near Denison Gap, crosses SCR 67 at mile 25.5 and proceeds westward to connect with SCR 21 about 3.5 miles west of the project area boundary.
- **SCR 46** travels west from WY 789 about one mile south of I-80 for approximately 2 miles, paralleling the Union Pacific railroad right-of-way to the former Creston Siding.
- **SCR 80 (Tipton Station Road)** is a 0.8-mile, 15-foot-wide native-material road that travels south from I-80 at Tipton and connects with an unnamed BLM road that provides access to lands along the southwestern boundary of the project area.
- **SCR 55 (Table Rock Road)** is a 4.6-mile, 20-foot-wide native-material road that provides access from I-80 to a small portion of land at the extreme western border of the project area.

3.16.5 BLM Roads

A number of BLM-designated roads provide access within the project area (**Map 3.16-2**). BLM has right-of-way agreements for all private lands crossed by three of the roads; other BLM numbered roads within the project area do not have right-of-way agreements in place for all the private lands crossed. Operators who need to use these roads to access leases must obtain their own right-of-way agreements with private landowners. Agency maintenance of BLM roads is relatively minimal; the RFO has one road-grader for 1,700 miles of roads in the RFO area. In some cases the operators maintain heavily used segments of BLM roads.

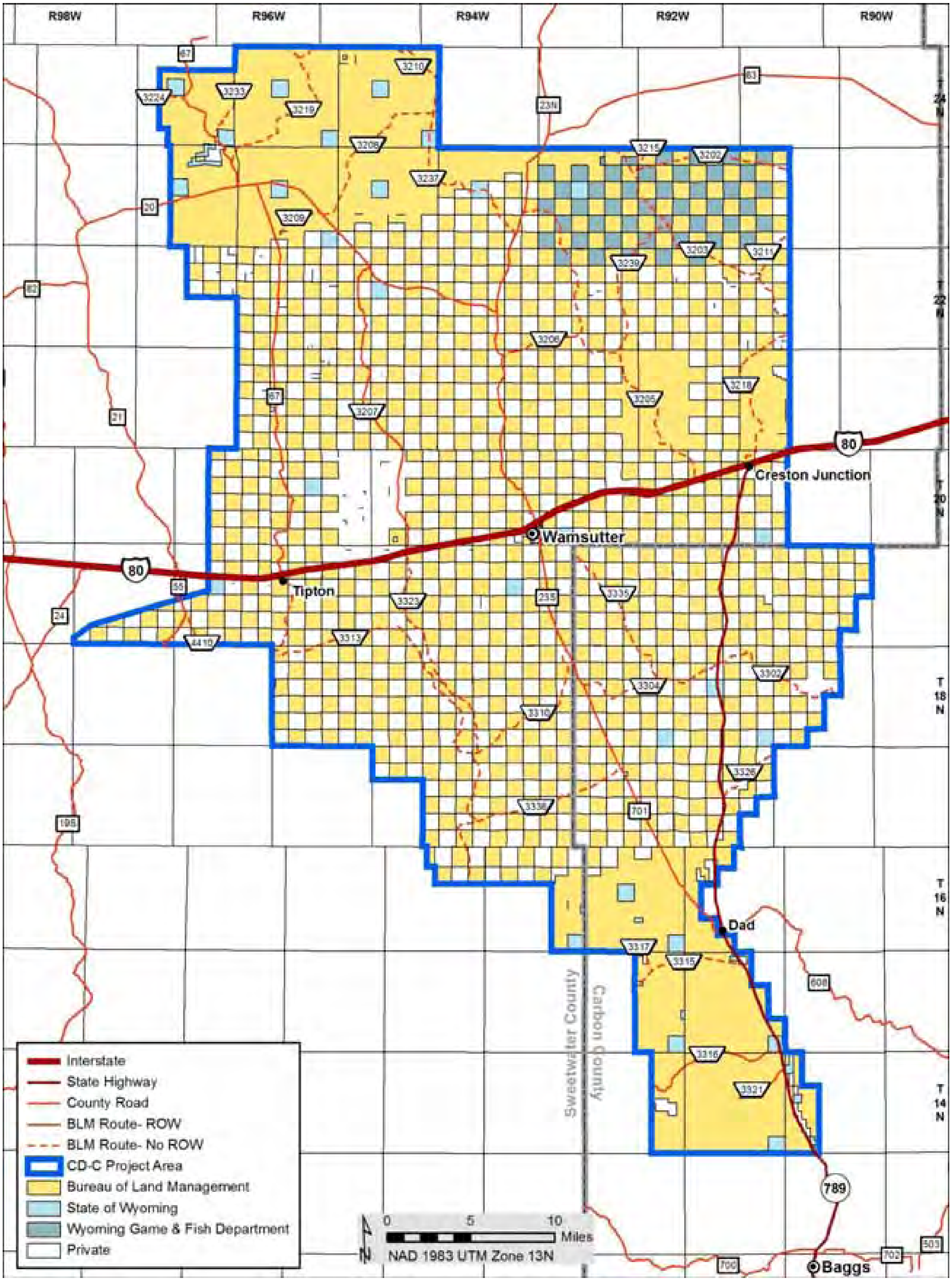
Most of the BLM-designated roads used to access natural gas development and production areas within the project area were not designed or constructed to accommodate heavy truck traffic and continuous all-weather use. As noted above, operators often improve and maintain roads that access development and production areas and some have developed agreements with private landowners for road improvement and maintenance. Dust, excessive speed, conflicts with livestock, and damage to grazing improvements such as fences, gates, and cattle guards are frequent problems within the project area (Miller 2007).

3.16.5.1 BLM Roads with Right-of-Way Agreements

- **BLM Road 3207 (Red Desert Road)** provides access to the north-central portion of the project area from I-80 at Red Desert. The road extends about 18 miles north towards the Lost Creek Basin.
- **BLM Road 3316 (Robbers Gulch Road)** travels west from WY 789, providing access into and across the southern portion of the project area about 15 miles north of Baggs.
- **BLM Road 3321 (Little Robber Road)** travels west from WY 789 for about five miles and provides access into the southern portion of the project area about 11 miles north of Baggs.

3.16.5.2 BLM Roads Without Full Right-of-Way Agreements

- **BLM Road 3202 (Stratton Road)** traverses the northeast corner of the project area for about 9 miles, connecting with BLM Road 3203 to the west and exiting the project area to the east.
- **BLM Road 3203 (Riner Road)** provides access to the northeast side of the project area from I-80 at Riner, about 14 miles east of Rawlins. The road extends about 10 miles to the northwest from I-80 before it enters the project area and then travels another 15 miles to the northwest before exiting the project area. Currently the road is not heavily used by gas industry traffic; rather it primarily provides access for ranchers, grazing operators, and recreation users of the area.
- **BLM Road 3205 (Continental Divide Road)** travels northwest from I-80 at Continental Divide, intersecting with SCR 23N near the northern boundary of the project area. BLM 3205 also intersects with BLM 3239 about 10 miles from its beginning.
- **BLM Road 3206 (Mineral X Road)** provides access east from SCR 23N to the Monument Lake area of the north-central project area, connecting with BLM 3205.
- **BLM Road 3208 (Lost Lake Road)** travels northeast from its origin on SCR 20 in the northwestern portion of the project area for about five miles to its intersection with BLM 3237, which then exits the project area.
- **BLM Road 3209 (Tipton Road)** connects SCR 20 to SCR 67 just below Horseshoe Bend in the northwestern part of the project area, a distance of about 3 miles.
- **BLM Road 3210 (Eagle’s Nest Road)** connects SCR 23N with BLM Road 3219 in the northwestern portion of the project area. For most of its length, BLM 3210 is outside the northern boundary of the project area.



Map 3.16-2. BLM roads within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

- **BLM Road 3211 (Larsen Knoll Road)** travels northeast for about 3 miles from its origin on BLM Road 3203 in the northeastern portion of the project area and then exits the project area.
- **BLM Road 3215 (Sooner Road)** travels north from its origin at BLM Road 3203 in the northeast corner of the project area and exits the project area within several miles.
- **BLM Road 3218 (Creston Junction Road)** travels north from I-80 at Creston Junction and travels about 8 miles north, exiting the project area on the eastern boundary.
- **BLM Road 3219 (Red Creek Road)** extends northeast from SCR 67 in the northwest corner of the project area and travels about 10 miles to an intersection with BLM 3210 and then exits the northern boundary of the project area.
- **BLM Road 3224 (Cronin Draw Road)** travels west from its origin at SCR 67 in the extreme northwest corner of the project area, exiting the project area within several miles.
- **BLM Road 3233 (Bush Lake Road)** travels north from its intersection with SCR 67, just north of Luman Ranch and exits the project area several miles to the north.
- **BLM Road 3237 (Government Reservoir Road)** travels northwest from its origin on SCR 23, providing access to the Lost Creek Butte area in the far north central portion of the project area
- **BLM Road 3239 (Chain Lakes Rim Road)** originates at BLM 3205 about 10 miles north of I-80 and travels to the east for about 8 miles, intersecting with BLM 3203 and providing access to the Chain Lakes area.
- **BLM Road 3302 (Divide Road)** extends east from WY 789 about 7 miles south of Creston Junction and provides access to the eastern border of the project area.
- **BLM Road 3304 (Eight Mile Lake Road)** provides access to the Creston/Blue Gap area on the west side of WY 789, terminating to the west at CCR 701 just south of its starting point at the Sweetwater County line.
- **BLM Road 3310 (Barrel Springs Road)** intersects SCR 23 about 7 miles south of Wamsutter and provides access to the southwest area of the project area.
- **BLM Road 3313 (Delaney Rim Road)** provides access from I-80 at Tipton to the southwestern part of the project area. The road travels about 5 miles south and then travels east along the south and east sides of the Delaney Rim for about 16 miles.
- **BLM Road 3315 (Standard Road**) travels west about 6 miles from its intersection with WY 789 about 2 miles south of Dad, providing access to the Blue Gap area.
- **BLM Road 3317 (Windmill Draw Road)** travels north from BLM Road 3315 to connect with several unnamed roads on the western edge of the project area.
- **BLM Road 3323 (Red Desert Road South)** extends south into the project area from I-80 at Red Desert. The road travels about 11 miles and provides access to the east side of the Delaney Rim and Barrel Springs Draw areas.
- **BLM Road 3326 (China Butte Road)** travels northeast for about 3 miles from its origination at WY 789 about 9 miles north of Dad, skirting Baldy Butte on the west and exiting the eastern boundary of the project area.
- **BLM Road 3335 (Echo Springs Road)** travels southeast for about 11 miles from its origin on SCR 23S just south of Wamsutter to its intersection with BLM Road 3304.
- **BLM Road 3336 (Eureka Headquarters Road**) travels for about 10 miles southwest from its intersection with CCR 701 about 3 miles southeast of the Sweetwater County line, providing access to the Barrel Springs area.
- **BLM Road 4410** [not shown on map] originates at SCR 55 about 2.5 miles south of I-80 in the western portion of the project area and travels south, exiting the project area in about 1.5 miles.

3.16.6 2007 Drilling and Production Traffic

Based on the per-well drilling/field-development and production operations factors used for the transportation assessment (**Section 4.16**), it is estimated that during 2009, a total AADT of 1,525 (including an AADT of 629 trucks) was generated by natural gas drilling and production activities within the project area. As noted in **Section 3.16.3**, an estimated total AADT of 1,060 traveled on highways providing access to the project area and the remainder occurred on county, BLM, and private roads within the project area.

3.17 NOISE

The common measure of noise in the United States is the A-weighted sound pressure level that measures noise in decibels (dBA). The EPA-established standard for acceptable environmental noise is 55 dBA. Noise levels greater than 55 dBA may disturb local residents and recreationists and could displace area wildlife. The degree of disturbance depends on the receptor's distance from the source, noise intensity and duration, as well as the sensitivity of the receptor.

The human ear is more sensitive to sound in the frequency range 1 to 4 kilohertz (kHz) than to sound at very low or high frequencies (EngineeringToolBox.com 2011). An A-weighting filter de-emphasizes low frequencies or pitches and therefore is less sensitive to very high and very low frequencies. Very high sound levels are more appropriately measured using the C scale. Measurements made on this scale are expressed as dBC (University of New South Wales 2011); C filters are seldom used (EngineeringTool-Box.com 2011). Animals tend to hear sound at frequencies that humans cannot; the C-weighted decibel scale may be appropriate for evaluating effects of some sounds on other species. For example, dogs hear noises up to 45 kHz, while humans only hear sounds up to about 23 kHz. This means that they could be hearing and responding to sounds that humans cannot hear at all. Cats can hear sounds as high as 64 kHz, bats up to 110 kHz, and porpoises up to 150 kHz (DOE 2011).

Median noise levels for the project area likely range from 20 to 40 dBA in the morning and evening and from 50 to 60 dBA in the afternoon when wind speeds are typically greatest. These levels correspond to noise levels of a soft whisper (30 dBA), a library (40 dBA), a quiet office (50 dBA), a small town (40–50 dBA), and a normal conversation (60 dBA). Additional noise comes from aircraft, traffic on county roads and state highways, operation of the existing gas compression stations, natural gas drilling and production areas, and transportation (railroad and interstate highway) corridors. Existing noise levels within the project area are for the most part representative of rural conditions and are expected to be between 35 and 45 dBA (Harris 1991), except near county roads and compressor stations where noise levels may be as high as 65 dBA. Noise may exceed 70 dBA in close proximity to specific pieces of equipment or operations (**Table 3.17.1**).

The BLM measured various aspects of development operations in the Jonah Field in western Wyoming and found flaring activities to be the loudest source of noise followed by drilling operations and compression. At 0.25 miles from the activity, noise was reduced to below the 55 dBA level (BLM 2006b). Mitigation measures such as hospital-grade mufflers on compressors and flowback separators on high-intensity flaring operations aid in reducing noise to acceptable levels. Noise levels from traffic along the interstate typically average greater than 70 dBA (BLM 2005d). Blickley and Patricelli (2010) provide the following insight relative to noise generated by human activities: "Most anthropogenic noise sources have energy concentrated in low frequencies (<250 Hz), which can travel long distances with relatively little energy loss. Such noise is also more difficult to control using traditional noise-abatement structures, such as noise reflecting or absorbing walls along highways or surrounding other fixed noise sources, such as industrial sites."

The 2009 Pinedale Anticline project area noise study (KC Harvey 2009) found noise levels at various sage-grouse lek locations in the Pinedale natural gas field to be in general compliance with the BLM stipulation requirements, as follows: “Average measured noise levels are all below the 10 dBA above background threshold level of 49 dBA. Two locations had noise levels below baseline, and the highest level was 47.4 dBA. Median noise levels are also below 49 dBA level at all measured locations.” Their observations continued, “Field personnel maintaining the noise meters noticed that windy conditions increased noise levels noticeably, sometimes to greater than 50 dBA. Since windy conditions are common in the area, wind noise may contribute significantly to the background noise levels (KC Harvey 2009).” It can be anticipated that the project area could have similar wind conditions.

The majority of the compressor stations in the CD-C project area may already meet the recommended 55 dBA (with an average day/night noise level of 49 dBA) for noise impacts to sensitive receptors at 0.25 mile (1,320 feet) from the source (Schomer 2005). This standard is commonly applied by the BLM to compressor stations within oil and gas development projects (BLM 2003).

Table 3.17-1. Typical noise measurements from common energy development-related sources in the CD-C project area

Description	HP	dB(A)	dB(C)
Two (2) Cat 3516 with noise wall	1,000	45	---
Two (2) Cat 3516 without noise wall	1,000	50	---
Two (2) Waukesha H24 and F18 compressor engines	---	75	---
Two (2) Electric driven compressors	---	65	---
One (1) Ajax Cooper 2802	250	51	---
One (1) Ajax Cooper 2803 compressor engine	400	52	---
One (1) Cat or Waukesha compressor engine	1,200	75	---
One (1) Cat or Waukesha with high-performance intake and exhaust silencers	1,200	70	---
One (1) Waukesha 5794LG- compressor engine; fan end	1,000	91	95
One (1) Cat 3516 compressor engine; fan end, quiet fan	1,000	63	
One (1) Dehyd boiler	15	52	---
One (1) Cummins electric generator skid unit	1,000	69	---
One (1) Cat 3608 compressor engine w/ 2 heat exchangers	---	79	---
One (1) Disposal-well pump building with electric motors inside	---	53	---
One (1) Cat 3608 compressor engine	1,000	58	---
One (1) Drill rig (Jonah Field)	---	69	
One (1) Ajax/Cooper compressor engine with weather cover	4,000	---	76
One (1) Champlin 242J-12 Ajax wellhead compressor	---	71	86

Noise Emission Data – Levels at 100 ft. collected by Engineering Dynamics Incorporated.

The project area is sparsely populated and rural in nature with a few small towns scattered along I-80 as well as a few temporary “man camps” in association with gas development activity in the area. Noise-sensitive areas would include private residences, greater sage-grouse habitats used during breeding and nesting seasons, mountain plover nesting areas, and occupied raptor nests. No noise standards have been established by the State of Wyoming or the affected counties.

Research into the effects of noise generated by oil and gas drilling and operations on sensitive wildlife species has not yet been completed.

■ MANAGEMENT ENVIRONMENT

3.18 RANGE RESOURCES

3.18.1 Introduction

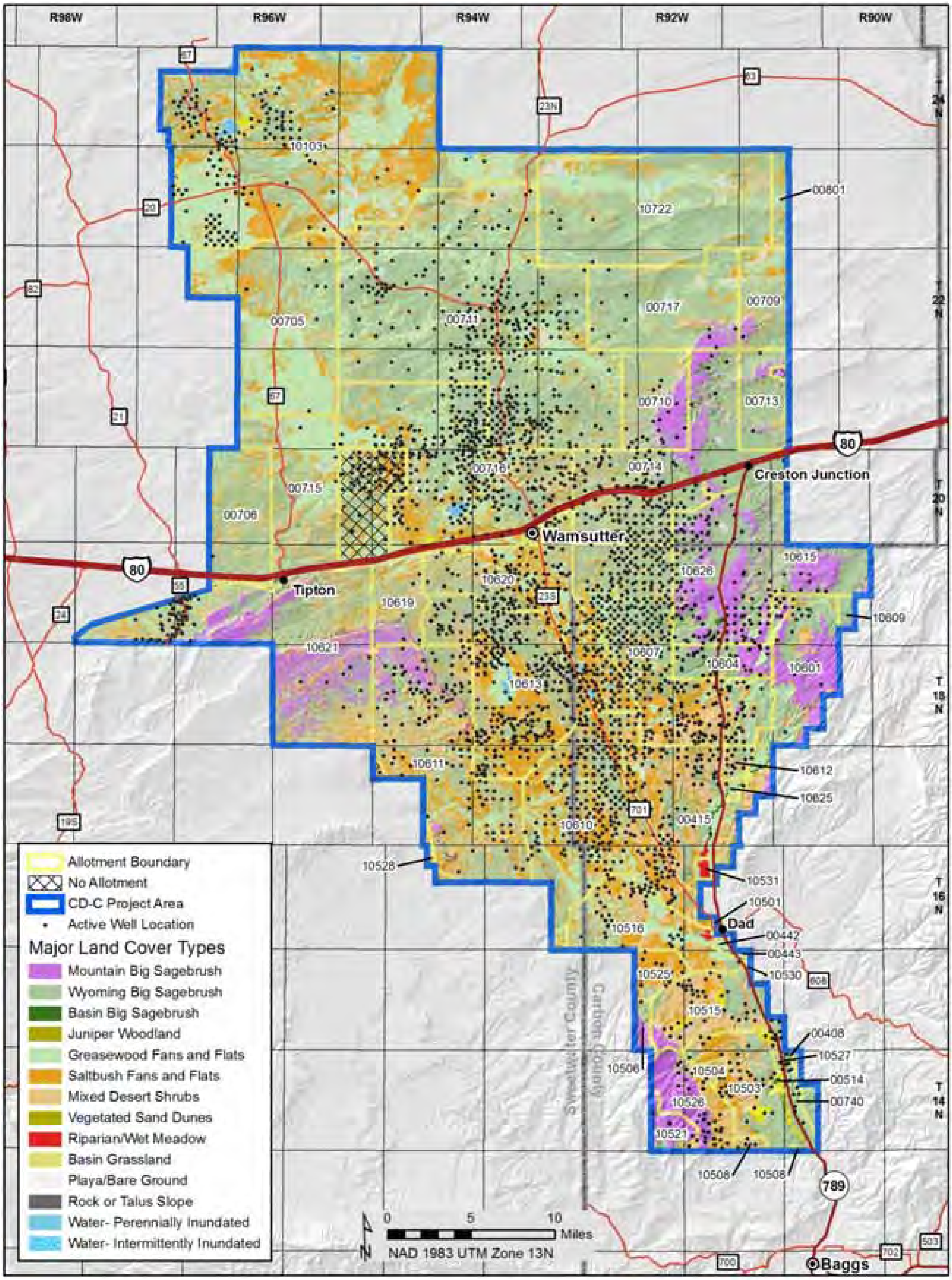
There are 47 allotments permitted for grazing use on public lands in the project area; their locations and boundaries are shown in **Map 3.18-1**. An allotment is defined as an area of land designated and managed for the grazing of livestock by one or more livestock operators. An allotment usually consists of public lands, but may include parcels of private and other federal or state-owned lands. Allotment size within the CD-C project area ranges from 120,536 acres (Cyclone Rim Allotment, 10103) to 118 acres for the Adam's Ranch Allotment, 10501. Two of the larger allotments (Cyclone Rim and Monument Lake 00711) make up approximately 23 percent of the total land surface area of the project area (**Table 3.18-1**).

Historical cattle use in this area began in 1871 when Noah Reader brought 2,000 head that were turned out at the mouth of Savery Creek south of the project area. Later in 1873, George Baggs brought 2,000 head into the valley near the vicinity of the town bearing his name (Baggs, WY). Livestock numbers increased rapidly until the disastrous winter of 1886–87 which ended the open-range industry in Wyoming when an estimated 65 percent of the state's cattle died in a series of extreme blizzards accompanied by unprecedented frigid temperatures (Bennett 1999, Larson 1942). In the absence of cattle sheep soon became the dominant livestock in the area and were dominant from the 1890s through the 1950s. The peak in sheep numbers in Wyoming occurred in 1909 when a total of 6,023,000 animals was recorded (Wyoming Agricultural Statistics Service [WASS] 1995). The total inventory of sheep in Carbon County has steadily decreased over the years to about 14,000 head recorded in 2006 (NASS 2008). Cattle numbers have slowly risen through the years, with many sheep allotments converting back to cattle use in the 1960s through the 1980s. The peak number of cattle (all cattle) in Wyoming occurred in 1975 at 1,690,000 head, compared to 1,430,000 head in 2007. The most recent cattle inventory in Carbon County was 97,000 head, including 58,000 head of beef cows (NASS 2008).

The affected grazing allotments in relation to the major land cover types within their boundaries are shown in **Map 3.18-1**. These allotments, which overlap portions of the CD-C project area, total 1,616,637 acres; approximately 1,050,200 acres (65.0 percent) are located within the CD-C project area. In the extreme western portion of the project area, the Rock Springs Field Office manages three small grazing allotment inclusions, totaling about 1,289 acres. A total of five "non-allotments" are located within the project area with a composite total of about 19,942 acres. The largest non-allotment is located in the area north of the Red Desert/I-80 exit and mainly consists of numerous private ranchettes.

The 47 grazing allotments (**Table 3.18-1**) are permitted for a total of approximately 191,746 animal unit months (AUMs), of which an estimated 123,910 would be available from within the CD-C. An AUM is defined in the Rawlins RMP FEIS as "a standardized unit of measurement of the amount of forage necessary for the sustenance of one animal unit for 1 month." (BLM 2008a). For fee calculation, an AUM is defined in the Rawlins RMP FEIS as "a unit of measurement that represents the privilege of grazing one animal unit for 1 month" (BLM 2008a).

Cattle operations are primarily cow/calf pairs. Cattle use occurs during all seasons, including winter use both south and north of I-80. Winter use depends mainly on the location of the allotment and the requirements of each individual livestock operation. Each allotment is usually used for one season, or longer if use is rotated between pastures. Most cattle operators using the project area calve on the range versus their homeplace.



Map 3.18-1. Affected grazing allotments in the CD-C project area in relation to major land cover types

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Sheep use is limited within the project area and is confined predominantly to the Willow Creek (10528), Mexican Graves (10516), South Barrel (10525), South LaClede (10610), North LaClede (10613), Red Creek (10521), Cherokee (00408), Chain Lakes (10722), Badwater (10601), South Wamsutter (10620), and Cyclone Rim (10103) allotments. The Chain Lakes and Cyclone Rim allotments located in the northern portion of the project area are primarily for winter use.

Table 3.18-1. Estimated allotment acreage and AUMs within the CD-C project area

Allotment number	Allotment name	Acres[1]		Percent		AUMs[1]		
		Entire allotment	Within CD-C[2]	Of entire allotment	Of all allotted acreage	Entire allotment	Acres per AUM (stocking ratio)	Within CD-C[2]
00408	Cherokee	66,491	3,803	5.7	0.36	9,963	7.2	531
00415	Doty Mountain	85,936	28,903	33.6	2.75	10,111	7.9	3,660
00442	Dad	675	620	91.7	0.06	114	6.4	97
00443	East Muddy	6,174	620	10.0	0.06	796	7.7	80
00514	Little Robber	507	507	100.0	0.05	250	1.9	264
00705	Red Desert	46,560	46,557	100.0	4.43	4,075	11.5	4,060
00706	G.L.	19,039	19,039	100.0	1.81	2,551	7.5	2,540
00709	Jawbone	23,029	11,449	49.7	1.09	2,570	9.0	1,272
00710	Monument Draw	15,344	15,344	100.0	1.46	1,834	8.4	1,825
00711	Monument Lake	119,666	119,666	100.0	11.39	15,324	7.8	15,270
00713	North Creston-West	10,662	10,646	99.9	1.01	1,938	5.6	1,898
00714	Latham	40,161	40,159	100.0	3.82	5,116	7.8	5,148
00715	North Tipton	26,199	26,199	100.0	2.49	2,972	8.8	2,981
00716	North Wamsutter	59,808	59,808	100.0	5.69	6,296	9.1	6,587
00717	Ruby Knolls	30,094	30,094	100.0	2.87	3,159	9.5	3,151
00740	Grieve Pasture	2,176	2,136	98.2	0.20	220	9.9	216
00801	Larson Knolls	10,215	3,843	37.6	0.37	1,287	8.0	480
10103	Cyclone Rim	307,361	120,536	39.2	11.48	42,975	7.2	16,785
10501	Adam's Ranch	305	118	38.8	0.01	773	0.4	323
10503	Big Robber	17,605	17,605	100.0	1.68	1,580	11.1	1,591
10504	Big Robber Spreaders	1,129	1,129	100.0	0.11	114	9.1	124
10506	Continental	25,774	2,091	8.1	0.20	2,817	9.3	224
10508	Cottonwood Hill	14,560	1,208	8.3	0.12	790	18.3	66
10515	Mexican Flats	15,497	15,493	100.0	1.48	1,738	9.0	1,712
10516	Mexican Graves	20,264	19,782	97.6	1.88	1,976	10.2	1,932
10521	Red Creek	32,288	3,984	12.3	0.38	3,036	10.6	376
10525	South Barrel	10,298	4,716	45.8	0.45	1,037	9.9	478
10526	South Flat Top	19,010	11,342	59.7	1.08	1,771	10.6	1,066
10527	V Spreaders	337	337	100.0	0.03	150	2.1	158
10528	Willow Creek	76,422	1,180	1.5	0.11	5,468	14.3	83
10530	South Muddy	1,569	182	11.6	0.02	123	12.7	14
10531	George Dew	1,011	1,010	99.9	0.10	215	4.1	249
10601	Badwater	22,303	20,760	93.1	1.98	2,662	8.2	2,538
10604	Coal Bank Wash	7,640	7,640	100.0	0.73	1,053	7.3	1,049
10607	Echo Springs	45,500	45,500	100.0	4.33	5,093	9.1	5,022
10609	Fillmore	41,969	1,380	3.3	0.13	6,422	6.2	222
10610	South Laclede	52,944	48,032	90.7	4.57	5,948	9.0	5,322
10611	North Barrel	59,296	52,816	89.1	5.03	6,875	8.1	6,493
10612	North Pine Butte	2,322	2,322	100.0	0.22	224	10.5	221

Table 3.18-1. Estimated allotment acreage and AUMs within the CD-C project area, *continued*

Allotment number	Allotment name	Acres[1]		Percent		AUMs[1]		
		Entire allotment	Within CD-C[2]	Of entire allotment	Of all allotted acreage	Entire allotment	Acres per AUM (stocking ratio)	Within CD-C[2]
10613	North Laclede	41,501	41,501	100.0	3.95	4,323	9.7	4,300
10615	Riner	55,978	33,507	59.9	3.19	7,036	8.1	4,139
10619	South Red Desert	10,404	10,404	100.0	0.99	1,680	6.2	1,686
10620	South Wamsutter	31,408	31,408	100.0	2.99	2,648	11.7	2,681
10621	Tipton	58,202	58,112	99.8	5.53	9,540	6.4	9,136
10625	South Pine Butte	968	968	100.0	0.09	217	4.9	199
10626	Lazy Y S Ranch	17,865	17,865	100.0	1.70	1,898	6.2	2,880
10722	Chain Lakes	62,170	57,874	93.1	5.51	2,988	20.8	2,778
n/a	No allotment[3]	0	19,942					
	Total	1,616,637	1,050,200	65.0	100.0	191,746	8.6	123,910

[1] *Totals include all lands: private, public, and state.*
[2] *Estimated.*
[3] *Not included in totals.*

The establishment and rapid spread of halogeton—a plant toxic to sheep, cattle, and herbivorous wildlife—in the project area has adversely affected livestock operations, especially sheep. Sheep losses due to halogeton are estimated to range between 150 to 200 head per year (Calton 2008). Cattle and domestic horses can also be poisoned by ingesting halogeton. Most livestock losses occur when hungry animals are allowed to graze in heavy infestations of halogeton. The toxic effect of ingesting halogeton is due to the high level of toxic sodium oxalates that occur in the plant, especially in the leaves. Halogeton is toxic at all growth stages but toxicity increases as the plants mature. Herbivorous wildlife have been observed to consume halogeton but it is believed their highly varied grass/forb/shrub diet prevents the animals from ingesting a lethal dose (Pfister 2012). Although undocumented, this probably applies to wild horses as well.

According to grazing regulations that became effective on August 12, 1995, the State Director of the Wyoming Bureau of Land Management (BLM) is required to develop and implement standards for healthy rangelands and guidelines for grazing management (Standards for Healthy Rangelands & Guidelines for Livestock Grazing Management for the Public Lands Administered by the BLM in the State of Wyoming at: < http://www.blm.gov/wy/st/en/programs/grazing/standards_and_guidelines/-standards.html>). Standards apply to all uses of BLM-administered public lands in Wyoming and represent the minimum acceptable conditions for public rangelands. The guidelines apply only to livestock grazing. The Wyoming standards and guidelines were submitted to the Secretary of the Interior in July 1997 and were approved August 12, 1997.

The RFO continues to implement or refine Best Management Practices (BMPs) for livestock grazing, which promote perennial vegetation to stabilize stream banks and improve cover and litter on uplands. Season, duration, and distribution of livestock are the principal factors in considering management changes to meet desired resource objectives for both riparian and upland habitats. Specific dates or times must be decided on a case-by-case basis. Methods to achieve this include, but are not limited to: herding, pasture fencing, water developments, and vegetation treatments. Vegetation treatments are designed to restore plant communities with diverse species, age classes, and cover types. The ultimate goal of these rangeland management tools is to improve watershed cover, riparian habitat, and upland plant communities to ensure that long-term range quality and national and Wyoming BLM Standards for Healthy Rangelands are being met.

These standards are the basis for assessing and monitoring rangeland conditions and trends. The assessments evaluate the standards and are conducted by an interdisciplinary team with participation from permittees and other interested parties. Assessments are only conducted on BLM-administered public land; however, interpretation of watershed health and water quality may reflect on all land ownerships within the area of analysis. The six standards are as follows:

- Standard 1 – Watershed Health
- Standard 2 – Riparian/Wetland Health
- Standard 3 – Upland Vegetation Health
- Standard 4 – Wildlife/Threatened and Endangered Species Habitat Health, Fisheries, Weeds
- Standard 5 – Water Quality
- Standard 6 – Air Quality

In the RFO, rangeland standards were assessed on an allotment basis from 1998 through 2001 (BLM 2001a). The allotments that did not meet Standards due to livestock grazing include the Cyclone Rim (10103) and Jawbone (00709) allotments. Neither of these allotments met Standard # 2 (Riparian/Wetland Health) (BLM 2001a, pp. 119-120). Other grazing allotments within the project area that failed to meet one or more of the six standards due to other causes such as weeds, oil and gas development, and other factors, include Red Desert (00705), G.L (00706), Monument Draw (00710), Monument Lake (00711), North Creston-West (00713), Latham (00714), North Tipton (00715), North Wamsutter (00716), Coal Bank Wash (10604), Echo Springs (10607), Fillmore (10609), Riner (10615), Ruby Knolls (00717), South Red Desert (10619), Tipton (10621), Lazy Y S Ranch (10626), and Chain Lakes (10722). In most instances, the specific areas that prevented the allotment from meeting a Standard were small compared to the total land surface area of the allotment and do not represent conditions over the total allotment.

The recent extensive drought in this area of Wyoming has affected livestock operations in several ways, including (1) the low soil-moisture levels associated with drought which limit plant growth and reduce forage yields; (2) the low soil moisture which limits root growth and makes it more difficult for range plants to reach scarce soil moisture; (3) low germination rates which hamper successful revegetation efforts; (4) over a series of drought or dry years, a shift in plant species to weedy, less-productive species (e.g., desert alyssum, halogeton, etc.); and (5) increased livestock medical costs associated with respiratory diseases attributable to dry ranges and increased dust levels (see **3.6.4, Fugitive Dust Effects on Vegetation**).

3.18.2 Existing Allotment Disturbance

GIS analysis of the project surface area was performed to estimate the total area of existing disturbance by allotment. The disturbance terminology was standardized to conform to that of Bargsten (2005) with the exception that all existing roads, pipeline disturbances, gas-compression facilities, storage-tank complexes, man-camps, construction/pipe yards, etc., were included in the HWA GIS analysis, regardless of whether or not they serviced an individual well or several. Bargsten (2005) defines short- and long-term disturbance as follows.

Short-term disturbance area: the maximum areal extent of ground disturbance associated with construction, drilling, and completion of an individual natural gas well, including the well pad, reserve pit, spoils pile(s), topsoil stockpile(s), and access road authorized to serve that individual well. The concept is referred to elsewhere in this document as *initial* disturbance.

Long-term disturbance area: the areal extent of un-reclaimed disturbance after interim reclamation occurs at an individual natural gas well. This is equal to the "life-of-project" disturbance area and represents the area, when interim reclamation is complete, that will remain in a disturbed state until the well is plugged and abandoned. This includes the production facilities, dehydrator, separator, wellhead, production tanks, and access road area that is surfaced and/or maintained free of vegetation.

The existing initial and long-term disturbance acres of the 47 CD-C allotments are shown in **Table 3.18-2**. The disturbance acreage in the five "non-allotments" and the three partial Rock Springs Field Office allotments was calculated but not used for AUM calculation results. The disturbance percentages represent the part of the allotment that is within the CD-C project area.

Table 3.18-2. Historic surface disturbance by allotment, initial and long-term

Allotment number	Allotment name	Total Acres in CD-C project area[2]	Initial[1]		Long-term[1]	
			Disturbance acres	% of allotment	Disturbance acres	% of allotment
00408	Cherokee	3,803	121.1	3.2	21.8	0.6
00415	Doty Mountain	28,903	1,317.4	4.6	211.1	0.7
00442	Dad	620	29.5	4.8	0.8	0.1
00443	East Muddy	620	9.0	1.5	3.6	0.6
00514	Little Robber	507	15.4	3.0	2.6	0.5
00705	Red Desert	46,557	543.5	1.2	100.1	0.2
00706	G.L.	19,039	723.3	3.8	18.4	0.1
00709	Jawbone	11,449	41.3	0.4	17.4	0.2
00710	Monument Draw	15,344	391.9	2.6	88.1	0.6
00711	Monument Lake	119,666	5,332.9	4.5	992.6	0.8
00713	North Creston-West	10,646	82.9	0.8	28.0	0.3
00714	Latham	40,159	2,690.7	6.7	337.5	0.8
00715	North Tipton	26,199	840.5	3.2	109.4	0.4
00716	North Wamsutter	59,808	5,694.9	**9.5**	820.8	1.4
00717	Ruby Knolls	30,094	341.5	1.1	65.3	0.2
00740	Grieve Pasture	2,136	120.1	5.6	18.4	0.9
00801	Larson Knolls	3,843	15.7	0.4	6.0	0.2
10103	Cyclone Rim	120,536	2,309.7	1.9	533.5	0.4
10501	Adam's Ranch	118	7.0	5.9	0.5	0.4
10503	Big Robber	17,605	639.7	3.6	130.4	0.7
10504	Big Robber Spreaders	1,129	48.4	4.3	5.9	0.5
10506	Continental	2,091	1.6	0.1	0.0	0.0
10508	Cottonwood Hill	1,208	65.2	5.4	16.3	1.4
10515	Mexican Flats	15,493	649.5	4.2	152.8	1.0
10516	Mexican Graves	19,782	613.0	3.1	126.4	0.6
10521	Red Creek	3,984	81.0	2.0	18.9	0.5
10525	South Barrel	4,716	128.2	2.7	32.5	0.7
10526	South Flat Top	11,342	306.1	2.7	77.2	0.7
10527	V Spreaders	337	27.5	**8.1**	4.3	1.3
10528	Willow Creek	1,180	0.0	0.0	0.0	0.0
10530	South Muddy	182	0.0	0.0	0.0	0.0
10531	George Dew	1,010	6.6	0.7	0.5	0.1
10601	Badwater	20,760	521.6	2.5	87.1	0.4
10604	Coal Bank Wash	7,640	483.4	6.3	79.0	1.0
10607	Echo Springs	45,500	5,012.9	**11.0**	835.1	1.8
10609	Fillmore	1,380	0.1	0.0	0.0	0.0
10610	South Laclede	48,032	4,185.4	**8.7**	646.5	1.3
10611	North Barrel	52,816	2,303.5	4.4	384.8	0.7
10612	North Pine Butte	2,322	152.8	6.6	31.7	1.4

Table 3.18-2. Historic surface disturbance by allotment, initial and long-term, *continued*

Allotment number	Allotment name	Total Acres in CD-C project area[2]	Initial[1]		Long-term[1]	
			Disturbance acres	% of allotment	Disturbance acres	% of allotment
10613	North Laclede	41,501	4,422.8	**10.7**	556.9	1.3
10615	Riner	33,507	1,271.0	3.8	205.8	0.6
10619	South Red Desert	10,404	204.1	2.0	47.2	0.5
10620	South Wamsutter	31,408	2,674.1	**8.5**	461.3	1.5
10621	Tipton	58,112	1,577.5	2.7	241.3	0.4
10625	South Pine Butte	968	43.2	4.5	9.9	1.0
10626	Lazy Y S Ranch	17,865	1,130.1	6.3	175.8	1.0
10722	Chain Lakes	57,874	292.6	0.5	85.1	0.1
n/a	No allotment[3]	19,942	1,747.7	n/a	683.5	n/a
Totals		**1,070,142**	**49,218.0**	**n/a**	**8,472.0**	**n/a**

[1] *Totals include all lands, private, public, and state.*
[2] *Estimated.*
[3] *Not included in totals.*

3.19 OIL AND GAS AND OTHER MINERALS

Mineral resources within the CD-C project area include deposits of base and precious metals, bentonite, gypsum, limestone, uranium, zeolite, gravel, and klinker, as well as oil, gas, coal, and coalbed methane (CBM) (BLM 2003b). Federal mineral management organizes minerals into three categories: locatable, leasable, and mineral materials.

Locatable minerals are all minerals subject to exploration, development, and production under the provisions of the Mining Law of 1872. Locatable minerals include both metallic minerals (gold, silver, lead, etc.) and nonmetallic minerals (such as fluorspar, asbestos, mica, and gemstones.). Mining claims can be located for such minerals pursuant to 43 CFR Part 3830. Originally, all minerals except coal were obtained under the Mining Law of 1872; however, Congress has removed certain minerals from the operation of the Mining Law. Since 1920, the federal government has leased energy fuels and certain other minerals. Since 1947, the federal government has sold common varieties of sand, gravel, stone, pumice, pumicite, cinders, and ordinary clay. Leasables and salables are described below.

Leasable minerals are subdivided into two classes, fluid and solid.

- Fluid minerals include oil and gas; geothermal resources and associated by-products; and oil shale, native asphalt, oil impregnated sands, and any other material in which oil is recoverable only by special treatment after the deposit is mined or quarried.
- Solid leasable minerals are those leased under the mineral leasing acts and those hardrock minerals leased under Reorganization Plan No. 3 of 1946 (acquired lands), such as coal and phosphates.

Leasable minerals are managed under the Mineral Leasing Act of 1920, as amended and supplemented.

Mineral materials, also termed “salable” minerals, include common varieties of sand, stone, gravel, pumice, pumicite, cinders and clay, which are generally put to use in building and construction. BLM disposes of mineral materials via contract sales where the material is sold by the ton or cubic yard at fair market value, or provides them to governmental entities or nonprofit organizations under free use permit pursuant to the regulations at 43 CFR Part 3600.

3.19.1 Locatable Minerals

The most important locatable mineral found in the CD-C project area is uranium. The Wyoming State Geological Survey's *Uranium Map of Wyoming* (WSGS 2010) shows four uranium mining districts in or near the CD-C project area. The Great Divide Basin Mining District is the largest and the only one within the CD-C project area, overlapping the upper third of the project area. Uranium-bearing prospects there occur in arkoses of the Battle Spring Formation (Pipiringos 1961) that is exposed just west of the project boundary; in coals of the main body of the Wasatch Formation, north of Wamsutter (Masursky 1962); and around the towns of Creston and Latham (Harris *et al.* 1985, Harris and King 1993). The only notable site of mining claims for locatable minerals in the CD-C project area is located within the Great Divide Basin sedimentary uranium deposits. Over 80 mining claims have been filed in sections 3, 10, 12-15, 24, and 35, T23 N:R94W in the north central portion of the project area, along the Crooks Gap Road (available at: http://www.blm.gov/landandresourcesreports/rptapp/criteria_select.cfm?rptId=19&APPCD=2&).

The Poison Basin (Baggs) Mining District lies just west of the town of Baggs and about five miles outside the CD-C project's southern boundary. The Ketchum Buttes District lies about 15 miles east of the project area in T15N:R89W. A fourth district, the Crooks Gap-Green Mountain Minding District, is located about 20 miles north of the project area boundary.

No uranium development activity has taken place within the CD-C project area, but historic activity has occurred in all four of the described districts and the Great Divide Basin and Crooks Gap-Green Mountain districts contain several proposed new developments. One, the Lost Creek Uranium In-Situ Recovery Project, is located several miles north of the CD-C project's northern boundary in sections 16–20, T25 N:R92W and sections 13, 24, and 25, T25N:R93W. The proposed mine is expected to be in operation for about 12 years.

3.19.2 Leasable Minerals

Coal and CBM occur in Tertiary and Cretaceous-age geologic formations, and oil and gas occur in geologic formations of Tertiary, Cretaceous, Jurassic, Triassic, and Pennsylvanian age underlying the project area. Oil shale resources occur within the Green River Formation in the Washakie Basin; however, the most geologically prospective oil shale resources of the Washakie Basin occur to the southwest of the CD-C project area (2012 Oil Shale and Tar Sands Draft Programmatic Environmental Impact Statement, posted at http://ostseis.anl.gov/documents/peis2012/) and so this resource will not be discussed further in this document. Other leasable minerals that occur within the CD-C project area are phosphate and sodium. The 2003 *Mineral Occurrence and Development Potential Report*, prepared for the RFO RMP (BLM 2003), indicates that the potential for development of phosphate is low. The report also concluded that the nature of the sodium deposits within the RFO (including the CD-C project area), in conjunction with the available domestic production capacity, suggests that there is little potential for commercial exploitation of the RFO's phosphate deposits. Because the potential for development is low, phosphate and sodium will not be discussed further in this document.

3.19.2.1 Coal and Coalbed Methane

Fort Union Formation

The Fort Union Formation of south and southwest Wyoming constitutes an enormous, largely untapped reserve of coal. Coals occur throughout the formation, but are thickest and most continuous in its lower part (the lower coal-bearing unit) (Smith *et al*. 1972, Sanders 1974 and 1975, Beaumont 1979, Edson 1979, Hettinger and Brown 1979, Honey and Roberts 1989, Honey and Hettinger 1989, Honey 1990, Jones 1991, Hettinger *et al*. 1991).

Within and adjacent to the project area, coal seams of the Fort Union Formation comprise the Creston-Cherokee and Green River coals. These coals are best developed along the east side of WY 789 in T19N:R92W and include about 20,364 leasable acres.

Studies of the Fort Union Formation coals in the project area and adjacent areas have been conducted by Sanders (1974, 1975), Edson (1979), Honey and Hettinger (1989), Honey and Roberts (1989), and Honey (1990). As many as ten coal seams have been mapped in the subsurface with individual seams averaging 10 to 20 feet thick, but thickening to as much as 40 feet. Net coal thickness increases in the subsurface southward toward the Baggs area where it may reach a maximum of about 75 feet. Thicker Fort Union coals have been interpreted to have accumulated in flood plains above and on the flanks of major Paleocene-age, south/north-oriented river systems. Thinner coal seams accumulated away from these main trunk streams.

The Fort Union Formation is a primary CBM target in the southeastern Greater Green River Basin, but the formation crops out at the surface only in the easternmost part of the project area, so few if any of the coalbeds that dip westward are buried deep enough to be candidates for development. Deeper buried coalbeds west and south of the area have ash-free gas contents generally less than 100 standard cubic feet per ton (scf/ton), but ranging from 9 to 561 scf/ton. Scott *et al*. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County underlying the project area to be less than 2 billion cubic feet (Bcf) per square mile (mi^2) near the eastern margins of its subcrop, to 6–8 Bcf/mi^2 in deeper buried areas north and west of Baggs. These values may be enhanced by migration of gases into the area from deeper parts of the basin. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, Fort Union coals rank as sub-bituminous high volatile C bituminous and high volatile B bituminous.

Lance Formation

Coals occur discontinuously in outcrops in the Lance Formation from I-80 south for about 25 miles. Averaging about five feet in thickness, but ranging from a few inches to 22 feet thick, these coals are thicker, more abundant, and laterally extensive in the lower part of the formation. The coals have limited lateral extent and usually cannot be traced more than a few hundred to several thousand feet. Lance Formation coalbeds are minor CBM targets (Scott *et al*. 1994).

Mesaverde Group

Coal occurs in outcrops in the Mesaverde Group in several places along the western edge of the Sierra Madre, and exists in the subsurface within the project area. These coals are best developed high in the Mesaverde Group near its contact with the overlying Lewis Shale in exposures east of the project area, along the eastern edge of the project area (Atlantic Rim and Green River Coal Fields) and in T15-16N:R90-91W (an unnamed coal field). These fields include about 230,400 leasable acres. Coals are also developed sporadically lower in the Mesaverde Group (Allen Ridge Sandstone) but these coals are thin and discontinuous. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, the Mesaverde coals underlying the project area rank as high volatile C bituminous, high volatile B bituminous and high volatile A bituminous.

Coals in the Ericson Sandstone (a/k/a Pine Ridge Sandstone or Williams Fork Formation) include the thickest and most extensive coals of the Upper Cretaceous in the Greater Green River Basin and are the basin’s prime CBM targets. The maximum net coal thickness of about 220 feet, contained in 40 individual coalbeds, occurs near Craig, Colorado. The coalbeds thin in a westerly and northerly direction, so that in the southeastern part of Carbon County, underlying the project area, net coal thicknesses range from 40 to 90 feet. These coals are interpreted to have accumulated in coastal plain environments and fluvial-dominated, wave-modified deltas, along a southwest/northeast-oriented strand (beach) line that faced southeastward into the Cretaceous epicontinental seaway.

Gas content values for coals developed in the Ericson Sandstone (a/k/a Pine Ridge Sandstone or Williams Fork Formation) range from less than 1 to more than 540 scf/ton, but are generally less than 200 scf/ton. Based on gas content values, Scott *et al*. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County underlying the project area to be less than or equal to 10 Bcf/mi^2 near the eastern margins of its subcrop and 8 to 40 Bcf/mi^2 in the extreme southwestern corner of the county.

Coals in the Rock Springs Formation (a/k/a Allen Ridge Sandstone or Iles Formation) are thinner and not as well-developed as those in the Pine Ridge and the formation is considered a minor coal-bearing unit and CBM target. A maximum net coal thickness of 32 feet occurs in the easternmost part of the Great Divide Basin, but in most other places it is typically less than 15 feet. These coals are interpreted to have accumulated in a variety of swampy environments above shoreline sandstones and in floodplains adjacent to delta river channels.

Based on samples from wells primarily in the Rock Springs Uplift, gas content values in the Rock Springs Formation (a/k/a Allen Ridge Sandstone or Iles Formation) range from zero to more than 650 scf/ton. No estimates of total coal gas reserves are available for this unit.

3.19.2.2 Oil and Gas

The region within which the CD-C project is located has produced substantial quantities of oil and natural gas, principally from Cretaceous rocks, but with additional notable resources derived from the Tertiary Wasatch and Fort Union Formations, and from the Pennsylvanian Tensleep Sandstone.

Developed oil and gas fields within the area are listed in **Table 3.19-1**. Most of these fields produce principally from stratigraphic traps in sandstones of the Tertiary and upper Cretaceous formations (DeBruin, 1996); a few produce from structural traps.

The Oil and Gas Fields Symposium Committee (1957, 1979, 1992), Gregory and DeBruin (1991), DeBruin and Boyd (1991), and DeBruin (1996) report oil and gas from wells penetrating the Cretaceous Niobrara, Lance, Shannon Sandstone, and Mesaverde formations in the region surrounding the towns of Dixon and Savery (east of the southern part of this study area), as well as some shows there from the Tensleep Formation. The Baggs South Oil and Gas Field and the West Side Canal Oil and Gas Field (Cronoble 1969; DeBruin 1993; Kaiser *et al.* 1994) produce oil and gas (largely gas) from combined stratigraphic and faulted structural traps in the lower Eocene Wasatch, the Paleocene Fort Union, and the Upper Cretaceous Lance, Fox Hills, Almond, and Lewis Shale (sandstone facies) in T12–13 N:R90–93 W, in the southern part of the adjacent Atlantic Rim CBM area.

Regionally, Colson (1969) reported Tertiary oil and gas production from all Tertiary stratigraphic units from the Tipton Tongue of the Green River Formation (within the report’s study area), down to the level of the Cretaceous/Tertiary (Lance/Fort Union) unconformity. In the South Baggs Field in T12 N:R92 W (south of this study area), oil and gas are concentrated at the crest of a structural high (probably a faulted anticline) in the Fort Union Formation. Farther east, production in the West Side Canal Field (T12N:R 91–92W) is from the lower sandy interval of the Paleocene Fort Union Formation, also in a structural trap on a faulted anticline.

Table 3.19-1. Oil and gas fields in the CD-C project area and cumulative production as of 2007

Field	General Location	Discovered	Producing Horizons (alphabetical)	Production/ Oil (BBLS)	Production Gas (MCF)
Baldy Butte	17N–92W	1982	Almond, Lewis, Mesaverde	280,142	25,717,419
Barrel Springs	16N–93W	1965	Almond, Lance, Lewis, Mesaverde	1,135,636	115,954,827
Bastard Butte	25N–97W	1978	Lewis	7,200	9,806
Battle Springs	23N–94W	1979	Almond, Ericson, Lewis, Mesaverde	17,732	1,754,063
Blue Gap	15N–92W	1974	Almond, Lance, Lewis, Mesaverde	393,537	44,171,587
Bush Lake	24N–96W	1978	Almond, Lance, Lewis	9,042	5,081,050
Coal Gulch	17N–93W	1977	Almond, Lewis, Mesaverde	1,461,251	110,000,237
Continental Divide	22N-93W	1964	Dakota, Ericson, Lewis, Mesaverde	54,117	875,731
Cow Creek	16N–92W	1960	Cow Creek, Dakota, Deep Creek, Frontier, Lewis, Mesaverde, Maropos, Muddy, Lakota, Nugget, Trout Creek	1,850	22,352,883
Creston	19N–92W	1960	Almond, Blair, Ericson, Frontier, Lewis, Mesaverde	481,245	36,871,009
Creston Southeast	19N–90W	1977	Almond	151	105,857
Delaney Rim Unit	18N–97-98W	1976	Almond, Lewis, Mesaverde	1,339,974	10,513,455
Echo Springs	19N–93W	1976	Almond, Ericson, Lewis, Mesaverde	9,942,729	572,186,906
Emigrant Trail	17N–95W	1981	Almond, Lance, Lewis, Mesaverde	68,305	2,009,639
Fillmore	20N–92W	1977	Almond, Ericson, Lewis, Mesaverde	335,805	8,633,145
Five Mile Gulch	21N–93W	1977	Almond Ericson, Lewis, Mesaverde	213,256	12,758,321
Frewen	19N–95W	1990	Almond Frontier, Lakota, Lewis, Mesaverde	789,764	22,250,444
Gale	23N–96W	1980	Ericson, Lewis	3,295	325,885
Great Divide	22–23N 95–96W	1978	Lance Lewis	346,116	10,674,736
Hay Reservoir	24N–97W	1977	Almond, Big Coal, Lance, Lewis, Mesaverde	2,615,544	165,002,506
Lost Creek Basin	23N–95W	1981	Ericson, Lewis, Mesaverde	28,413	635,377
Lost Creek	23N–97W	1972	Lewis	375	29,301
Monument Lake	21N–92W	1977	Almond, Ericson, Mesaverde	20,057	1,634,814
Nickey	24N–96W	1980	Almond, Lewis	1,511	1,785,984
Red	16N–94W	1979	Mesaverde	2,240	106,418
Red Desert	18N–97-98W	1971	Almond, Lewis, Mesaverde	240,542	23,318,701

Table 3.19-1. Oil and gas fields in the CD-C project area and cumulative production as of 2007, *continued*

Field	General Location	Discovered	Producing Horizons (alphabetical)	Production/ Oil (BBLS)	Production Gas (MCF)
Robbers Gulch	14N–91W	1962	Almond, Lance, Lewis, Mesaverde	238,479	35,649,093
Salazar	16N–95W	1975	Lewis, Mesaverde	4,735	535,536
Sentinel Ridge	23N–94W	1977	Almond Ericson, Lewis, Mesaverde	4,761	1,045,093
Shell Creek	19N–96W	1977	Almond, Mesaverde	11,935	521,586
Siberia Ridge	21N–94W	1976	Almond, Ericson, Lewis, Mesaverde	2,427,328	147,569,111
Standard Draw	18N–93W	1978	Almond, Ericson, Lakota, Lewis, Mesaverde, Steele	8,467,259	505,804,384
Stock Pond	22N–95W	1978	Almond, Ericson, Mesaverde	10,502	1,318,232
Strike	22N–95W	1994	Almond, Ericson, Lewis, Mesaverde	138,919	2,000,549
Table Rock	18–19N 97–98W	1946	Almond, Blair, Carney Coal, Dakota, Ericson, Fort Union, Fox Hills, Frontier, Lewis. Madison, Mesaverde, Morgan, Nugget, Wasatch, Weber	6,378,299	716,430,993
Table Rock SW	18N–98W	1955	Almond, Lewis	37,589	1,628,192
Tierney	19N–94W	1973	Almond, Frontier, Lewis, Mesaverde	1,394,555	42,717,016
Wamsutter	20–21N 94–95W	1958	Almond, Ericson, Lance, Lewis, Mesaverde, Rock Springs	3,745,535	36,672,037
Wells Bluff	18N-96W	1977	Almond, Ericson, Mesaverde	24,480	555,970
Wild Rose	17-18N-94W	1975	Almond, Ericson, Fort Union, Lance, Lewis, Mesaverde	6,692,296	399,132,288
Windmill Draw	15N-94W	1979	Almond, Ericson, Mesaverde	1,987	870,431

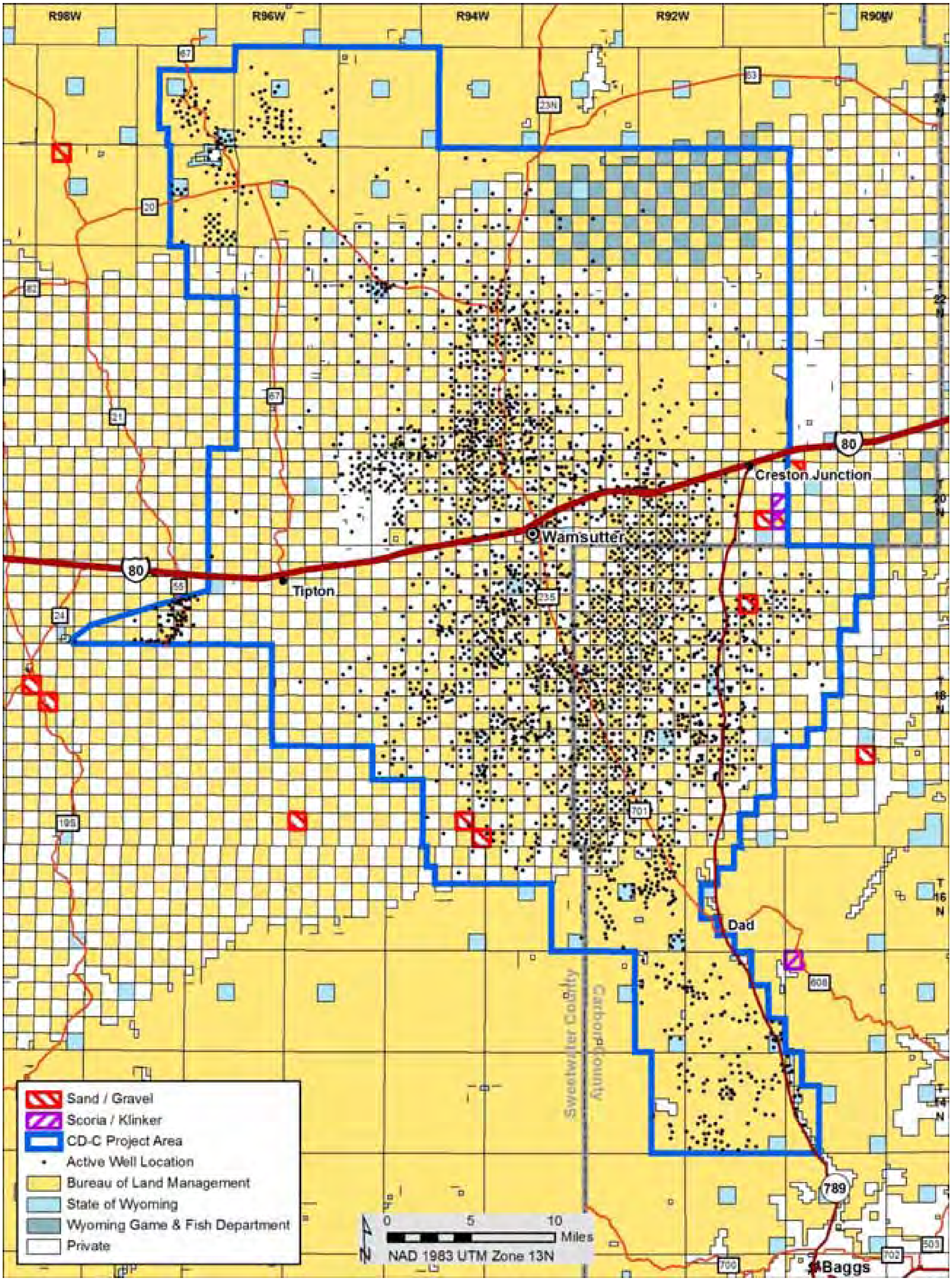
3.19.3 Mineral Materials

Mineral materials, also termed “salable” minerals, include common varieties of sand, stone, gravel, pumice, pumicite, cinders and clay, which are generally put to use in building and construction. Salable minerals disposition is addressed under the Materials Act of July 31, 1947, as amended by the Acts of July 23, 1955 and September 28, 1962 (BLM 2003b). The BLM disposes of mineral materials via contract sales where the material is sold by the ton or cubic yard at fair market value, or provides them to governmental entities or nonprofit organizations under free-use permit pursuant to 43 CFR Part 3600 regulations. Potential purchasers or permittees may conduct pre-application sampling and testing of a mineral material deposit per 43 CFR 3601.30 (BLM 2012d).

The most significant salable mineral within the RFO—and within the CD-C project area—is aggregates, or sand and gravel, occurring in the project area typically as terrace and alluvial sand and gravel deposits and as windblown (dune) deposits. Mapped occurrences of sand and gravel deposits are found at the following general locations in and near the project area (2003b):

- T25N:R95-96W North of Lost Creek Basin (terrace)
- T22N:R95-96W Northeast flank of the Red Desert Basin (terrace)
- T20-21N:R92W Creston Junction area (terrace)
- T24N:R96W East of Hay Reservoir (alluvial)
- T24N:R95W Mouth of Eagle's Nest Draw (alluvial)
- T19N:R93W Echo Springs, southeast of Wamsutter (alluvial)
- T12-17N:R91-92W Muddy Creek area (alluvial)
- T21-23N:R95-96W Red Desert Basin (windblown sand)
- T16-17N:R93-94W Barrel Springs Draw (windblown sand)

Also present within the project area are pumice and scoria, near Creston Junction, and baked and fused shale (known locally as "scoria" or "klinker" but not technically a true volcanic scoria), with several large deposits in the area stretching from Creston Junction to Baggs. Both are important local sources of aggregate. Some of these deposits have been developed as gravel pits. Sources on BLM-administered land are located near Wamsutter (T19N:R95W), Creston Junction (T20N:R91W), and along the Little Snake River (T12-13N:R90-91W) (BLM 2003b). Several sites on private lands also provide mineral materials. **Map 3.19-1** shows the locations of permitted sand and gravel and scoria mines by section within and adjacent to the CD-C project area (WDEQ – Land Quality Division 2012).



Map 3.19-1. Permitted sand, gravel, and scoria/klinker mines within and near the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

3.20 HEALTH AND SAFETY

Existing health and safety concerns in and adjacent to the project area include occupational hazards associated with natural gas exploration and operations, the operation of vehicles on improved and unimproved roads, natural gas pipeline operations, winter driving and working conditions, hunting-related firearms accidents, collisions with livestock and big game, and low-probability natural hazards associated with events such as landslides, flash-floods, range fires, or winter blizzards.

3.20.1 Worker Safety

Health and safety concerns within the existing project area are primarily the occupational hazards associated with oil and gas development and production activities. Operators and service companies working within the field are governed by the State of Wyoming Department of Employment Workers Occupational Health and Safety (WOSHA) program. WOSHA has adopted the federal Occupational Safety and Health Administration (OSHA) general construction program rules and regulations and has special rules for oil and gas well drilling, well servicing, and special servicing operations.

The project workforce can be divided into two groups: those associated with drilling and completion activities and those involved in production operations. Drilling services employment categories had a non-fatal accident rate of 6.8 per 100 employees in 2004 compared to the operations support category non-fatal accident rate of 2.7 in the same year (U.S. Department of Labor, OSHA 2007). Due to the high level of accidents (greater than three lost work-day injuries and illness, or LWDII) experienced in these occupations, oil and gas well drilling is one of the OSHA target industries in a cooperative effort between OSHA and industry partners to reduce accident and fatality rates. By 2009, these accident levels had dropped to 1.9 and 2.2, respectively (OSHA Bureau of Labor Statistics 2009). By comparison, all private industry workplaces reported a LWDII injury rate of 4.0 per 100 employees in 2009 (Bureau of Labor Statistics 2009).

Natural gas gathering, compression, stabilization, and transmission operations currently take place in the project area. Most natural gas transmission and gathering pipeline operations are regulated by the U.S. Department of Transportation (USDOT) Office of Pipeline Safety (OPS). In 2006 there were 133 onshore natural gas transmission and gathering line accidents reported nationwide, resulting in three fatalities and four injuries; in 2010 there were 92 such accidents including eight fatalities in the transmission line system (USDOT OPS 2011). The OPS regulations require stringent system maintenance programs, emergency response planning, risk management planning, and individual personnel operations and maintenance training for each natural gas pipeline system.

3.20.2 Public Health and Safety

The project area is attractive to local residents as a recreation area for such pursuits as bird and big game hunting, rock-hounding, and seeking solitude. The area is also home for scattered rural families and their ranching operations.

The roads within the project area see a wide variety of use. BLM and county roads have historically been built to the appropriate standards for the anticipated use, as have the private roads in the area. Single-lane dirt roads provide access to individual well sites and are used primarily by site workers but may be used by bird and big game hunters. In an effort to protect their employees, as well as the public, the Operators have safe driving policies in place. The project area is intersected by I-80. This very high-volume interstate highway provides access to the project area for contractors, drilling crews, production personnel, and the general public. This topic is more fully discussed in **Section 3.16 Transportation**.

The OPS regulates some aspects of gas-gathering and transmission pipelines operated in the field and beyond. USDOT regulations also address the safe transportation of hazardous materials (i.e. condensate, crude oil, methanol, drilling mud chemicals) on the national roads and highways. The gas produced in the project area is generally "sweet," meaning it does not contain hydrogen sulfide (H_2S), and therefore it does not pose a H_2S hazard to the general public or to site workers.

Fire-prevention measures for pipeline and site construction are in place during the summer construction season. These include using equipment with spark arrestors, welding in cleared areas only, and the ready availability of fire extinguishers or water trucks in the event fire occurs. The BLM requires extra precautions in the event of drought or high fire danger.

Local and state emergency responders are annually provided information regarding the location and nature of hazardous materials that are held in quantities in excess of their regulatory threshold planning quantity (TPQ) or 10,000 pounds, as appropriate. All Operators and their contractors are required to supply this information under the Community Right-to Know Laws (40 CFR 355 and 370, as amended). Each Operator has an Emergency Action Response Plan as well as access to the trained personnel and equipment needed to respond to releases of hazardous materials or other hazardous conditions in the project area.

3.20.3 Other Risks and Hazards

Any firearm-related accidents would occur primarily during hunting season. No data were available to estimate or discuss the likelihood of risk for gas-field workers to be injured by hunters. Risk of human-caused fire in the project area is low.

3.21 WASTE AND HAZARDOUS MATERIALS MANAGEMENT

Numerous companies operate within the project area; all Operators and their contractors are responsible for compliance with all local, state, and federal regulations applicable to their operations for environmental protection. Different companies have different compliance philosophies, ranging from minimal compliance to compliance programs that exceed regulatory requirements.

3.21.1 Waste Management

The management of non-exempt hazardous and non-hazardous (solid) wastes is regulated under the Resource Conservation and Recovery Act (RCRA) (40 CFR Part 260-268) while the management of releases of hazardous materials into the environment is regulated under the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) (40 CFR Part 300-374). Oil and gas exploration, production, gas-gathering, processing wastes, and releases of hazardous materials into the environment are generally considered to be RCRA-exempt and are regulated by the WOGCC or WDEQ and the BLM. All wastes are to be treated or disposed of in an approved manner consistent with existing laws and regulations (Gold Book, BLM 2007b). Non-exempt wastes will not be mixed with exempt wastes. BLM Wyoming has established policy regarding the management of exploration and production wastes (WY 2012-007, November 15, 2011), and the applicable standards from the IM will be considered and evaluated at the time APDs or Sundry Notices are reviewed by the BLM.

A number of permitted solid or hazardous waste sites in the project area are identified in the WDEQ Solid and Hazardous Waste Division database. These range from the historic Wamsutter landfill to active disposal facilities for specific gas-field operational areas.

Non-hazardous solid waste typically includes oil and gas exploration, production, and gas-gathering, as well as processing wastes and releases of hazardous materials into the environment, and is considered RCRA-exempt. These materials are variously regulated by WDEQ, WOGCC, and the BLM. Buried materials may also be present in association with historic homestead locations. Non-hazardous solid wastes generated from operations are hauled to municipal landfills in Wamsutter, Rock Springs, and Rawlins.

Hazardous wastes are generated in association with some gas-processing operations in the CD-C project area. These wastes and disposal sites are permitted and managed in compliance with the WDEQ hazardous waste program regulations.

Non-hazardous trash and debris are collected in dumpsters or trash cages at the individual well sites, compressor stations, construction sites, and man camps. Trash is also collected in individual containers or bags for off-site disposal. These waste materials are disposed of in accordance with state standards as imposed by the county sanitarian.

Drilling Mud – Portions of the project area have been producing natural gas and oil since at least 1958. Regulations and industry standards for the management of wastes have changed substantially since that time. Until the 1980s waste materials generated during drilling, production, and processing operations would typically have been buried near the point of generation within the field area. Reserve pit contents may have been buried at older producing or plugged-and-abandoned well sites. The disposal of these materials is now regulated and approved by the WOGCC and the BLM. More recently some of the Operators have recycled drilling mud between wells for re-use. This practice reduces the volume of material to be disposed of. Historically, the BLM required drilling pits to be fenced upon rig release and backfilled within six months of well completion. If a liner has been used in the reserve pit, any liner material must be removed to below ground-level before being covered. Completion fluids are also recycled to the extent possible to minimize waste disposal but are generally produced to an open pit onsite for disposal. Reserve-pit and well-completion wastes are generally classified by the EPA as “exempt non-hazardous” and are not regulated by the RCRA (40 CFR 261.4).

In the event **flaring or venting of natural gas** is required to facilitate safe operations, Operators must comply with the notification provisions of BLM Notice to Lessee (NTL)-4A, which allows the flaring of gas in emergencies for up to 30 days or 50 MMcf. Longer duration or higher-volume flaring events would require subsequent BLM approval. Operators must also follow WDEQ Air Quality and WOGCC rules.

Produced water within the project area is currently managed through the use of private and commercially permitted evaporation ponds and injection/disposal wells. These facilities have been permitted by the WOGCC, WDEQ, and the BLM as applicable. The specific permitting mechanism depends on facility ownership, source of produced water, and location. Historically, water may have been allowed to evaporate onsite using individual produced-water disposal pits; this practice is no longer common.

Sanitary wastes are disposed of in permitted septic systems for permanent and long-term temporary facilities such as offices and man camps. Portable toilets are provided for long-term construction, drilling, and completion operations; these wastes are hauled to municipal sewage-treatment plants for disposal.

3.21.2 Hazardous Materials Management

The affected environment for releases of wastes or hazardous materials includes air, water, soil, and biological resources that may be impacted by the release in the course of transportation, use, or storage of the material in construction or field operations. Areas that are particularly vulnerable to the release of such materials include wetlands, water bodies, areas of shallow groundwater and areas where wildlife and humans could be directly impacted.

Hazardous materials are used in drilling, field development, construction, completion, and production operations. BLM requires that NEPA documents list and describe any materials categorized as Hazardous or Extremely Hazardous that would be produced, used, stored, transported, or disposed of as a result of a proposed project (IM 1994-081, WY Information Bulletin 1997-011 and IM WY-94-059). This compilation for the CD-C project can be found in **Appendix K, Hazardous Materials Management Summary**. Operators are encouraged to substitute less-toxic yet equally effective products when available (BLM 2007b) in all phases of operations. Substitutions are not always available; therefore, it is acknowledged that hazardous materials may be used in the project area.

Numerous companies operate within the project area; each has a responsibility to comply with the state and federal regulations applicable to its operations. Different companies have different compliance philosophies, ranging from minimal compliance to compliance programs that exceed regulatory requirements. Each company is required to provide the RFO with an Emergency Response Plan that covers its operations within the RFO. These documents serve two purposes: to ensure that company personnel are aware of the need to notify the RFO in the event of an emergency involving hazardous substances, produced water, and/or hydrocarbons; and to verify that contingency planning for such an emergency is in place. Company documents regarding spill-response planning, Community Right-to-Know reports, Spill Prevention, Control, and Countermeasure (SPCC) plans, and documents containing other relevant information, are maintained by the individual Operators.

3.21.3 Hazardous Materials Releases and Spill Response

The Operators have trained personnel and/or contractors as well as the equipment needed to respond to releases of hazardous materials in the project area. Wells in the project area are completed in a number of different hydrocarbon reservoirs and produce a variety of fluids including condensate and oil in addition to natural gas and water. There is potential for these produced fluids as well as materials brought in for operations such as fuel, lube oils, mud products, and completion fluids to be released into the environment. Releases of materials are reported to state and federal regulators as required. BLM NTL-3A is the appropriate mechanism for reporting spills (of hydrocarbons, produced water, or other hazardous materials), accidents, blowouts, or other undesirable events that occur from federal minerals or on BLM-managed surface; otherwise, spills of hydrocarbon, produced water, and/or hazardous materials are reported to WDEQ (Section 4 of Chapter 4 of WDEQ Wyoming Water Quality Rules and Regulations) and WOGCC (Section 3 of Chapter 4 of WOGCC Rules). Remediation of contaminated soils or off-site disposal of contaminated material is approved by BLM prior to the management action. Operators must comply with the applicable provisions of the EPA’s SPCC regulations found at 40 CFR 112. These regulations require secondary containment for mobile and non-mobile equipment as well as some transportation-related activities that contain oil in volumes greater than 1,320 gallons that could impact navigable waters of the U.S. in the event the material is released. This rule applies to compressor stations, drilling and production operations, as well as other activities within the project area. Most Operators in the project area have prepared contingency plans that will be activated should there be an emergency or hazardous materials release.

4. ENVIRONMENTAL CONSEQUENCES

4.0.1 Introduction

The purpose of this chapter is to assess and disclose the environmental effects of the Continental Divide-Creston Natural Gas Development Project. The analysis is guided by the regulations set forth by the Council on Environmental Quality (CEQ), which call for analysis of the direct, indirect, and cumulative effects of the Proposed Action and the alternatives (40 CFR 1500-1508). Direct effects are those caused by an action and occurring at the same time and place as the action—for example, the surface disturbance that occurs when a well pad is constructed. Indirect effects are caused by the action but "are later in time or farther removed in distance"—for example, the effects on watersheds if a well pad is not successfully reclaimed. Cumulative impacts are those that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Direct and indirect impacts of the CD-C project are described in this chapter; cumulative impacts are described in **Chapter 5**. Throughout the EIS, the words *impact* and *effect* are used interchangeably.

The CEQ regulations also call for a discussion of the significance of the impacts. Significance requires considerations of both context and intensity. Significance can vary dependent on the setting in which the Proposed Action and the alternatives are to take place. Each resource section in this chapter includes a brief description of the considerations made in determining the significance of the environmental effects for the resource under discussion.

The regulations also direct the resource specialist to describe ways in which adverse environmental impacts may be mitigated. For the Proposed Action and all of the alternatives, a broad set of discretionary mitigation measures would be applied when appropriate as a matter of course by the BLM. These measures are frequently referred to as Best Management Practices (BMPs) and are often applied by the BLM as Conditions of Approval (COAs) on natural gas Applications for Permit to Drill (APDs). BMPs that may be applicable to the CD-C project and the standard set of oil and gas COAs applied by the Rawlins Field Office (RFO) are described in **Appendix C**. The Rawlins Resource Management Plan (RMP) also contains descriptions of BMPs that could be applied by the BLM as necessary. Each resource section may contain additional recommended mitigation measures if the resource specialist determines that mitigation measures in the standard suite of BMPs would not be sufficient.

The Proposed Action and five alternatives are considered in this document. The requirements of each of the alternatives apply only to public lands administered by the BLM and to federal mineral estate.

- **The Proposed Action**. The Operators propose to drill up to 8,950 additional natural gas wells throughout the CD-C project area, on public and private mineral estate, over 15 years, with a project life of up to 55 years. About 42 percent of the 8,950 new wells would be directional wells from multiple-well pads. One result of directional drilling is reduced surface disturbance per well bore.
- **Alternative A: 100-Percent Vertical Drilling**. This alternative (and all the other action alternatives) would also include up to 8,950 additional wells in the project area. However, it is assumed that directional drilling would not be used at all—that there would be no multiple-well pads—and that consequently project surface-disturbance would be greater than for the Proposed Action.
- **Alternative B: Enhanced Resource Protection.** The Enhanced Resource Protection Alternative requires protections and mitigation beyond the measures ordinarily applied for certain resources that are of high value or may be at greater risk of adverse impacts, such as pronghorn and mule deer crucial winter range. The alternative also describes surface disturbance and species population thresholds that, if crossed, would signal the need for still more protections and mitigation and outlines the additional measures that may be needed.

- **Alternative C: Surface Disturbance Cap—High and Low Density Development Areas.** This alternative places a cap of 60 acres per section on the amount of unreclaimed surface disturbance on public land in those parts of the CD-C project area that have had high-density development. For the remainder of the project area—the low-density development areas—the cap on surface disturbance would be 30 acres per section. All prior surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap.
- **Alternative D: Directional Drilling.** This alternative requires that all future natural gas wells on federal mineral estate be drilled from multi-well pads, which would require the use of directional drilling technology to reach targeted downhole locations. One new multi-well pad per section (or per lease if the lease area is less than a section) would be permitted. In sections that have already had oil and gas development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted. In sections that have not had oil and gas development at all, one new well pad would be permitted for all future development. One road and pipeline corridor per well pad would be permitted. Under certain conditions, Operators may request that an APD be excepted from the general rule.
- **Alternative E: No Action**. Under the No Action Alternative, it is assumed that none of the natural gas development activities proposed by the CD-C Operators would occur. The analysis of the No Action alternative assumes that previously authorized activities would continue but that no new development would take place under this proposal.

The Proposed Action and alternatives are described in more detail in **Chapter 2, Alternatives Including the Proposed Action.** None of the alternatives is designated as the BLM's preferred alternative. The BLM NEPA Handbook (H-1790-1) calls for expression of the BLM's preferred alternative in the Draft EIS if one exists (BLM 2008c). The BLM does not have a preferred alternative for the CD-C Natural Gas Development Project at this time. The BLM believes that the Proposed Action and the action alternatives all have elements that would address the project purpose and need and will review public comment on the Draft EIS before determining a preferred alternative. A preferred alternative will be designated in the Final EIS.

4.0.2 Historic and Future Impacts

The CD-C natural gas development project is an in-fill project. This means that future natural gas development in the project area would be a continuation of activity that has been ongoing there for some time. Natural gas exploration and development in the Continental Divide-Creston area began in the 1950s. The Wamsutter field was the first field established in the area, in 1958, followed by the Creston field in 1960, the Continental Divide field in 1964, and the Blue Gap field in 1974. Since initiation of drilling, about 4,400 natural-gas wells have been drilled in the project area. **Map 4.0-1** displays the locations of those wells. The annual rate of development increased from the late 1990s until 2008 when 304 gas wells were drilled. Since then, drilling has proceeded at a rate of about 200 wells per year.

This previous natural gas development has generated substantial surface disturbance. As shown in **Table 4.0-1**, oil and gas development in the project area prior to 2006 had resulted in the disturbance of an estimated 49,218 acres, of which 8,472 acres remain unvegetated and in use for facilities such as well pad access roads, well-production facilities, and pipeline facilities. The many pipelines that cross the area contributed about half the historic surface disturbance—over 26,500 acres. Wamsutter is a major pipeline hub that serves many natural gas pipelines, all of which cross the CD-C project area. An additional 10,958 acres were disturbed for purposes other than oil and gas development, principally federal, state, and county highways and roads, but also ranching and agricultural activities. Taken together, these figures indicate that 5.6 percent of the surface of the CD-C project area's 1.1 million acres has been disturbed at some time in the past. Depending on the success of reclamation efforts, about 42,500 acres of that initial disturbance are in various stages of ecological restoration.

Map 4.0-1 displays the spread and the density of the past natural gas surface disturbance. Individual sections are color-coded from dark green to red according to the amount of surface disturbance that has occurred in the section. Dark green represents a section that has seen no disturbance at all; red represents a section that has had more than 75 acres of disturbance (12 percent or more of the surface area of the section).

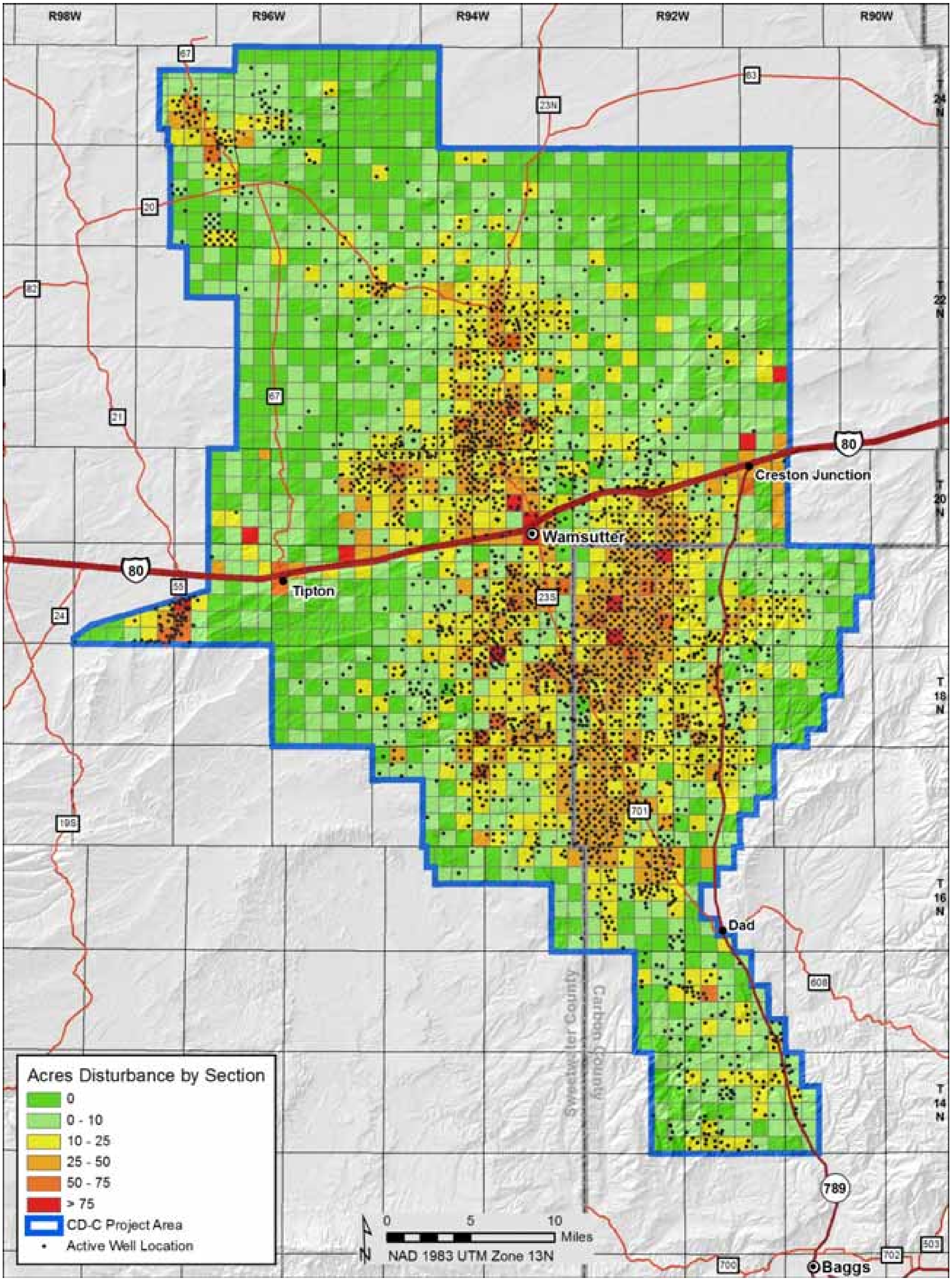
For the most part, the greatest disturbance is located in the same areas with the greatest amount of drilling. The exceptions are those sections that have major industrial facilities. The past development and the disturbance have primarily been located in the central part of the project area, along either side of the Wamsutter Road, south of I-80, and on either side of the Crooks Gap Road, north of I-80. Large areas in the northeast and the western parts of the project area have seen relatively little development.

Table 4.0-1 also shows the additional disturbance that would be generated by the Proposed Action and each alternative. Displayed immediately below the figures for the initial and long-term disturbance that would be produced by each alternative are the comparable figures for the combined initial disturbance (*Combined IN*) and the combined long-term disturbance (*Combined LT*) of previous actions and those of the alternative.

Adding the estimated 47,200-acre disturbance associated with the Proposed Action to the 60,176 acres previously disturbed would mean that ten percent of the project area—107,376 acres—would be disturbed by the time the Proposed Action is completed. To the extent that past reclamation efforts have been successful and that future reclamation is also successful, a minimum of 3.4 percent—36,524 acres—of the lands within the project area would remain in an unvegetated state on a long-term basis (the *Combined LT* disturbance).

The CD-C project area is managed under the provisions of Federal Land Policy and Management Act for multiple use. Range, minerals, recreation, wild horses, wildlife, and other resources and uses are considered in the BLM's management of the federal lands and balance is sought between them. Rangeland health assessments are guided by the "Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands" (Standards and Guidelines) (BLM 2001a). The Standards apply to all resource uses for public lands including oil and gas development. Guidelines provide for, and guide the development and implementation of, reasonable, responsible, and cost-effective management practices at the grazing allotment and watershed level.

There are two primary watersheds within the CD-C area. If a watershed assessment reveals that a Standard(s) is not being met, factors contributing to the non-attainment are identified and management recommendations are developed so the Standard(s) may be attained. When a Standard(s) is failed, corrective action must be taken by whatever permitted entity is causing the failure. During the CD-C implementation period, any failures to attain Standards may be due to ranching practices, oil and gas development activities, other activities that have been permitted, or a combination of many factors. If oil and gas operators are found to be causing or contributing to non-attainment of a standard, the BLM will require their participation and contribution to corrective actions that may be required. Further monitoring and adaptive management may be required from any parties contributing to the problem. This provision applies to all rangelands/habitat found within the project area. Close cooperation between the BLM, range permittees, oil and gas companies, and perhaps others may be required to successfully attain any Standards that are not being met. The environmental effects assessed in this chapter take into account compliance with the Standards and Guidelines and related periodicmonitoring of rangelands.



Map 4.0-1. Past surface disturbance, by section, within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Table 4.0-1. CD-C surface disturbance – historic, Proposed Action and Alternatives (acres)

Category	Surface Disturbance						
	Oil and Gas			Grand Total	*Percent of Project Area*	Change from Proposed Action	
	Well Pads (incl. roads)	Related Facilities[1]	Total			acres	%
Historical							
Initial	20,524	28,694	49,218	60,176	*5.6%*	—	—
Long-term	6,403	2,069	8,472	17,663	*1.7%*	—	—
Proposed Action							
Initial	41,889	5,311	47,200	47,200	*4.4%*	—	—
Long-term	17,998	863	18,861	18,861	*1.8%*	—	—
Combined IN[2]	62,413	34,005	96,418	107,376	*10.0%*	—	—
Combined LT[2]	24,401	2,932	27,333	36,524	*3.4%*	—	—
Alternative A: 100-Percent Vertical Drilling							
Initial	56,385	5,311	61,696	61,696	*5.8%*	14,496	*30.7%*
Long-term	23,270	863	24,133	24,133	*2.3%*	5,272	*28.0%*
Combined IN[2]	76,909	34,005	110,914	121,872	*11.4%*	14,496	*13.5%*
Combined LT[2]	29,673	2,932	32,605	41,796	*3.9%*	5,272	*14.4%*
Alternative B: Enhanced Resource Protection Alternative							
Initial	40,205	5,311	45,516	45,516	*4.3%*	-1,684	*-3.6%*
Long-term	17,386	863	18,249	18,249	*1.7%*	-611	*-3.2%*
Combined IN[2]	60,729	34,005	94,734	105,692	*9.9%*	-1,684	*-1.6%*
Combined LT[2]	23,789	2,932	26,721	35,912	*3.4%*	-611	*-1.7%*
Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section							
Initial	37,644	5,311	42,955	42,955	*4.0%*	-4,245	*-9.0%*
Long-term	16,455	863	17,318	17,318	*1.6%*	-1,543	*-8.2%*
Combined IN[2]	58,168	34,005	92,173	103,131	*9.6%*	-4,245	*-4.0%*
Combined LT[2]	22,858	2,932	25,790	34,981	*3.3%*	-1,543	*-4.2%*
Alternative D: Directional Drilling							
Initial	31,138	5,311	36,449	36,449	*3.4%*	-10,751	*-22.8%*
Long-term	14,089	863	14,952	14,952	*1.4%*	-3,908	*-20.7%*
Combined IN[2]	51,662	34,005	85,667	96,625	*9.0%*	-10,751	*-10.0%*
Combined LT[2]	20,492	2,932	23,424	32,615	*3.0%*	-3,908	*-10.7%*
Alternative E: No Action							
Initial	0	0	0	0	*0.0%*	-47,200	*-100.0%*
Long-term	0	0	0	0	*0.0%*	-18,861	*-100.0%*
Combined IN[2]	20,524	28,694	49,218	60,176	*5.6%*	-47,200	*-44.0%*
Combined LT[2]	6,403	2,069	8,472	17,663	*1.7%*	-18,861	*-51.6%*

[1] *Estimated future disturbance is unchanged under each alternative for "Related O&G Facilities," except for No Action, which has no disturbance.*

[2] *"Combined IN" equals the sum of historic initial disturbance and future initial disturbance.*
"Combined LT" equals the sum of historic long-term disturbance and future long-term disturbance.

Alternative A, 100-Percent Vertical Drilling, would result in the greatest surface disturbance—61,696 acres—a 31 percent increase over the Proposed Action. When combined with previous disturbance, 11.4 percent of the project area—121,872 acres—would be disturbed by the time Alternative A is implemented. A minimum of 3.9 percent—36,524 acres—of the lands within the project area, the *Combined LT* disturbance, would remain in an unvegetated state on a long-term basis. The remaining action alternatives, Alternatives B through D, would each produce successively less surface disturbance than either the Proposed Action or Alternative A. Alternative B, Enhanced Resource Protection, would generate an estimated initial disturbance of 45,516 acres, 3.6 percent less than the Proposed Action. Alternative C, Cap on Surface Disturbance, would generate an estimated initial disturbance of 42,955 acres, 9.0 percent less than the Proposed Action. Alternative D, Directional Drilling, would produce the lowest initial surface disturbance—an estimated 36,499 acres—and a 22.8 percent reduction from the Proposed Action. It would also produce the lowest combined initial disturbance—96,625 acres—and the lowest combined long-term disturbance—32,615 acres. Alternative E, No Action, would produce no new disturbance and thus no addition to the previous totals.

Another indicator of the degree of disturbance that an alternative would generate is the number of well pads likely to be used to implement the Operators' drilling plans. The Proposed Action and all the action alternatives would each permit the drilling of the proposed 8,950 wells but the requirements of the alternatives would alter the degree to which directional drilling is used and therefore the number of wellpads. As indicated earlier, the Proposed Action assumes that about 42 percent of the 8,950 wells would be drilled using directional techniques from multi-well pads. A total of 6,126 well pads is implied. **Table 4.0-2** shows the estimated number of well pads that would be used in each of the alternatives. Alternative A assumes only vertical drilling would apply so the number of well pads is the same as the number of wells: 8,950. Under Alternative D, it is estimated that virtually all wells drilled to federal mineral estate would be drilled from a multi-well pad, with the construction of an estimated 4,032 well pads, a 34.2 percent reduction from the Proposed Action. The relative distribution of vertical and directional wells on private and state minerals would remain unchanged.

Table 4.0-2. CD-C estimated well pad numbers by alternative

Alternative	Well Pads	% Change
Proposed Action	6,126	—
Alternative A: 100-Percent Vertical Drilling	8,950	46.1%
Alternative B: Enhanced Resource Protection	5,798	-5.4%
Alternative C: Surface Disturbance Cap	5,299	-13.5%
Alternative D: Directional Drilling	4,032	-34.2%
Alternative E: No Action	0	-100.0%

The amount of surface disturbance generated by the project is an important indicator of the overall level of direct impacts that would be produced. This figure is directly related to the soils, watershed, and vegetation impacts that would result from the project. The number of well pads used to drill out the project is also an important indicator, not only because it is a major determinant of the amount of surface disturbance needed, but also because it indicates the number of sites that will be disturbed and the degree to which the landscape would be fragmented by the well sites and the access roads to them. Each disturbance site is also the focal point of impacts that extend outward from the site and the fewer the number of sites, the less these impacts would be felt. The presence of industrial facilities, in particular the noise and the regular human activity associated with the sites, alters the way that the surrounding landscape serves as wildlife habitat. For example, not only is browse and forage removed by construction of a well pad, but access to forage may be inhibited by the noise, activity, and dust produced around a well pad. The impact may differ for each species. In terms of wildlife impacts, the effect is generally captured by the term "habitat fragmentation." It is not just a wildlife phenomenon, however, as the same factors apply to visual and recreation resources, grazing management, watershed management, and other resources.

Past disturbance is a direct indicator of the degree to which environmental and human resources in the project area have already been affected. It represents changes to the visual environment, wildlife habitat, transportation system, recreation, and other resources that are already in place. Unlike analyses of other projects where there has been little or no prior development, the impact analysis of future development in the CD-C project area must be described in the context of the substantial impacts that have already occurred.

Two examples illustrate the ways in which the analysis of future impacts can be altered by impacts that have already taken place.

- Visual impacts are generally discussed in terms of the degree to which a proposal would alter the natural visual environment. In the case of the CD-C project area, past development has already introduced a substantial industrial element into many viewsheds in the area. This is reflected in the Rawlins RMP's current classification of its visual resources and therefore the level of landscape change future actions would be allowed to have. The Rawlins RMP's current land classifications (expressed as Visual Resource Management, or VRM, classes) are the basis for the visual resources analysis presented in this chapter (see **Section 3.11.3**).
- The transportation system and the traffic it carries is often a major cause of environmental impacts produced by a natural gas development project. In the CD-C project area, most of the collector and arterial roads and many of the local roads that would be needed for full-field development have already been constructed and are in use. This means that the disturbance associated with future road construction would be substantially less than if the infrastructure were not already in place. On the other hand, the wildlife habitat fragmentation and disturbance associated with natural-gas access roads and traffic is already a fact in much of the area. The analysis of impacts on wildlife reflects this existing state.

4.0.3 Distribution and Density of Future Impacts

The Proposed Action does not define the specific locations of any natural gas wells or associated facilities proposed for the CD-C project area. The analysis of impacts described in this chapter assumes that facility construction and well-drilling could occur anywhere within the project area and that all parts of the area would be affected. However, the historic development in the project area provides an indicator as to the likely spatial distribution and density of future development.

Map 4.0-2 shows the locations of natural gas wells drilled to date in the CD-C project area and the current well spacing designated by the Wyoming Oil and Gas Conservation Commission (WOGCC) throughout the project area. *Spacing* refers to the spatial density of wells per section (640 acres) producing from the same reservoir, usually stated in terms of acres. It is a formal designation that has been approved by the WOGCC. In **Map 4.0-2**, the currently approved spacing in the yellow areas is 160 acres, meaning one well is permitted in each 160-acre parcel. Currently approved spacing in the orange areas is 80 acres (one well per 80 acres) and in the red areas is 40 acres, with a variant in some parcels—pink—that is about 60 acres.

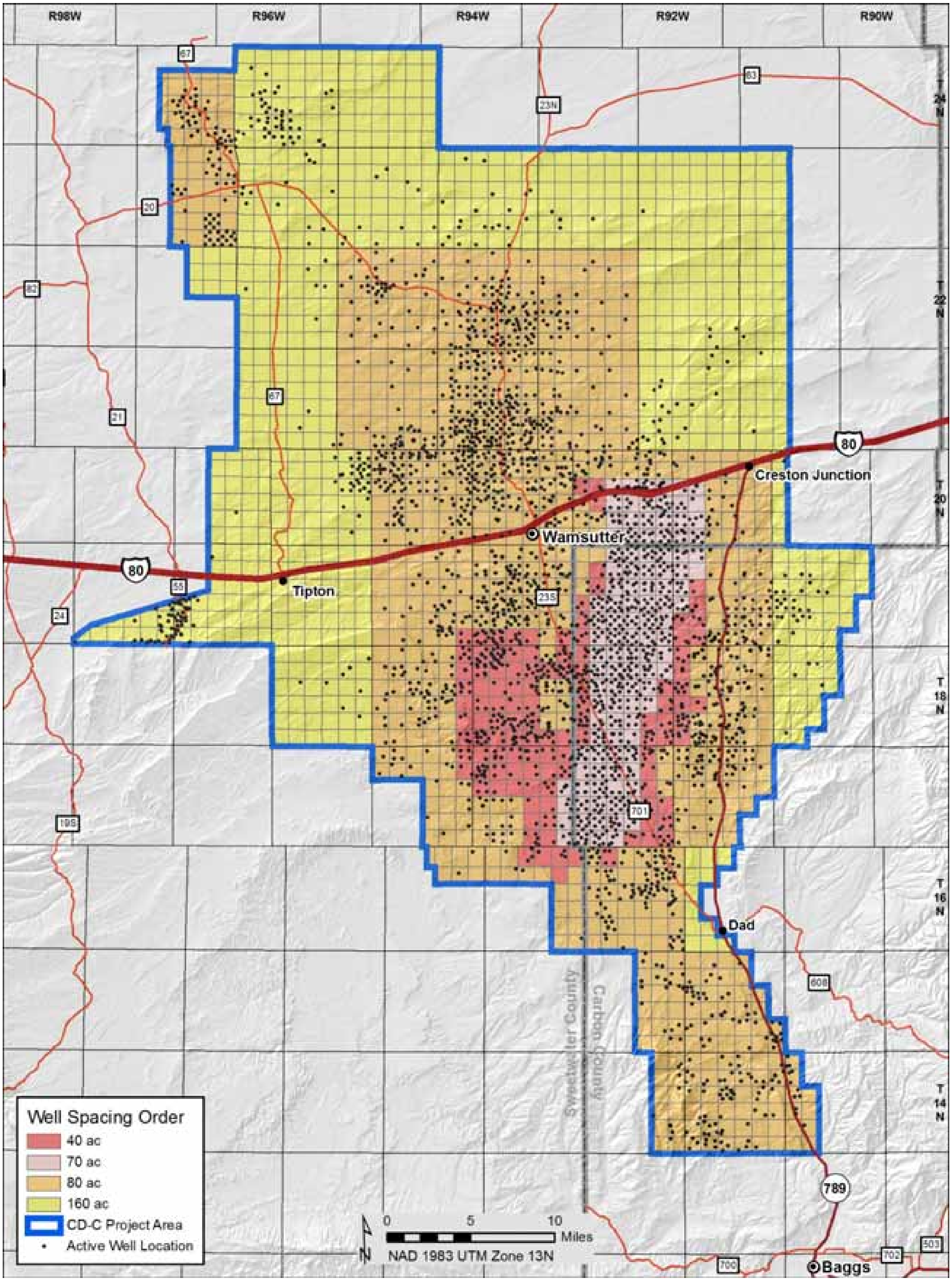
Spacing designations refer not to the number of surface locations of the wells (well pads) but to the number of down-hole (bottom-of-hole) locations. Thus, an 80-acre spacing that allowed for eight wells per section could result in as many as eight well pads or as few as one, if all wells were drilled from the same pad. If all wells in this example were drilled from their own individual pad, 50 or more acres of surface disturbance could result (at 6.3 acres of disturbance per well pad). However, with application of directional drilling techniques, perhaps only one or two surface locations (well pads) per section would be needed, and the resultant surface disturbance could be 20 acres or less. A central feature of Alternatives C and D is the effort to constrain the number of surface locations used to achieve the down-hole locations rather than the number of down-hole well locations.

Generally, spacing units reflect the judgment of the Operators—with WOGCC concurrence—as to the number of wells that would be required to efficiently develop and recover the natural gas resource in an area. It is not uncommon to begin development of a field with relatively low well spacing, e.g., one well per 160 acres, and then seek approval from WOGCC for "tighter" spacing to 80 acres, 40 acres, or less, as production occurs and more is learned about the gas reservoir. As the map shows, the "tightest" spacing is in the areas with the greatest number of wells. As the CD-C's natural gas resource was developed over the last six decades, operators determined that more wells would be needed to fully recover the gas and so more dense spacing was sought by the operators and approved by the WOGCC.

The analysis of impacts in the CD-C project area assumes that the spacing units depicted in **Map 4.0-2** would likely be realized as the area's natural gas resource is developed. That means that at full development, in areas with 40-acre spacing, there would be one well every 40 acres, or 16 wells per section. Areas with 80-acre spacing would have eight wells per section and areas with 160-acre spacing would have four wells per section. In general terms, that would result in the most intense future development occurring on either side of the Wamsutter and Crooks Gap Roads in the central part of the CD-C project area as those areas that have seen the most development to date are "filled in." The areas surrounding this area of intense development would also be "filled-in" but with lower density: eight wells per section. The remainder of the project area would see less-intense development with its 160-acre spacing, or potentially four wells per section.

The analysis assumption anticipates that, as development proceeds, some operators are likely to conclude that full development of the natural gas resource in certain parts of the CD-C project area requires tighter spacing. In those cases, they would request a reduction from 160-acre spacing to 80-acre spacing, or from 80-acre to 40-acre spacing, with well densities increasing from four to eight wells per section or from eight to 16 wells per section. The areas where this might occur cannot be predicted but such increases in density are within the scope of the analysis.

While the same number of wells is proposed for the Proposed Action and Alternatives A through D, the disturbance area for each would vary according to the degree to which directional drilling is pursued. Directional drilling allows more than one well to be drilled at a location, resulting in an estimated average initial disturbance of 2.45 acres per well bore, including both an allowance for the well pad and for the access road to the location. For a vertically drilled well, the estimated initial disturbance would be 6.3 acres per well, including well pad and access road. The total estimated disturbance for each alternative is shown in **Table 4.0-1**. Since **Alternative A, 100-Percent Vertical Drilling**, has no directional drilling, it has the highest total surface disturbance, an estimated 61,696 acres. The Proposed Action, with an estimated 42-percent directional drilling component, would produce an initial surface disturbance of 47,200 acres. **Alternatives B** through **D** have successively less surface disturbance as the amount of directional drilling increases with each. **Alternative E, No Action**, would have no drilling and no surface disturbance at all.



Map 4.0-2. Current well spacing orders in the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

■ PHYSICAL ENVIRONMENT

4.1 GEOLOGY

4.1.1 Introduction

Of the geological features described in **Section 3.1 Geology**, the surface environment would be impacted by the Proposed Action and the action alternatives, affecting the geology of the CD-C project area and causing mass movement, a geological hazard. Removing vegetation and soils could lead to altered hydrology, decreased infiltration rates, and increased overland flow rates. Unmitigated, accelerated erosion could cause gullying in some areas and rapid deposition or siltation in other areas with associated erosion effects. Mass movements, including landslides, could be triggered in areas that become over-steepened by erosional removal of slope-supporting material. Altering existing topography, particularly by steepening slopes, could also trigger mass movements and accelerated erosion.

The magnitude of impacts to the geology and associated geological hazards in the project area would be reduced by the implementation of mitigation measures for geology, soils, vegetation, and water resources as described in **Appendix C**.

4.1.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes no management objectives or significance criteria for geology.

The following significance criterion for geology was adapted from the Atlantic Rim Field Development Natural Gas Development Project Final EIS (BLM 2006a):

1. Impacts to geology would be significant if project implementation results in increased runoff and erosion that leads to mass movement (including landsliding), subsidence, flooding, or increased deposition or siltation that alters the landscape.

4.1.3 Direct and Indirect Impacts

4.1.3.1 Impacts Common to All Action Alternatives

Impacts could occur to the geologic environment caused by project implementation and operation (e.g., alteration of existing topography, initiation of mass movements, including landslides). Impacts could occur to project facilities as a result of inherent geologic hazards. The likelihood of these impacts occurring as a result of project implementation is remote, particularly with adoption of the mitigation measures for geology, soils, vegetation, and water resources described in **Appendix C** and adherence to Wyoming Department of Environmental Quality (WDEQ) and WOGCC requirements. The potential for impacts depends on where surface disturbance occurs and the total amount and distribution of disturbance both spatial and temporally.

4.1.3.2 Proposed Action and Alternatives

Impacts to the geological environment would be more likely with alternatives that have the greatest amount of concentrated (spatially and temporally) surface disturbance. The Proposed Action and the Alternatives would result in differing amounts of initial and long-term ground disturbance, largely because of varying numbers of wells drilled directionally from multiple-well pads. The Proposed Action, with mixed vertical and directional drilling, would produce 47,200 acres of disturbance. Alternative A has only vertical drilling and consequently would result in an estimated 61,696 acres of disturbance, a 30-percent increase (**Table 4.0-1**). Because surface disturbance would be greater, Alternative A would have a greater chance of impacting the geological environment. Alternatives B, C, and D would each have decreasing levels of surface disturbance and hence decreasing risks of impact. Alternative E, No Action, would have no potential for impacts. With application of appropriate mitigation measures, the significance criterion would not be met.

4.1.4 Impact Summary

While the likelihood of geological impacts occurring as a result of project implementation is remote, the Proposed Action and all of the alternatives have the potential for direct and indirect impacts to geology to the extent that the ground is disturbed by development activities. Successful application of mitigation measures described in **Appendix C** would minimize the risk of those impacts occurring and remove the likelihood of meeting the significance criterion.

4.1.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Mitigation measures for geology, soils, vegetation, and water resources described in **Appendix C** would avoid or minimize impacts to the surface geologic environment and lessen the possibility of mass movement and flooding; therefore, no additional mitigation measures are necessary.

4.2 PALEONTOLOGIC RESOURCES

4.2.1 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives associated with paleontology:

- Identify paleontological resources by defining priority inventory areas based on probability of occurrence of high-value resources.
- Assess the need for project or site-specific treatment plans or other protective measures in areas of high risk for development or at high risk for adverse effects.
- Develop, maintain, and encourage opportunities for scientific research of paleontological resources.
- Provide educational opportunities and public outreach programs.
- Develop and maintain interpretation of paleontological resources in areas of high public interest and access.

Impacts to paleontological resources would be considered significant if the following were to occur:

1. An action or development causes substantial direct or indirect damage or destruction to important paleontological resources.

4.2.2 Direct and Indirect Impacts

4.2.2.1 Impacts Common to All Action Alternatives

Excavation of pipeline trenches and construction of well pads, access roads, and ancillary facilities associated with the Proposed Action or its alternatives could result in the exposure and possible destruction of paleontological resources (frequently referred to here as *fossils* or *fossil resources*), either directly as a consequence of construction or indirectly as a result of increased erosion rates. Increased access resulting from development may increase the visibility of fossil resources and lead to increased illegal fossil collection. The potential for impacts increases in areas where geological formations rated as having a moderate to very high PFYC (3, 4, or 5) are exposed at the surface or shallow enough to be affected by excavation. The CD-C project area is underlain by geological units that have a moderate to very high potential of producing scientifically important fossils. These units (with their PFYC in parentheses) include the Battle Spring (3), Fort Union (3), Green River (5) and Wasatch (5) formations.

Excavation of pipelines and construction of other project facilities could also result in the discovery of new paleontological resources. If these newly discovered resources are properly recovered and catalogued into the collections of a museum repository, the Proposed Action and its alternatives could result in a better understanding and knowledge of this resource. In addition, increased access would allow easier access by professional, permitted paleontologists and geologists, who hope to make scientifically significant discoveries.

Implementation of mitigation measures described in **Appendix C** would lessen the chance that scientifically important fossils would be damaged or destroyed directly or indirectly. The Paleontological Resource Preservation Act (PRPA) described in **Section 3.2.1** broadened the guidance for surveying for paleontological resources and mitigating potential impacts. That guidance is captured in BLM Instruction Memorandum [IM] No. 2009-011, *Assessment and Mitigation of Potential Impacts to Paleontological Resources* (BLM 2008d). The IM is summarized here and is included in its entirety in **Appendix D, Paleontological Resources Program Guidance**.

IM 2009-011 calls for the BLM to assess the possible effects on paleontological resources of all proposed surface-disturbing activities on public lands or split-estate lands. If the assessment indicates "(a) the presence or high probability of occurrence of vertebrate fossils or uncommon nonvertebrate fossils (PFYC Class 4 or 5), or that the probability is unknown (Class 3), in the area of a proposed federal action or transfer of title, and (b) a reasonable probability that those resources will be adversely affected by the proposed action," then measures such as a field survey, onsite monitoring, special stipulations, avoidance, or other mitigation may be required.

The preferred mitigation technique is to change the project location based on the results of the field survey. Monitoring may be required as part of overall mitigation for a project, arising out of the NEPA process, or upon the discovery of paleontological resources during project activities. The purpose of onsite monitoring is to assess and collect any previously unknown fossil material uncovered during the project activities or soon after surface-disturbing actions.

4.2.2.2 Proposed Action and Alternatives

Impacts to paleontological resources would be more likely with alternatives that have the greatest amount of concentrated surface disturbance, both spatially and temporally. The Proposed Action and the alternatives would result in differing amounts of initial and long-term ground disturbance, largely because of varying numbers of wells drilled directionally from multiple-well pads. The Proposed Action, with mixed vertical and directional drilling, would produce 47,200 acres of disturbance. Alternative A would have only vertical drilling and consequently would result in an estimated 61,696 acres of disturbance, a 30-percent increase (**Table 4.0-1**). Alternatives B, C, and D would each have decreasing levels of surface disturbance—with 45,516 acres, 42,955 acres, and 36,449 acres respectively—and hence decreasing risks of impact. Because surface disturbance would be greater, Alternative A would have the greatest chance of impacting paleontological resources. Under Alternative E, No Action, no paleontological impacts would occur in the CD-C project area. With application of appropriate mitigation measures, the significance criterion would not be met.

4.2.3 Impact Summary

Implementation of the Proposed Action or the alternatives has the potential to impact paleontological resources to the extent that the ground is disturbed by development activities. Successful application of mitigation measures described in **Appendix C** and **Appendix D** would minimize and mitigate these impacts and remove the possibility of causing substantial direct or indirect damage or destruction to important paleontological resources. The significance criterion would not be met.

4.2.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Because the potential for substantial adverse impacts on important paleontological resources would be minimized by the mitigation measures described in **Appendix C** and in **Appendix K**, no additional mitigation measures would be necessary.

4.3 SOILS

4.3.1 Introduction

Impacts to the soil resource resulting from construction and installation of well pads and wells, access roads, pipelines, and compressor stations include the removal of vegetation and soil, exposure of soil, soil compaction, and undesirable mixing of soil horizons. In addition, saline and/or sodic soil conditions could be created from the release of fracturing fluids, drilling fluids, or produced water. These impacts could subsequently result in a loss of soil productivity, increased susceptibility of the soil to wind and water erosion, increased surface runoff, increased sedimentation and elevated salt loads within project area water resources, and the spread of invasive/noxious plants.

4.3.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives associated with the soil resource:

- Soils should be stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.
- Soil productivity should be maintained.

The following criteria serve as a basis to assess the intensity, duration, and magnitude of soil impacts associated with implementation of the Proposed Action and action alternatives. Soil impacts would be considered significant if:

1. Soil productivity is reduced to a level that prevents the disturbed area from recovering to pre-disturbance soil/vegetation productivity levels;
2. Reclamation monitoring does not indicate a trajectory towards success within two to five years of reclamation; or
3. Disturbed areas are not adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality.

4.3.3 Direct and Indirect Impacts

Impacts to the soil resource under the Proposed Action and all alternatives include removal of vegetation and soil, exposure of soil, soil compaction, undesirable mixing of soil horizons, and the creation of saline and/or sodic soil conditions.

<u>Removal of Vegetation and Soil Resulting in Exposure of Soil.</u> Removal of vegetation and soil during construction and production activities, and the subsequent exposure of the soil, can lead to increased susceptibility to erosion and loss of soil productivity. Soils are more susceptible to erosion if they are not protected by vegetation cover or are left exposed to wind or water flow. This is exacerbated during intensive storm events, floods, or drought conditions. Removal of vegetation and litter from the construction/production sites removes organic material that eventually could become soil organic matter. Loss of topsoil, from removal during construction or production activities or from erosion, can result in the loss or reduction of soil organisms, viable seed-bank, and soil nutrients. Finally, exposed soils are more susceptible to invasive plant establishment. The effects of vegetation and soil removal and exposed soils can be minimized through the implementation of proper soil-salvaging techniques and prompt

attention to soil stabilization (see the Rawlins RMP Record of Decision (ROD), Appendix 36 [BLM 2008b]).

Soil Compaction. Soil compaction from construction and production activities on the disturbed areas can reduce soil productivity and increase surface runoff. Soil compaction affects soil structure and reduces pore size. Excessive compaction can lead to reduced water infiltration into the soil and reduced permeability of water through the soil; reduced diffusion of oxygen, carbon dioxide, and other gases into and out of the soil; reduced plant-root penetration; and reduced plant growth and production. The effects of compaction can be reduced at the time of reclamation through sound site-preparation practices, including ripping.

Undesirable Mixing of Soil Horizons. Loss of soil productivity could result when construction and production activities disturb the soil resource. The mixing of soil horizons, where subsurface soil horizons are brought to the surface and mix with or replace surface-soil horizons, can result in less biologically productive surface soils. Soil-horizon mixing can result in elevated soil pH, increased soil salinity, higher sodium and calcium carbonate concentrations, decreased levels of soil nutrients and organic matter, and altered soil structure, texture, and rock content. The effects of soil mixing can be minimized or eliminated through proper soil salvaging (see the Rawlins RMP ROD, Appendix 36 [BLM 2008b]).

Creation of Saline/Sodic Soil Conditions. Spilled fracturing fluids, drilling fluids, and produced water could lead to loss of soil productivity through the creation of saline/sodic soil conditions at production facilities during construction and production activities. Depending on the size and type of spill, the effect on soils would vary considerably. Saline soils can interfere with plant germination and growth, and sodic soils can become hard and crusted with effects similar to those of compacted soils. The effects of spilled fracturing fluids, drilling fluids, and produced water can be minimized through proper implementation of the Spill Prevention, Control, and Countermeasure (SPCC) Plan, and the use of approved disposal methods for produced water.

While the types of soil impacts would be similar for the Proposed Action and the action alternatives, the impacts of each alternative would vary according to the amount of surface disturbance and the effectiveness of reclamation efforts. Impacts to soils are assumed to be proportional to the amount of new surface disturbance for each alternative (i.e., increased disturbance would result in a proportionate increase in adverse impacts to soils). To a great extent, the amount of surface disturbance is directly correlated with the degree to which directional drilling is pursued in an alternative, since directional drilling results in an estimated average initial disturbance of 2.45 acres per well bore, including well pad and access road, while the average vertical well produces 6.3 acres of initial disturbance. **Section 4.0.2, Historic and Future Impacts**, in **Table 4.0-1,** provides detailed information on the estimated disturbance by alternative. Section 4.0.2 also describes the extent of past surface disturbance in the CD-C project area. Historic disturbance in the area amounts to an estimated 60,176 acres, almost 82 percent—49,218 acres—of which is related to historic oil and gas development. All of the surface disturbance and soil impacts described in the subsections below would be in addition to those that have already occurred.

In general, the extent of impacts to the soil resource would be greatly influenced by the success of mitigation and reclamation efforts. Emphasis would be placed on the stabilization of disturbed soils, particularly via the establishment of vegetative ground-cover during the first growing season following disturbance. Reclamation potential of soils in the CD-C project area is primarily poor with major limitations being saline/sodic soil conditions and either clayey or sandy soil textures (**Table 3.3-1**). In addition to these soil limitations, low annual precipitation of 10–14 inches in conjunction with erosion by wind and water could make successful reclamation more difficult to attain. Revegetation may be challenging on the estimated 75 percent of the project area indicated as possessing fair or poor reclamation potential (Table 3.3-1). However, current technology exists to stabilize disturbances, minimize erosion, and increase reclamation success provided that construction, maintenance, and operation of well pads and associated disturbances are in accordance with planned mitigation measures and reclamation.

For the Proposed Action and Alternatives, strict adherence to the Rawlins RMP and required Conditions of Approval and Best Management Practices (**Appendix C**) is vital to minimize impacts to sensitive soils. Included in the RMP guidance are Appendix 1 – Wyoming Bureau of Land Management Mitigation Guidelines for Surface Disturbing and Disruptive Activities, Appendix 13 – Reducing Nonpoint Source Pollution with Best Management Practices, Appendix 15 – Best Management Practices for Reducing Surface Disturbance and Disruptive Activities, and Appendix 36 – Reclamation Plan (BLM 2008b). In accordance with RMP Appendix 36, each Operator will be required to develop and submit to the BLM for approval a site specific reclamation plan for each well location that describes how the Operator will achieve the following goals for interim and final reclamation (found in Instruction Memorandum No. WYD-03-2011-002):

- Protection of existing native vegetation;
- Minimal disturbance of existing environment;
- Soil stabilization through establishment of ground cover;
- Establishment of native vegetation consistent with land use planning; and
- Monitoring and management of the reclamation sites to evaluate reclamation success.

Full and successful implementation of the above measures would insure that none of the three significance criteria would be exceeded. Soil productivity would not be reduced such that pre-disturbance conditions could not be recovered, the reclamation trajectory would be toward success, and disturbed areas would be adequately stabilized. Failure to successfully implement the required measures could produce significant impacts.

4.3.3.1 Proposed Action

The Proposed Action would result in adverse soil impacts including the removal of vegetation and soil resulting in exposure to erosion, soil compaction, undesirable mixing of soil horizons, and creation of saline/sodic soil conditions, directly related to the amount of surface disturbance that would occur. Initial (short-term) soil disturbance associated with the construction and operation of 8,950 natural gas wells, associated access roads and related facilities is estimated at 47,200 acres (**Table 4.0-1**). This disturbance comprises 4.4 percent of the total project area. Combined with the historic disturbance of 60,176 acres, 10 percent of the surface of the CD-C project area would be affected. The initial CD-C project-related disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 18,861 acres, or 1.8 percent of the total project area.

The soils assessment described in Chapter 3 ranked the project area soil limitations related to wind erosion, water erosion, runoff potential, road construction potential, and reclamation success (**Table 3.3-1**). The current number of wells drilled in each of the rating class areas for each limitation was also summarized in the table.

The distribution of soil limitations for the Proposed Action, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is provided in **Table 4.3-1.** For the 47,200 acres of initial disturbance for the Proposed Action, this translates to 34,343 acres with a slight limitation for water erosion, 36,656 acres with a moderate limitatiofor wind erosion, 16,775 acres with a moderate limitation for runoff potential, 30,115 acres with a moderate limitation for road construction, and 27,095 acres with a poor reclamation potential.

Table 4.3-1. Distribution of soil limitations based on current well locations within the CD-C project area[1]

Potential Limitation	Rating Class/Limiting Features	Percentage of Existing Wells in Each Rating Class	ACRES OF DISTURBANCE IN EACH RATING CLASS					
			Proposed Action	Alternative A 100-Percent Vertical Drilling	Alternative B Enhanced Resource Protection	Alternative C Cap on Surface Disturbance, High & Low Density	Alternative D Directional Drilling	Alternative E No Action
Water Erosion	Slight	73.00	34,343	44,890	33,118	31,254	26,520	16,367
	Moderate	21.00	10,148	13,264	9,786	9,235	7,836	4,836
	Severe	3.00	1,398	1,827	1,348	1,272	1,079	666
	Not Rated / Water	2.80	1,312	1,714	1,265	1,194	1,013	625
Wind Erosion	Slight	14.00	6,437	8,414	6,207	5,858	4,971	3,068
	Moderate	78.00	36,656	47,913	35,348	33,359	28,306	17,470
	Severe	5.90	2,796	3,654	2,696	2,544	2,159	1,332
	Not Rated / Water	2.80	1,312	1,714	1,265	1,194	1,013	625
Runoff Potential	Low	0.48	224	293	216	204	173	107
	Low To Moderate	0.88	414	541	399	377	320	197
	Low to High	6.60	3,106	4,060	2,996	2,827	2,399	1,480
	Moderate	36.00	16,775	21,926	16,176	15,266	12,954	7,995
	Moderate to High	30.00	13,962	18,249	13,463	12,706	10,781	6,654
	High	25.00	11,614	15,182	11,200	10,570	8,969	5,535
	Not Rated / Water	2.30	1,104	1,444	1,065	1,005	853	526
Road Construction Limitations	Moderate	64.00	30,115	39,364	29,040	27,406	23,255	14,352
	Moderate / Severe	0.00	0	0	0	0	0	0
	Severe	33.00	15,791	20,641	15,227	14,371	12,194	7,526
	Not Rated / Water	2.70	1,294	1,692	1,248	1,178	1,000	617
Reclamation Potential	Good	14.00	6,454	8,437	6,224	5,874	4,984	3,076
	Fair	26.00	12,357	16,151	11,916	11,245	9,542	5,889
	Poor	57.00	27,095	35,416	26,128	24,658	20,923	12,913
	Not Rated / Water	2.70	1,294	1,692	1,248	1,178	1,000	617

Notes

[1] *Information from two soil surveys completed by the BLM was used to assess the potential limitations of the CD-C project area soils (Texas Resource Consultants, 1981; Wells et al., 1981). Information from individual soil map units was used to evaluate the soil limitations. If multiple soil series existed within a single map unit, rankings were assigned based on the soil series that comprised the greatest acreage within the unit.*

Although the extent of areas with soil limitations makes it likely that implementation of the Proposed Action would occur on soils that possess severe limitations, total avoidance of these areas would not be feasible. Adherence to the Rawlins RMP and required Conditions of Approval (COAs) and Best Management Practices (BMPs) (**Appendix C**) would ensure that disturbed areas are stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality, and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.2 Alternative A: 100-Percent Vertical Drilling

Adverse soil impacts under Alternative A would be similar to the Proposed Action but the extent and the degree of the impacts would be greater because the amount of surface disturbance would be greater. The construction of 8,950 natural gas wells using only vertical drilling techniques, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 61,696 acres, 30.7 percent greater than the Proposed Action. This disturbance would comprise approximately 5.8 percent of the total project area. Combined with the historic disturbance of 60,176 acres, over 11 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) from 6.3 acres to approximately 2.6 acres, reducing the long-term surface disturbance to approximately 40 percent of the initial disturbance area. During the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 24,133 acres, or 2.3 percent of the total project area.

While the same number of wells is proposed for both the Proposed Action and Alternative A, the disturbance area would be 14,496 acres (30.7 percent) greater for Alternative A because all of the wells would be drilled using vertical drilling techniques. With the use of vertical drilling techniques, only one well can be drilled at a single location, resulting in approximately 6.3 acres of initial disturbance per well. For a directionally drilled well, the initial disturbance would be 2.45 acres per well bore.

The distribution of soil limitations for Alternative A, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is provided in **Table 4.3-1**. For the 61,696 acres of initial disturbance for Alternative A, this translates to 44,890 acres with a slight risk for water erosion, 47,913 acres with a moderate risk for wind erosion, 21,926 acres with a moderate runoff potential, 39,364 acres with a moderate limitation to road construction, and 35,416 acres with a poor reclamation potential (**Table 4.3-1**).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative A would occur on soils that have severe limitations, total avoidance of these areas would not be feasible, especially given the increased surface disturbance under this alternative. Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.3 Alternative B: Enhanced Resource Protection

Adverse soil impacts under Alternative B would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques, together with associated access roads and related facilities, under the terms of Alternative B would produce initial (short-term) soil disturbance estimated at 45,516 acres, 3.6 percent less than the Proposed Action. This disturbance would comprise 4.3 percent of the total project area. Combined with the historic disturbance of 60,176 acres, almost 10 percent of the surface of the CD-C project area would be affected. The initial project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the short-term disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 18,249 acres, or 1.7 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative B, the total disturbance area would be 1,684 acres (3.6 percent) less for Alternative B. Alternative B would disturb less area than the Proposed Action since more directional wells would be drilled—an estimated 438 more—resulting in less disturbance per well.

The distribution of soil limitations for the 8,950 wells included under Alternative B, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 45,516 acres of initial disturbance for Alternative B, this translates to 33,118 acres with a slight risk for water erosion, 35,348 acres with a moderate risk for wind erosion, 16,176 acres with a moderate runoff potential, 29,040 acres with a moderate limitation to road construction, and 26,128 acres with a poor reclamation potential (**Table 4.3-1**).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative B would occur on soils that have severe limitations, total avoidance of these areas would not be feasible, although the risk of adverse impacts would be reduced slightly because of the slightly reduced disturbance (3.6 percent). Adherence to the Rawlins RMP and required Conditions of Approval and Best Management Practices (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and potential impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.4 Alternative C: Cap on Surface Disturbance for High and Low Density Development Areas

Adverse soil impacts under Alternative C would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques under the terms of Alternative C, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 42,955 acres, 9.0 percent less than the Proposed Action. This disturbance would comprise 4.0 percent of the total project area. Combined with the historic disturbance of 60,176 acres, almost 10 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 17,318 acres, or 1.6 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative C, the total disturbance area would be 4,245 acres (9 percent) less for Alternative C. Alternative C would have less total disturbance than the Proposed Alternative since additional directional wells would be drilled—an estimated 1,103 more—resulting in less disturbance per well.

The distribution of soil limitations for the 8,950 wells included under Alternative C, assuming that future drilling would result in the same spatial distribution as current wells in the project area, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 42,955 acres of initial disturbance for Alternative C, this translates to 31,254 acres with a slight risk for water erosion, 33,359 acres with a moderate risk for wind erosion, 15,266 acres with a moderate runoff potential, 27,406 acres with a moderate limitation to road construction, and 24,658 acres with a poor reclamation potential (Table 4.3-1).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative C would occur on soils that have severe limitations, total avoidance of these areas would not be feasible. However, the risk of adverse impacts would be reduced because of the reduced disturbance under this alternative (9.0 percent). Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.5 Alternative D: Directional Drilling

Adverse soil impacts under Alternative D would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques under the terms of Alternative D, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 36,449 acres, 22.8 percent less than the Proposed Action. This disturbance would comprise 3.4 percent of the total project area. Combined with the historic disturbance of 60,176 acres, 9 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 14,952 acres, or 1.4 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative D, the total disturbance area would be 10,751 acres (22.8 percent) less for Alternative D. Alternative D would have less total disturbance than the Proposed Alternative since additional directional wells would be drilled—an estimated 2,793 more—resulting in less disturbance per well.

The distribution of potential soil limitations for the 8,950 wells included under Alternative D, assuming that future drilling would result in the same spatial distribution as current wells in the project area, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 36,449 acres of initial disturbance for Alternative D, this translates to 26,520 acres with a slight risk for water erosion, 28,306 acres with a moderate risk for wind erosion, 12,954 acres with a moderate runoff potential, 23,255 acres with a moderate limitation to road construction, and 20,923 acres with a poor reclamation potential (Table 4.3-1).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative D would occur on soils that have severe limitations, total avoidance of these areas would not be feasible. However, the risk of adverse impacts would be reduced because of the reduced disturbance under this alternative (22.8 percent less). Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality, and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.6 Alternative E: No Action

Under the No Action Alternative, it is assumed that no new natural gas drilling would occur. Adverse soil impacts would be limited to those related to historical disturbance in the project area. The No Action Alternative assumes that previously authorized activities would continue but that no new programmatic development would occur under this proposal. Historic development has resulted in the disturbance of 60,176 acres, about 5.6 percent of the surface of the CD-C project area. This disturbance level would not increase under the No Action Alternative. The historic disturbance is considered temporary, because it is assumed that successful interim reclamation would reduce the average unvegetated disturbance to approximately 30 percent of the initial disturbance area. Therefore, the long-term historic disturbance area is expected to decrease to 17,663 acres, or 1.7 percent of the total project area.

For the No Action Alternative, no new impact to the soil resource would occur. Soil impact would be greatly reduced since no new disturbance would occur under this alternative (47,200 acres less than the Proposed Action).

4.3.3.7 Impacts Summary

For the Proposed Action, the total area of disturbance is estimated to be 47,200 acres, which would comprise approximately 4.4 percent of the project area. For Alternative A, the total area of disturbance is estimated to be 61,696 acres, which would comprise approximately 5.8 percent of the project area; Alternative A would result in a 30.7 percent increase over the disturbance anticipated for the Proposed Action. Alternative B would have a total disturbance area of 45,516 acres, which would comprise 4.3 percent of the project area; Alternative B would result in a 3.6percent decrease from the disturbance anticipated for the Proposed Action. Alternative C would have a total disturbance of 42,955 acres, which consists of 4.0 percent of the project area; Alternative C would result in a 9percent decrease from the disturbance anticipated for the Proposed Action. Alternative D would have a total disturbance of 36,449 acres, which consists of 3.4 percent of the project area; Alternative D would result in a 22.8percent decrease from the disturbance anticipated for the Proposed Action. Finally, for Alternative E, the No Action Alternative, no new surface disturbance would occur.

Full and successful implementation of the required mitigation measures and BMPs would ensure that none of the three significance criteria would be exceeded. Soil productivity would not be reduced such that pre-disturbance conditions could not be recovered, the reclamation trajectory would be toward success, and disturbed areas would be adequately stabilized. Failure to successfully implement the required measures could result in significant impacts.

4.3.3.8 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives would result in adverse soil impacts including the removal of vegetation and soil resulting in exposure to erosion, soil compaction, and undesirable mixing of subsurface soil horizons with potential saline/sodic soil conditions. However, full and successful implementation of the required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs would ensure that none of the three significance criteria would be exceeded.

No additional mitigation measures would be required.

4.4 WATER RESOURCES

4.4.1 Introduction

Authorization of the proposed project would require full compliance with the Rawlins RMP, the Federal Clean Water Act (CWA), EO 11990 (wetlands protection), and EO 11988 (floodplain protection). These regulations require that certain permits/authorizations be obtained from the State of Wyoming (WDEQ-WQD and WOGCC) and the BLM and other federal agencies. Permits are required from WDEQ-WQD or WOGCC for disposal of produced water. State and federal approval is required for Applications for Permit to Drill (APDs); Federal Lease Obligations; development of surface runoff, erosion, and sediment control plans; injection-well permitting; oil-spill containment and contingency plans; Stormwater Pollution Prevention Plans; Spill Prevention Control and Countermeasures Plans; and CWA Section 404 permits.

For the purposes of this analysis, the evaluation of the Proposed Action and alternatives assumes adherence to these plans, permits, leases, and regulations for the protection of water resources. Many impacts associated with natural gas development are common to all alternatives and therefore are analyzed for general impacts in **Section 4.4.3**. The magnitude of impacts varies by alternative, so the magnitude of impacts is discussed as they relate to each alternative.

Up to 500 of the 8,950 proposed wells could be coalbed natural gas (CBNG) wells. The volume of water produced in CBNG development is much greater than for conventional natural gas production. During initial coal-seam depressurization, CBNG wells can produce from 500–1,000 bbls/day of produced water compared to the average of 18 bbls/day for a conventional well. The actual volumes produced and the methods by which the produced water would be managed are greatly dependent on the site-specific development proposals. For that reason, this document does not contain any description of produced-water disposal for CBNG development and does not analyze the impacts of such development. Should the BLM receive site-specific CBNG proposals in the project area, the proposals, including the treatment of produced water, will be analyzed in a separate NEPA document at that time.

4.4.2 Assumptions for Analysis

Under all alternatives, the following would be adhered to: Operator-committed measures, required BMPs, including BMPs for Non-Point Source Pollution as applicable, as well as the regulations and plans described in **Section 4.4.1**. Per NEPA guidance, this analysis will be based on the premise that standard operating procedures including these BMPs and regulations would be followed under each alternative. **Appendix C** includes a summary description of the BMPs and APD Conditions of Approval typically used by the BLM in the Rawlins Field Office to implement the federal laws, regulations and policy aimed at mitigating environmental impacts.

4.4.2.1 Surface Water Analysis Assumptions

The analysis for surface water is based on the following specific assumptions:

- Disturbance to soil and vegetation, including compaction of soil, would increase water runoff and downstream sediment loads and lower soil productivity, thereby degrading water quality, channel structure, and overall watershed health.
- The degree of impact attributed to any one disturbance or series of disturbances is influenced by several factors including location within the watershed, time and degree of disturbance, existing vegetation, soil characteristics, type of disturbance, and precipitation.
- Increased pollutants in surface waters would degrade habitat used by aquatic life and would affect other uses (e.g., stock-watering, irrigation, and drinking-water supplies).
- The BLM would continue to develop and maintain water sources in upland areas to reduce impacts on wetland/riparian areas and provide a resource for livestock grazing.
- Access roads would follow standard construction practices. However, even properly designed roads would still alter hillslope hydrology and concentrate overland flow, increasing erosion in some areas. In areas with steep topography, roads are expected to be longer, resulting in greater impacts to surface-water resources.
- Fine-textured soils are more susceptible to water erosion and compaction when wet than medium- or coarse-textured soils; coarse-textured soils are more susceptible to wind erosion.

4.4.2.2 Groundwater Analysis Assumptions

Groundwater would be affected during construction of wells or by other subsurface project-development activities. The most likely pathway for groundwater contamination would be undetected spills and leachate from leaking produced-water facilities or mud pits. Additionally, undetected defects in either casing installation or cementing would be the most likely scenario for groundwater contamination to occur from actual gas well drilling and completion activities. Leakage from freshwater storage pits (used in fracturing operations) or other storage pits needed for well completion has the potential to leach salts from soils and impact shallow groundwater. Chemicals used for production drilling could cause local contamination of soils and groundwater if not managed properly. By design, the BLM approves APDs and associated drilling plans to protect potentially potable/usable groundwater intervals. Construction of well pads, proper disposal practices, proper well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize adverse effects on groundwater quality. Withdrawal of produced water during production activities would impact target aquifers as would injection of the produced water.

4.4.3 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives associated with water resources (cited appendices are in the Rawlins RMP ROD, BLM 2008b):

- Maintain or improve water quality by managing surface land use and groundwater resources, where practical and within the scope of the BLM's authority, according to the State of Wyoming Water Quality Rules and Regulations (Appendix 11).
- Maintain the hydrologic and water-quality conditions needed to support riparian/wetland areas; minimize flood and sediment damage to water resources from human and natural causes; analyze and, where possible, minimize levels of salt-loading in watersheds; and protect water resources used by the public (including impoundments, reservoirs, pipelines, and irrigation ditches) and by federal, state, and local agencies for fisheries, wildlife, wild horses, livestock, agricultural, recreational, municipal, and industrial uses.
- Address all accidental spills of environmental pollutants on federal lands according to Appendix 32.
- Implement intensive management of surface-disturbing activities (Appendix 13) in watersheds contributing to water bodies listed on the Wyoming 303(d) list of water bodies with water-quality impairments or threats, within the BLM's authority.
- Maintain or improve wetland/riparian areas as required by the Wyoming Standards for Healthy Rangelands (BLM 1997).
- Avoid playas when locating infrastructure due to poor soils and potential flooding.
- Ensure that activities that would cause water depletion within the Colorado River system or the North Platte River system comply with existing agreements, decrees, rules, and regulations (Appendix 11).

Significance criteria are developed to gauge the magnitude of an impact on the human and natural environment. An impact on water resources as a result of project actions would be considered significant if its magnitude is such that mitigation measures discussed in Appendix C are insufficient and additional mitigation measures are warranted or if it were to persist indefinitely.

4.4.3.1 Surface-Water Significance Criteria

Impacts to surface water supplies would be considered significant if any of the following were to occur:

1. Degradation of water quality beyond the designated use of the receiving water body, or other violations of federal or state water-quality standards, or negatively impacting a water body listed on the State 303(d) list of Impaired or Threatened Waterbodies.
2. Project activities that elevate salt-loading to the Colorado River system above background conditions.
3. Unmitigated loss of wetlands or wetland function (EO 11990 and 11988).

4. Project-related activities that degrade wetland/riparian areas such that, as a minimum physical state, Standards for Healthy Rangelands (BLM 1997) are not being maintained.
5. Streamflow characteristics of intermittent drainages or perennial streams are altered such that established uses are affected.
6. Alteration of stream-channel geometry or gradient by accelerated runoff and erosion (e.g., undesirable aggradation, degradation, or side-cutting) beyond what would be expected by natural processes.
7. Contamination of surface water from spilled fracking fluids, drilling fluids, and produced water.
8. Soil loss greater than 2 tons per acre per year in areas attributed to surface disturbance.

4.4.3.2 Groundwater Significance Criteria

Impacts to groundwater resources or springs caused by project activities would be considered significant if any of the following were to occur:

1. Interruption of the natural flow or level of groundwater to existing local springs, seeps, or flowing artesian wells, regardless of use or non-use.
2. Degradation of groundwater quality in any aquifer such that it can no longer meet its classified current use(s). This includes impacts to underground sources of drinking water (USDW) or sole source aquifers (SSAs).
3. Spills or releases of fuels, liquids, chemicals, or hazardous materials (including but not limited to fracking fluids, drilling fluids, and produced water) that affect the quality of groundwater.

4.4.4 Direct and Indirect Impacts

The following impact discussions consider whether project impacts will result in the exceedance of one or more of the water resources significance criteria detailed above. The potential for an impact meeting or exceeding one or more of the significance criteria listed above is based on legal requirements (i.e., government regulatory standards), public perception, available scientific and environmental documentation, and professional judgment of resource specialists, as specified in 40 CFR 1508.27. The evaluation assumes successful implementation of BMPs and COAs.

4.4.4.1 Impacts Common to the Proposed Action and All Alternatives

The project area encompasses approximately 1.1 million acres. Existing development in the project area has resulted in 56,647 acres of surface disturbance, of which 13,706 acres remain unvegetated (**Table 4.0-1**). The project area contains several active gas fields. To date, over 4,800 wells have been drilled in the project area; about 3,000 are still active producing natural-gas wells with accompanying production-related facilities, roads, and pipelines. Impacts to Muddy Creek have already occurred and two portions of Muddy Creek are now listed on the State 303(d) list of Impaired or Threatened Waterbodies due to habitat degradation (WDEQ 2012). According to WDEQ, the impairment to the middle portion of Muddy Creek is primarily due to livestock grazing, exacerbated by accelerated erosion associated with oil and gas activities (WDEQ 2010). The impairment to the lower portion of Muddy Creek is primarily due to exceedances of the chloride and selenium criteria (WDEQ 2012). Watershed restoration projects in the Muddy Creek sub-basin have also been implemented through the Grizzly Wildlife Habitat Management Area (WHMA), which includes the upper Littlefield Creek drainage and other portions of the upper Muddy Creek drainage (BLM 2008a). Under all action alternatives, revised and newly implemented BMPs and COAs, as outlined in Appendix C, would be attached to individual APDs. Given that there could be up to 30 companies operating within the project area, each with a unique approach to environmental protection measures, implementation of the BMPs and COAs will not be uniform.

Variability in approaches will lead to differences in the level of environmental protection afforded. While these BMPs and COAs would not completely eliminate the potential for significant impacts, they would become the basis for enhanced environmental protection and offer a level of safeguard throughout the project area not present in earlier phases of development. Per NEPA guidance, this analysis is based on the premise that standard operating procedures including these BMPs, COAs, and regulations would be followed under each alternative and by each individual operator.

Since specific locations for well sites or areas of concentrated development have not been identified in the Proposed Action or alternatives, this analysis will consider general project impacts. The Proposed Action and all action alternatives assume the construction of up to 8,950 wells and associated roads and pipelines over the course of 15 years. As discussed in **Section 4.0.3**, the well spacing would vary by area and includes: 40- to 60-acre spacing (12 to 16 wells per section), 80-acre spacing (eight wells per section), and 160-acre spacing (four wells per section) (**Map 4.0-2**). The areas of proposed dense (40- to 60-acre) well spacing are generally associated with active gas fields. Overall, approximately 60 percent of the project area may not undergo concentrated development (i.e. 40 to 60 or 80-acre well spacing). The extent of the unused (or less-used) portion of the project area would be defined by the suitability of production of natural gas and may or may not be continuous. Those areas without concentrated well locations would potentially experience surface disturbance from roads and pipelines to access wells and could also include areas of less-dense conventional well development. The Operators have indicated that they would vary well spacing when geology, permeability, and other conditions allow, but such areas have not yet been defined.

Approximately 30 injection wells for produced-water disposal would be utilized for the project. Both injection and natural gas wells could share pads, although specific locations cannot be predicted. A very small percentage of the conventional well locations would be unsuccessful and would be plugged, abandoned, and reclaimed.

Surface Water Impacts Common to All Alternatives

The differing amounts of surface disturbance by alternative result from the varying number of well pads and the extent of required access roads and pipelines needed for resource development. The magnitude of impacts to surface water versus the acres of surface disturbance is not a one-to-one ratio. Roads and well pads will impact surface hydrology beyond their initial disturbance footprint. For the purposes of this impacts analysis, a change (increase or decrease) in the amount of surface disturbance generally translates to a corresponding change in the magnitude of impacts to surface water.

The main impacts to surface-water resources from this project are brought about by contamination of surface water from the authorized discharge of hydrostatic test water and the accidental discharge (spill) of fracking fluids, drilling fluids, and produced water, and the impacts (including sediment loading) from surface disturbance related to project development/maintenance.

Discharge/Spills. The authorized discharge of hydrostatic test water (water used to test the integrity of pipelines) and the accidental surface discharge of fracking fluids, drilling fluids, and produced water would impact nearby surface-water quality by degrading water quality (related to Criteria 1 and 7), which could in turn impact wetlands (related to Criteria 3 and 4) and increase salinity levels (related to Criterion 2). There would be no authorized surface discharge of produced water as a result of the action alternatives. The magnitude of any impact would depend on the quality and quantity of the hydrostatic test water and any fluids accidentally discharged and the distance of the discharge/spill from a regulated water body (e.g. wetland, riparian area, and ephemeral, intermittent, or perennial stream). The following considers whether project impacts will result in the exceedance of water resources significance criteria based on discharge/spill impacts.

Use or discharge of hydrostatic test water would be accomplished in a manner that should not affect soils, stream channels, surface water, and groundwater quality. After testing operations are completed, the water would be pumped into water-hauling trucks and transported to drilling locations within the project area to be used in conjunction with drilling operations or reused for other aspects of the construction and/or production process. However, if such water is not reused it must be disposed of in such a manner that soil-scouring and water-quality impairment would not result. Hydrostatic test water would be evaluated for compliance with state water-quality standards and no test water would be discharged unless such water meets these standards. Test water not utilized for drilling operations that meets water-quality standards would be disposed of onto undisturbed land having vegetative cover or into an established drainage channel in a manner that would not cause erosion (appropriate erosion control measures would be utilized). Furthermore, use and disposal of hydrostatic test water would comply with the mandatory right-of-way stipulation for hydrostatic testing, as well as the CWA required plan of development and the Wyoming Pollutant Discharge Elimination System (WYPDES) permit that would be required for the proposed project. The quantity of test water discharged would be dependent on the length of the pipelines needed for the handling of produced water (the longer the pipeline segment the more water is needed for testing).

Spills of oil from production facilities would be controlled with the site-specific implementation of Spill Prevention Control and Countermeasures (SPCC) Plans, which would be developed by the Operators in accordance with 40 CFR Part 112. Each Operator would maintain a complete copy of the SPCC plan at the facility or at the nearest field office and have the plan available to the Regional Administrator for onsite review. BLM Notice NTL-3A requires the reporting of spills, accidents, blowouts, or other undesirable events that occur from federal minerals or on BLM-managed surface and IM WY-2009-21 provides guidance and standards for spills and cleanup criteria for on-lease spills; otherwise, spills of hydrocarbon and hazardous materials meeting the requirements outlined in Section 4 of Chapter 4 of WDEQ Wyoming Water Quality Rules and Regulations would be reported to WDEQ-WQD.

Surface Disturbance/Sediment Loading. Project development could result in up to approximately 61,700 acres (Alternative A) of new surface disturbance related to road, pipeline, well pad, and facilities construction. These activities would result in a loss of vegetation and subsequent increased soil-surface exposure (related to Criteria 2, 3, 4, 5, 6, and 8); mixing of soil horizons (related to Criteria 2 and 8); soil compaction resulting in decreased infiltration capacity (related to Criteria 5, 6, and 8); loss of topsoil productivity (related to Criteria 5, 6, and 8); an increased susceptibility of the soil to water erosion (related to Criteria 2, 5, and 6); and off-site sedimentation that would cause channel instability and degradation of surface-water quality (related to Criteria 1, 2, 5, and 6). The magnitude of any impact would depend on the amount and type of disturbance and will be discussed by alternative.

Matherne (2006) noted increased sediment production from well pad locations and confirmed that roads and well pads can provide conditions for focusing runoff and locally increasing erosion. Based on field observations, Matherne found that roads on sideslopes facilitate the erosional process in three ways: (1) they cut across and collect runoff from previously established drainages; (2) where they are cut into hillsides or into the land surface, roads provide focal points for the initiation of erosion; and (3) they provide conduits for sediment transport. Once mobilized, a portion of this sediment (resulting from these erosional processes) would move into channels in pulses that occur in relation to storm events. Some of this sediment would be temporarily stored in drainage bottoms and on hillslopes and a portion would be stabilized by vegetation and not travel to nearby drainages. Soil loss to water erosion is discussed in detail in **Section 3.3.2.1**.

As described in **Section 3.3 Soils**, the project area contains many soils that are saline or sodic. These soils, when eroded as a result of surface disturbance, will make salt available to surface waters. **Table 3.3-1** summarizes the soil limitations within the project area for the following five categories: water erosion, wind erosion, runoff potential, road construction, and reclamation potential. Overall the risk of water erosion is slight (69.9 percent of the total project area has a slight water erosion potential). Only 4.3 percent of the project area contains soils rated as having severe water-erosion potential. Soil characteristics such as depth, permeability, runoff rate, water capacity, and susceptibility to erosion vary widely. The diversity of soil parameters would require a broad spectrum of reclamation techniques. In addition, low annual precipitation and wind and water erosion would make successful reclamation in the project area difficult to attain. Therefore, the overall potential for successful reclamation is poor to fair.

Revegetation would likely be difficult in a large portion of the project area due to the high concentration of salts in the soils. Salt concentrations are exacerbated by surface-disturbing activities. Due to the scarcity of wetland/riparian sites in the project area, the probability of well pads, roads, pipelines, and ancillary facilities directly impacting these resources is low. Impacts to wetland/riparian sites would occur as a result of sediment transported down drainages but the extent of impacts to wetland/riparian sites would be influenced by the distance of the disturbance from the wetland/riparian sites and the success of mitigation and reclamation efforts. Revegetation may be challenging on the estimated 75 percent of the project area indicated as possessing fair or poor reclamation potential (84 percent of area with historic disturbance) (**Table 3.3-1**). Current technology exists to stabilize disturbances, minimize erosion, and increase reclamation success provided that construction, maintenance, and operation of well pads and associated disturbances are in accordance with planned mitigation measures and reclamation. The Rawlins RMP (BLM 2008a) specifies that a buffer of 500 feet be maintained around perennial waters, springs, wells, wetlands and a buffer of 100 feet be maintained around the inner gorge of ephemeral channels. Formal wetland delineations have not been confirmed by the USACE for the entire project area. Wetlands have been confirmed along Muddy Creek, which is a Waters of the U.S. A relevant Nationwide Permit as authorized by Section 404 of the CWA would be required from the U.S. Army Corps of Engineers (USACE) Wyoming Regulatory Office for any disturbance activities in wetlands or Waters of the U.S. Additional BMPs and COAs that would protect wetland/riparian sites are included in **Appendix C**.

Reclamation Success and Surface Water Impacts. Successful reclamation does not necessarily return an area to its previous hydrologic function. For example, re-establishing 80 percent of pre-disturbance ground-cover in 5 years would be considered successful (BLM 2008b). Perennial forbs, brush, and trees generally are more effective at reducing rain splash and can provide structure on the soil surface that can reduce surface runoff energy, but are generally not required for reclamation. Anderson (1975), in a study of 23 watersheds, found that conversion of steep forest and brush-lands to a grassland increased sediment yields by five times. Although this is an extreme case, it points out that not all vegetation functions the same at reducing surface runoff. Where interim reclamation has been successful, sagebrush and other shrub reestablishment would occur within the project life; however, many areas would not return to pre-disturbance function until 30 to 50 years after final reclamation.

Surface Water Use. One of the management objectives included in the Rawlins RMP (BLM 2008a) associated with water resources prescribes that activities that would cause water depletion within the Colorado River system or the North Platte River system comply with existing agreements, decrees, rules, and regulations (Appendix 11). No surface water would be utilized to satisfy water demand, as the water needed for drilling and completion activities would come from new and existing State Engineer's Office (SEO)-approved local water wells.

Summary. An estimated 60,176 acres of surface disturbance has already occurred within the project area, a majority prior to stringent regulatory oversight, which may have resulted in the exceedance of some of the surface-water significance criteria listed above. As such, surface water impacts from the proposed project could exacerbate the magnitude of existing deteriorated conditions. The magnitude of any project related impacts and the potential to meet or exceed the significance criteria would depend on the disturbance associated with each alternative and will be discussed by alternative. Successfully utilizing BMPs and COAs listed in **Appendix C** to stabilize disturbance, minimize erosion, and increase reclamation success would reduce the potential for adding to the magnitude of existing impacts.

Groundwater Impacts Common to All Alternatives

All of the action alternatives would result in the same number of new wells drilled (8,950 natural gas and 30 injection), with the difference being the number of well pads and the extent of required access roads and pipelines needed for resource development. Because the action alternatives adjust the number of well pads, the alternative with the lowest number of pads would minimize risk of contamination of the groundwater resource; a lower number of well pads would reduce the probability of a pad being near a water well or above a shallow aquifer, which could then be impacted by development activity. Also, fewer pads would require fewer roads; both factors would reduce the amount of groundwater use for construction and dust suppression.

Groundwater impacts would occur during the removal of groundwater for drilling, extraction of natural gas, and dust abatement; from improper drilling operations, especially poor casing and cementing of the well bore; from accidental releases of fluids (spills) associated with drilling and fracking operations, produced water, and other hazardous liquids to soils and surface-water systems; and through subsurface disposal (injection) of produced water.

Groundwater Removal. Impacts from groundwater removal are associated with impacts to groundwater quantity and the potential to impact springs and flowing wells. There are no significance criteria related to impacts to groundwater quantity from groundwater removal. Criterion 1 is related to impacts to springs, seeps and flowing wells from groundwater removal.

In terms of subsurface impacts, the development in the proposed project area would consist of natural gas wells completed primarily in the Almond Formation, a member of the late Cretaceous Mesaverde Group. There is no current practical beneficial use for water in this stratum due to the high level of total dissolved solids (TDS), the presence of hydrocarbons, and the availability of higher quality water from shallower aquifers. Secondary natural gas reserves may also be encountered in other formations. There are 288 existing non-energy related/non-industrial domestic, municipal, or stock wells within the project area or 1 mile adjacent to it (SEO 2011). Only four of these wells are completed at depths that would include aquifers of the Mesaverde Group and, depending on their location respective to the deeper natural gas development, could be affected by groundwater withdrawals relating to conventional oil and gas production. Due to the low density of non-energy related water wells in the project area, impacts related to groundwater removal would not be considered significant.

While the number of natural gas wells proposed remains the same, each alternative results in a different number of well pads. As such, there would be a slight difference between alternatives based on the quantity of water needed for road and well pad construction and dust suppression and this difference is reflected in the per-well range of water needed discussed below. Applying the expected per-well water volume of 24,000 to 42,000 bbls/well needed for drilling and completion and well pad and road construction and assuming 600 wells/year, the water demand for the proposed action and the action alternatives would be between 1,856 ac-ft (14.3 million bbls) and 3,248 ac-ft (25.1 million bbls) per year (based on information provided in **Section 2.2.1.2 Drilling and Completion**). The total water demand over the 15 years required for well drilling would be between 27,840 ac-ft (214.1 million bbls) and 48,720 ac-ft (375.9 million bbls). This total amount of water needed for drilling and completion activities would come from new and existing SEO-approved local water wells. While estimates of available water in all aquifers beneath the project area are not available, using estimates of the volume of producible groundwater from Cleary *et al.* (2010), the volume of groundwater above 1,000 feet in the Tertiary age aquifers under the project area alone is approximately 9.67 million ac-ft. Therefore, the total for all water needed for well development and pad and road construction represents between 0.3 and 0.5 percent of the available water in the Tertiary age aquifers under the project area. As discussed in **Section 3.4.3.1**, available water is also found in Quaternary, Upper and Lower Cretaceous, and Jurassic age aquifers. Fisk (1967) estimated that the volume of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft within the Washakie Structural Basin. The combined annual recharge for the Great Divide and Washakie structural basins was estimated at 11,300 ac-ft (Fisk 1967), which is well above the estimated annual 1,856 ac-ft to 3,248 ac-ft water demand for the CD-C project.

Due to technological difficulties and regulatory constraints related to water quality, relatively little produced water can be beneficially used at this time (based on information provided by the Operators). Reuse of drilling mud is currently being employed and is reducing the water demands. As described in **Section 3.4.3.2 Groundwater Use**, there are presently 1,081 groundwater wells (including the 288 non-energy related wells referenced above) permitted within 1 mile of the project area. The total water demand would not likely adversely affect the existing surface-water or groundwater rights in the project area, provided full coordination is implemented with the SEO and the BLM. The total water demand would not cause significant adverse impacts on the groundwater resources within the project area.

The project area contains springs and flowing wells that are important local water sources for livestock, wildlife, and wild horses. The springs in the area occur south of I-80 in the Green River Formation and north of I-80 in the Wasatch and Battle Springs Formations (Mason and Miller 2005; Bartos *et al.* 2006). Impacts related to groundwater removal would not be considered significant for Criterion 1 resulting from the Proposed Action or any action alternatives, as the source aquifers are stratigraphically higher than the natural gas exploration targets. Groundwater withdrawals from water wells have the potential to interrupt flowing wells only if supply wells are completed in the same aquifer as the flowing well and close enough to this flowing well to cause interference.

One of the management objectives associated with water resources that is included in the Rawlins RMP (BLM 2008a) prescribes that activities that would cause water depletion within the Colorado River system comply with existing agreements, decrees, rules, and regulations. Water needed for drilling and completion activities would come from new and existing State Engineer's Office (SEO)-approved local water wells; most (96 percent) SEO-approved wells are completed in Tertiary age aquifers, particularly the Wasatch Formation. According to Mason and Miller (2005), the Wasatch Formation has the potential to lose groundwater to the southeast and ultimately to the Colorado River system. Roughly 20 percent of the Wasatch Formation within the CD-C project area is within that portion of the Washakie Structural Basin that loses groundwater to the southeast toward the Little Snake River, a tributary of the Colorado River. As such, an interruption of this groundwater flow could lead to depletions to the Colorado River system, although the proportion of flow in the Little Snake River that comes from groundwater discharge from the Wasatch Formation has not been quantified. The most important agreement affected by depletions in the project area is the Upper Colorado River Endangered Fish Recovery Program, a partnership working to recover the endangered fish of the Upper Colorado River Basin. Under the Recovery and Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River Basin, "any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish." **Section 4.9.3.1** includes a brief description of the Upper Colorado River Endangered Fish Recovery Program and how depletion fees defined under the RIP are calculated.

The magnitude of depletions is difficult to determine at this time since the specific locations of the drill pads and associated roads and pipelines are not known, but the estimated annual freshwater use within the CD-C project area would range from 1,856 to 3,248 ac-ft /yr and would average 2,552 ac-ft /yr. Assuming that CD-C project groundwater use from the Wasatch Formation is evenly distributed across the project area, approximately 20 percent of the groundwater would come from that portion of the Wasatch Formation that could contribute water to the Little Snake River. Therefore, an average of 510 ac-ft/yr of groundwater would be removed from the Wasatch Formation in this area. Fisk (1967) estimated that the Wasatch Formation within the Washakie Structural Basin holds some 300,000,000 ac-ft of groundwater in storage. In light of this volume of groundwater in storage, the 510 ac-ft/yr withdrawn from the Wasatch Formation within the Washakie Structural Basin would likely have no measurable effect on Colorado River Flows. If, however, it is determined that groundwater withdrawals result in a depletion in the

Colorado River, an agreement would be reached prior to operation between the BLM and the USFWS as to how much each Operator would contribute to the Upper Colorado River Endangered Fish Recovery Program for water depletions.

Drilling Operations. Well-drilling, completion, and operation activities would impact groundwater resources (related to Criteria 2 and 3). Construction of well pads, disposal practices, well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize the risk of degrading groundwater quality.

Well-drilling and completion activities are not likely to impact existing groundwater quality if the project is in compliance with the BLM's Onshore Oil and Gas Order No. 2. These guidelines specify the following:

> *…proposed casing and cementing programs shall be conducted as approved to protect or isolate all usable water zones, potentially productive zones, lost-circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use* (BLM 1988).

The BLM's Onshore Oil and Gas Order No. 2 defines "usable water" as groundwater with TDS of 10,000 parts per million or less encountered at any depth. This definition of useable water corresponds to the EPA's definition of a USDW. To comply with the order, wells must be completed using state-of-the-art techniques, such as cementing and other proven technologies, such that usable water and unusable water do not mix. Assuming compliance with this order, no contamination of usable groundwater would likely occur. Well-drilling and completion as proposed in **Chapter 2 Proposed Action and Alternatives** complies with Onshore Order No. 2. However, improper drilling and completion techniques, especially poor casing and cementing of the well bore, would result in degradation of groundwater quality due to the potential release of drilling fluids and hydrocarbons and the mixing of variable-quality waters from different water-bearing strata that are pierced by the borehole.

A central feature of the well completion process is hydraulic fracturing (fracking), which involves injecting fracturing fluids into the target formation at a force exceeding the parting pressure of the rock, thus inducing a network of fractures through which oil or natural gas can flow to the wellbore. The fractures are filled with sand or other porous materials which serve as proppants to facilitate recovery of natural gas. Hydraulic fracturing has been used for decades in the CD-C area. It is currently excluded from Underground Injection Control regulation under the Safe Drinking Water Act (SDWA) except when diesel fuel is used as a component of the fracking fluid.

The EPA is currently conducting an industry-wide study that seeks to understand any relationships between hydraulic fracturing and drinking water. As part of that study, the EPA issued information requests to leading national and regional hydraulic fracturing service providers. The EPA is seeking information on the chemical composition of fluids used in the hydraulic fracturing process, data on the impacts of the chemicals on human health and the environment, standard operating procedures at hydraulic fracturing sites and the locations of sites where fracking has been conducted (EPA 2010a). No studies related to impacts from hydraulic fracturing have been conducted in the CD-C project area and no occurrences of drinking water contaminated by fracking have been recorded.

Newly adopted WOGCC regulations require Operators to provide the Commission with the exact chemical content of their fracking fluid. While the information may be held as proprietary, the Commission will be able to provide WDEQ with the chemical composition of the fracking fluid if there is ever a question of aquifer contamination. The BLM has issued a proposed rule governing "Oil and Gas; Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands." As proposed, this rule would (1) provide disclosure to the public of chemicals used in hydraulic fracturing on public land and Indian land, (2) strengthen regulations related to well bore integrity, and (3) address issues related to flowback water (BLM 2012e).

The BLM is also proposing a rule to ensure that fracturing operations conducted on the public mineral estate (including split estate where the federal government owns the subsurface mineral estate) follow certain best practices, including the public disclosure of chemicals used in hydraulic fracturing operations on federal lands, confirmation that wells used in fracturing operations meet appropriate construction standards, and a requirement that operators put in place appropriate plans for managing flowback waters from fracturing operations (Federal Register 2012b).

It is expected that fracking effects would not extend beyond 500 feet from the well bore (EPA 2002). Accordingly, the potential for contamination of groundwater by the fracking fluids would be limited to this distance from each well over the production interval. Because fracking would be conducted at considerable depths (8,000 to 12,000 feet below ground surface), groundwater resources near the surface, such as springs, the shallow alluvium, and domestic wells would not be affected.

Due to the use of state-of-the-art drilling and well-completion techniques, including techniques incorporated in the BLM's Onshore Oil and Gas Order No. 2, and if BMPs and COAs related to drilling are implemented, impacts related to degradation of groundwater quality would not be considered significant for Criteria 1, 2 and 3. In addition, the likelihood of mixing, which could occur during the relatively short period of time during drilling, would be low and impacts would not be considered significant for Criterion 2.

Spills. Reserve pits would be used to contain drilling fluids, cuttings, and wastewater produced from the well-drilling operations (related to Criterion 3). The reserve pits would be constructed with an impermeable liner to prevent seepage and possible contamination of surface and groundwater. Likewise, the storage of fresh water, either in lined pits, tanks, or storage pits would be in accordance with WOGCC rules on private and state mineral estate and with BLM's IM WY-2012-007 on public minerals. Reserve and storage pits on federal mineral estate are evaluated and approved by the BLM through the APD, right-of-way grant, or Sundry Notice permitting processes.

Spills could also occur from water and condensate gathering pipelines. State-of-the-art pipeline construction techniques, including hydrostatic pressure testing, would limit the impacts from the project and impacts from spills would not be considered significant for Criterion 3.

Accidental spills of oil from production facilities would be addressed through implementation of SPCC Plans, which would be developed by the Operators in accordance with 40 CFR Part 112. Each Operator would maintain a complete copy of the SPCC plan at the facility or at the nearest company field office and have the plan available to the Regional Administrator for onsite review. BLM Notice NTL-3A requires the reporting of spills, accidents, blowouts, or other undesirable events that occur from federal minerals or on BLM-managed surface and IM WY-2009-21 provides guidance and standards for spills and cleanup criteria for on-lease spills; otherwise, spills of hydrocarbon and hazardous materials meeting the requirements outlined in Section 4 of Chapter 4 of WDEQ Wyoming Water Quality Rules and Regulations would be reported to WDEQ-WQD.

If state-of-the-art pit construction techniques are used, if Hazardous Materials Emergency Response Plan and SPCC Plans are implemented, and with the implementation of BMPs and COAs related to handling of fluids, the likelihood of degradation of groundwater as a result of spills would be limited and the impacts would not be considered significant for Criterion 3.

Subsurface Disposal. Groundwater aquifers would be affected during disposal of produced water from oil and gas activities (related to significance Criterion 2). Produced water would be transported by truck to approved water-disposal injection wells or evaporation ponds, or by pipeline to treatment facilities. A majority of the produced water would likely be injected with a smaller portion disposed of via water treatment facilities/surface evaporative pits (based on information provided by the Operators). Subsurface water disposal methods are administered by the EPA under the underground injection control (UIC) program (40 CFR 144). The UIC program ensures that injection wells meet appropriate performance criteria for protecting USDWs. There are five classes of injection wells permitted under the UIC program based on similarity in the fluids injected, activities, construction, injection depth, design, and operating techniques. Class II and Class V injection wells would likely be used to dispose of produced water resulting from the CD-C project. Class II injection well permits are issued by the WOGCC for injection of fluids associated with oil and conventional natural gas production by an individual operator (EPA 2011a). Class V injection wells are permitted through WDEQ-WQD and cover wells not included in Classes I-IV. In general, Class V wells inject non-hazardous fluids into or above USDWs and are typically shallow, onsite disposal systems, such as septic systems and for disposal of CBM produced water. An average of 98 percent of produced water from natural gas wells in the vicinity of the project area is disposed of by injection, based on 2010 production and injection rates for wastewater from eight local gas production fields (WOGCC 2011a).

During the period of full production for the Proposed Action and action alternatives, there would be approximately 7,600 ac-ft of water produced per year that would require disposal, based on an average of 18 bbls/day/well for each of the 8,950 wells. Lesser amounts would be produced each year prior to and following the period of peak water production. Using the current 98 percent average rate of injection of produced water, approximately 7,500 ac-ft/year of the CD-C produced water would be injected during the height of the CD-C project under the action alternatives.

The construction of an estimated 30 additional injection wells and 20 other water handling facilities is planned in order to dispose of produced water related to the action alternatives. The Operators have not identified the anticipated well class or reservoirs capable of taking injected water at the volumes needed by the production rates projected in the area. The minimum and maximum volumes currently permitted for injection into existing disposal wells in the area range between 1,000 bbls/day (47 ac-ft/year) and 33,000 bbls/day (1,552 ac-ft/year) per well, respectively, depending on the hydraulic properties of the target aquifer (WOGCC 2011a). If all of the project-related produced water were to be injected, the average per-well volume of injected water for the 30 additional injection wells would need to be approximately 252 ac-ft /year (to achieve the approximate 7,500 ac-ft/year needed for well disposal). This is well within the range of permitted injection volumes of existing disposal wells.

There are currently 22 permitted oil and gas related wastewater disposal facilities within 20 miles of the project area (not including subsurface disposal wells) (WDEQ 2011). A majority of these facilities utilize some variation on evaporation. Other forms of disposal include a variety of separation methods (reverse osmosis or ion exchange). It is expected that these facilities would continue to be utilized to the extent possible. Project plans include an estimated 20 additional produced water handling facilities. According to Boysen *et al.* (2002), individual facility evaporation rates of 30 gallons per minute (48 ac-ft/year) at wastewater disposal facilities utilizing misting towers are achievable. Given the proposed 20 additional wastewater disposal facilities, the capacity is more than adequate to dispose of produced wastewater that is not injected (100 ac-ft/year).

If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and the impacts related to Criterion 3 would not be considered significant.

Groundwater Impacts Summary. Impacts from groundwater removal are associated with impacts to groundwater quantity and the potential to impact springs and flowing wells. Groundwater removal by the project is expected to be well below the annual recharge of the structural basins underlying the project area. The likelihood of these withdrawals interrupting flowing wells is low. The 510 ac-ft/yr withdrawn from the Wasatch Formation within the Washakie Structural Basin would likely have no measurable effect on Colorado River flows.

Drilling and completion would result in degradation of groundwater quality if drilling fluids, hydrocarbons, or variable-quality water from different strata are released into water-bearing strata that are pierced by the borehole. With use of state-of-the-art drilling and well-completion techniques, including proper casing and cementing of the well bore, and implementation of drilling BMPs and COAs, impacts related to drilling of natural gas wells would not be considered significant for Criteria 1, 2, or 3.

If state-of-the-art pit construction techniques are used, if Hazardous Materials Emergency Response Plan and SPCC Plans are implemented, and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of spills would be limited and the impacts would not be considered significant for Criterion 3.

If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of subsurface disposal of produced water disposal would be limited and the impacts related to Criterion 3 would not be considered significant.

4.4.4.2 Impacts Associated with the Proposed Action

The types of impacts would be the same as those discussed in **Section 4.4.4.1 Impacts Common to the Proposed Action and All Alternatives**, but would vary in magnitude when compared to the other alternatives. Under the Proposed Action, 6,126 pads would be required for the 8,950 wells. Total construction-phase surface disturbance would be 47,200 acres (approximately 4.4 percent of the project area). With successful reclamation during the life of the project (45 to 55 years), total disturbances would be reduced to about 19,000 acres (about 1.8 percent of the project area). The construction disturbance would not be uniformly distributed across the project area, but rather, project facilities would be located where the efficiency and feasibility of extracting the natural gas would be the highest. As described earlier, most of the project area has fair/poor reclamation potential, which is considered difficult to reclaim. Where sagebrush, juniper, or other vegetation that is difficult to reestablish is disturbed, the location would not return to pre-disturbance hydrologic function until 30 to 50 years after the end of the project in some locations, as described in Section 4.4.4.1.

Surface Water. As with all following action alternatives, the magnitude of the surface water impacts would be primarily related to the amount of sediment mobilization resulting from disturbance (the number and size of the drill pads, the distance and width of the roads, and the distance and width of the pipeline corridors). The quality and quantity of the hydrostatic test water discharged, the quality and quantity of any fluids accidentally discharged, and the distance of the discharge/spill from a water body or water course (e.g. wetland, riparian area, and ephemeral, intermittent, or perennial stream) would also be of concern. No test water would be discharged unless such water meets State water-quality standards. The quantity of test water discharged would be dependent on the length of the pipelines needed to manage produced water (volume related to pipe length) and the amount of test water not reused for other purposes.

Impacts related to disturbance/sediment would be considered significant (depending on the amount of disturbance) for surface water Criteria 1, 2, 5, 6 and 8 as a result of the fair/poor reclamation potential for a majority of the project area. Impacts related to disturbance/sediment loading would not be considered significant for Criteria 3 and 4.

Impacts related to the discharge/spill of water would not be considered significant for Criteria 1, 2, 3, 4, and 7. The State water quality standards regulating discharge of test water, the BMPs and COAs for construction and maintenance of pipelines and reserve pits, and the Hazardous Materials Management and Release Contingency Plans and SPCC Plans would minimize effects of spills.

Groundwater. The magnitude of the groundwater impacts from the Proposed Action (and all following action alternatives) would be related to the number of wells and well pads proposed and the extent of required access roads and pipelines needed for resource development. Groundwater impacts would occur during the removal of groundwater (Criterion 1), from improper drilling operations, especially poor well casing and cementing practices (Criteria 1, 2, and 3), through subsurface disposal (injection) of produced water (Criterion 2), and from accidental releases of fluids [spills] (Criteria 2 and 3).

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets.

Impacts related to improper drilling techniques would be not be considered significant for groundwater Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the implementation of drilling BMPs and COAs.

4.4.4.3 Alternative A: 100-Percent Vertical Drilling

The types of impacts for Alternative A would be the same as those described in **Section 4.4.4.1**, but the disturbance (initial and long-term) would increase when compared to the Proposed Action. This alternative assumes that no wells would be drilled using directional-drilling techniques. Under Alternative A, 8,950 pads would be required for the 8,950 wells. Total construction-phase surface disturbance would be 61,696 acres, 56,400 acres related to well pads and roads. This is 31 percent more than the Proposed Action.

Surface Water. Impacts from both authorized and accidental surface discharge of fluids related to surface water Criteria 1, 2, 3, 4, and 7 would be greater than the Proposed Action. Considering the significant increase in the amount of surface disturbance, impacts would be considered significant related to discharge/spill of water, depending on the locations of the drill pads and associated roads and pipelines.

Impacts related to disturbance/sediment loading would be considered significant for surface water Criteria 1, 2, 4, 5, 6, and 8, primarily as a result of the significantly greater amount of surface disturbance.

Groundwater. Under Alternative A, the per-well water use would be skewed toward the maximum of 42,000 bbls/well due to the additional water needed for road and pad construction and dust abatement. Because produced water cannot be used for dust abatement and since this alternative has the greatest amount of surface disturbance, Alternative A would likely place the greatest demand on the aquifers targeted for water supplies. Because this alternative increases the number of well pads, the risk of contamination of the groundwater resource would increase due to the greater probability of a pad being near a water well or above a shallow aquifer, which, by proximity, raises the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

The potential to meet or exceed groundwater Criterion 1 from impacts related to groundwater removal would be greater than the Proposed Action because of increased water demands for hydrostatic testing and dust suppression but the impacts would not be considered significant since the source aquifers for the springs or seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative A would not significantly impact groundwater quantities. Impacts from degradation of groundwater from disposal wells would not be considered significant for Criterion 2 since disposal wells would be installed according to EPA and WDEQ requirements and since BMPs and COAs related to handling of fluids would be implemented. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and the impacts from spills resulting from Alternative A would not be considered significant for Criterion 3.

4.4.4.4 Alternative B: Enhanced Resource Protection

The types of impacts for Alternative B would the same as those described in **Section 4.4.4.1**, but the short- and long-term disturbance would decrease when compared to the Proposed Action. Under Alternative B, 5,798 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 45,516 acres, 4 percent less than the Proposed Action. This alternative identifies the resources that may be more at risk from natural gas development and the enhanced resource protections that would be implemented for these resources, which include enhanced protections and mitigation. The alternative also recognizes that future development may be more intensive than currently expected or may have unintended consequences, resulting in impacts to wildlife habitats and populations in areas that were not anticipated or impacts that occur at a faster pace than anticipated. Under Alternative B, RMP development restrictions would be expanded near perennial waters, springs, wells, and wetlands from 500 feet to 0.25 mile and the avoidance distance within the Muddy Creek/Red Wash sensitive fish habitat area would be expanded to 0.5 mile. Water quality monitoring on upper Muddy Creek would be extended to lower Muddy Creek within the CD-C area, which has been designated a 305(b) threatened stream. Although this alternative describes protections and mitigations for specifically identified resources, the overall purpose of the alternative would be to maintain healthy ecosystem function at the landscape level over the entire project area. In so doing, the alternative thus strives to ensure that the Wyoming Standards for Healthy Rangelands will be satisfied, as well as State water quality state standards.

Surface Water. Impacts to the surface-water resource would be less in magnitude than those for the Proposed Action due to the reduced amount of surface disturbance and the enhanced protection of the specific resources and habitats (particularly along Muddy Creek and its tributaries, where setback distances on federal minerals and surface would be increased from 500 feet to 0.25 mile or even 0.5 mile in some cases), which would reduce surface-water impacts. While this alternative does not significantly reduce the acres of disturbance compared to the Proposed Action and impacts would still occur, it does identify surface disturbance and population thresholds that, if exceeded, would signal the need for still more protections and mitigation and then outlines the additional measures that may be required.

Impacts from both authorized and accidental surface discharge of fluids related to surface water Criteria 1, 2, 3, 4, and 7 would be less than the Proposed Action. Impacts related to the discharge/spill of water would not be considered significant considering the decrease in the amount of surface disturbance and the increased buffers around surface-water features.

Impacts related to the disturbance/sediment loading would be considered significant for Criterion 6, depending on the locations of the drill pads and associated roads and pipelines. Impacts related to disturbance/sediment loading would not be considered significant for Criteria 1, 2, 3, 4, 5, 6, and 8. Even though this alternative is directed primarily at habitat protection, it would reduce the potential for creating impacts that exceed surface-water Criteria 2 and 8 compared to the Proposed Action, given the reduced number of well pads, reduced surface disturbance, and increased setback distances from specified high value water resources.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, lowers the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative B would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. Disposal wells are installed according to EPA and WDEQ requirements and BMPs and COAs related to handling of fluids would be implemented so the likelihood of degradation of groundwater as a result of water disposal would be limited and impacts would not be considered significant for Criterion 2. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and the impacts from spills resulting from Alternative B would not be considered significant for Criteria 2 and 3.

4.4.4.5 Alternative C: Surface Disturbance Cap—60 Acres and 30 Acres per Section

The types of impacts for Alternative C would be the same as those described in **Section 4.4.4.1**, but would be reduced in magnitude when compared to the Proposed Action because of the decrease in disturbance (initial and long-term). Under Alternative C, 5,299 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 42,955 acres, 9 percent less than the Proposed Action. This alternative designates parts of the project area as "high-density" areas—those areas that have undergone the greatest natural gas development to date. Within the high-density areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance at any one time per section of public land. For the remainder of the project area—the low-density areas—the disturbance cap would be 30 acres per section. All prior surface disturbances related to long-term use for roads or on-pad production facilities and all disturbances that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap. The aim of this alternative is to encourage better reclamation and reduced surface disturbance, primarily through increased directional drilling.

Surface Water. Impacts to surface water from Alternative C would be less in magnitude than those for the Proposed Action due to the capping of disturbance within a 640-acre section of public land. The disturbance cap in place under this alternative would be closely related to the density of existing disturbance and the amount of existing reclamation in the project area and would incentivize successful reclamation.

Impacts related to the discharge/spill of water would not be considered significant for Criteria 1, 2, 3, 4, and 7 considering the decrease in the amount of surface disturbance.

Impacts related to disturbance/sediment loading would be considered significant for Criteria 2 and 6.

Impacts related to the disturbance/sediment loading would not be considered significant for Criteria 1, 3, 4, 5, and 8. This is primarily due to the large reduction in surface disturbance compared to the Proposed Action.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, lowers the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative C would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and impacts would not be considered significant for Criterion 2. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and impacts from spills resulting from Alternative C would not be considered significant for Criteria 2 and 3.

4.4.4.6 Alternative D: Directional Drilling

The types of impacts for Alternative D would be the same as those described in **Section 4.4.4.1**, but would be reduced in magnitude when compared to the Proposed Action because of the decrease in initial and long-term disturbance. Under Alternative D, 4,032 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 36,449 acres, 23 percent less than the Proposed Action. All natural gas wells on public lands and federal mineral estate would be drilled from multi-well pads. In sections that have not had oil and gas development at all, one new well pad would be permitted for all future development. No numerical disturbance caps, no rollover credits, and no new requirements on reclamation are part of this alternative.

Surface Water. Impacts to surface water would be less in magnitude than those for the Proposed Action due to the significant reduction in the amount of surface disturbance. Alternative D has the least amount of surface disturbance of the action alternatives.

Impacts from both authorized and accidental surface discharge of fluids related to surface water would not be considered significant for Criteria 1, 2, 3, 4, and 7 considering the decrease in the amount of surface disturbance.

Impacts related to disturbance/sediment loading would be considered significant for Criteria 2 and 6.

Impacts related to the disturbance/sediment loading would not be considered significant for Criteria 1, 3, 4, 5, and 8. This is largely the result of reduced disturbance acreage compared with the Proposed Action.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, raises the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative D would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and the potential of meeting or exceeding Criterion 2 would be low. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and impacts from spills resulting from Alternative D would not be considered significant for Criteria 2 and 3.

4.4.4.7 Alternative E: No Action

Under the No Action Alternative (**Section 2.2.6**), there would be no new surface water or groundwater impacts.

4.4.5 Summary of Impacts

All action alternatives would result in increased natural gas development in the CD-C project area, with the principal difference between the alternatives being the amount of surface disturbance. Surface water impacts resulting from drill pad, access road, facility site, and pipeline right-of-way disturbance would include: increased sediment loads due to removal of vegetation; exposure of the soil; mixing of soil horizons; soil compaction; and changes in water quality, channel geometry, and channel stability.

Groundwater impacts would result from the removal of groundwater and subsurface disposal (injection) of produced water. Impacts to groundwater could also be caused by improper drilling operations—especially poor well casing and cementing practices—and by accidental releases of fluids associated with drilling operations, produced water, and other hazardous liquids to soils and surface-water systems. The following discussion reviews impacts by alternative and discusses the potential to meet or exceed significance criteria for surface water and groundwater for each action alternative. The evaluation assumes successful implementation of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs included in **Appendix C**. **Table 4.4-1** summarizes the impacts discussion.

Table 4.4-1. The potential for Significant (S) or Not Significant (NS) impacts for surface water and groundwater significance criteria.

Surface-Water Significance Criteria								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Proposed Action	S	S	NS	NS	NS	S	NS	S
Alternative A	S	S	S	S	S	S	S	S
Alternative B	NS	NS	NS	NS	NS	S	NS	NS
Alternative C	NS	S	NS	NS	NS	S	NS	NS
Alternative D	NS	S	NS	NS	NS	S	NS	NS
Groundwater Significance Criteria								
	1	**2**	**3**					
Proposed Action	NS	NS	NS					
Alternative A	NS	NS	NS					
Alternative B	NS	NS	NS					
Alternative C	NS	NS	NS					
Alternative D	NS	NS	NS					

A summary of the water resources impact significance criteria is included here. The full description of the criteria is found in **Section 4.4.3.1, Surface Water Significance Criteria**, and **Section 4.4.3.2 Groundwater Significance Criteria**.

<u>Surface-Water Significance Criteria</u>

1. Degradation of water quality.
2. Elevated salt-loading to the Colorado River system.
3. Loss of wetlands or wetland function.
4. Degradation of wetland/riparian areas.
5. Alteration of streamflow characteristics.
6. Alteration of stream-channel geometry or gradient.
7. Surface water contamination from spilled fluids.
8. Soil loss greater than 2 tons per acre per year.

<u>Groundwater Significance Criteria</u>

1. Impairment of springs, seeps, or flowing artesian wells.
2. Degradation of groundwater quality in any aquifer.
3. Groundwater contamination from spilled fluids.

Under the Proposed Action, 6,126 pads would be required for 8,950 wells. The primary surface water impacts of the Proposed Action would be brought about by contamination from the authorized and accidental discharge of fluids and the impacts from surface disturbance related to project development and maintenance. Groundwater impacts would occur during the removal of groundwater and through subsurface disposal (injection) of produced water. Impacts to groundwater could also be caused by improper drilling operations and from accidental releases of fluids (spills). Impacts to surface water would be considered significant for Criteria 1, 2, 6, and 8, depending on the locations of the drill pads and associated roads and pipelines. Impacts would not be considered significant for groundwater.

Alternative A (100-Percent Vertical Drilling) assumes that all of the wells would be drilled vertically, resulting in an increase in the number of pads (to 8,950) and associated roads and pipelines. Alternative A would increase the amount of construction-phase surface disturbance by 31 percent compared to the Proposed Action. The types of surface water and groundwater impacts would be the same as for the Proposed Action but the magnitude of the impacts would increase. Impacts to surface water would be considered significant for all eight criteria. Impacts would not be considered significant for groundwater.

Alternative B (Enhanced Resource Protection) would reduce the number of pads (to 5,798) and reduce the amount of construction-phase surface disturbance by nearly 4 percent compared to the Proposed Action. The magnitude of surface water impacts would decrease when compared to the Proposed Action as a result of the reduced number of well pads—and hence the amount of surface disturbance—and specifically from the enhanced protection of the Muddy Creek watershed. Impacts to surface water would be considered significant for Criterion 6. Impacts would not be considered significant for groundwater.

Alternative C (Surface Disturbance Cap—60 Acres and 30 Acres per Section) would reduce the number of pads (to 5,229) and thus reduce the amount of surface disturbance by 9 percent compared to the Proposed Action, which would reduce the magnitude of surface-water impacts. In addition to the reduction of surface disturbance, the aim of this alternative is to encourage improved reclamation success, primarily through increased directional drilling. Impacts to surface water would be considered significant for Criteria 2 and 6. Impacts would not be considered significant for groundwater.

Alternative D (Directional Drilling) would reduce the amount of construction-phase surface disturbance by 23 percent compared to the Proposed Action, which would reduce the magnitude of surface-water impacts. This alternative reduces surface disturbance primarily through increased directional drilling, which would reduce the number of pads (to 4,032) and associated roads, pipelines, and other facilities. This alternative has the least amount of surface disturbance of the action alternatives. Impacts to surface water would be considered significant for Criteria 2 and 6. Impacts would not be considered significant for groundwater.

Under Alternative E (No Action Alternative), it is assumed that the development activities proposed by the CD-C Operators would not occur and there would be no new surface water or groundwater impacts.

4.4.6 Unavoidable Adverse Impacts and Additional Mitigation Measures

Surface Water. All of the impacts defined in the eight surface water significance criteria (**Section 4.4.3.1**) would be mitigated to some extent by the measures found in the BMPs and COAs in **Appendix C** and by the measures found in state and federal law and regulation. Some of the impacts would be further mitigated by provisions of the different alternatives. For the most part, loss of wetland function and degradation of wetland/riparian areas (Criteria 3 and 4), alteration of streamflow characteristics (Criterion 5), and contamination from spilled industrial fluids and produced water (Criterion 7) would be addressed by these existing protections and mitigations. The exception is Alternative A where surface disturbance would be at such a level that impacts would not be adequately mitigated.

Total surface disturbance also contributes to the exceedance of significance criteria related to degradation of water quality and potential soil loss (Criteria 1 and 8). Under the Proposed Action and Alternative A, total surface disturbance would be great enough that existing protection and mitigation measures would not necessarily prevent exceedance of significance levels for these criteria. Alternative B specifies an increase in set-back distances within the Muddy Creek watershed, from 500 feet to 0.25 mile for springs, wells, and wetlands and to 0.5 mile from perennial streams. This increased set-back would ensure that Criteria 1 and 8 are not exceeded if state and private lands are included in the set-back. The reduction in surface disturbance brought about by Alternatives C and D (9 and 23 percent, respectively) combined with existing mitigation measures would reduce the likelihood of these alternatives exceeding Criteria 1 and 8.

Alternative B would also avoid exceedance of Criterion 2—salt loading—because of the increased set-back. The Proposed Action and Alternatives A, C, and D would exceed Criterion 2.

Criterion 6—alteration of stream-channel geometry or gradient by accelerated runoff and erosion—would be exceeded by the Proposed Action and all action alternatives.

Impacts could be reduced for the Proposed Action and Alternatives A, C, and D with the application of features found in Alternative B. Increased set-back distances would decrease impacts with regard to Criteria 1 through 4. Such a measure would be most effective if private and state lands were included in the setback. Implementation of preconstruction planning and design activities that emphasize proper placement, construction, and maintenance of roads, culverts, drainage ditches would also reduce impacts.

Alternatives C and D would have reduced impacts with regard to all the significance criteria because they are structured to decrease both the number of well pads—disturbance sites—as well as the total acreage of disturbance. Any measures applied to the Proposed Action or Alternatives A and B that decrease the number of disturbance sites and the amount of surface disturbance would also reduce the risk of those alternatives exceeding the significance criteria.

Groundwater. Groundwater resources would not incur significant adverse impacts with the appropriate application of protections and mitigation measures found in **Appendix C** and in state and federal laws and regulations. No additional mitigation measures would be necessary.

4.5 AIR QUALITY

4.5.1 Introduction

The air quality analysis addresses the potential impacts on ambient air quality and Air Quality Related Values (AQRVs) from air emissions due to the Proposed Action and alternatives and from other regional emissions sources within a defined study area. Potential ambient air quality impacts were quantified and compared to applicable state and Federal ambient air quality standards and Prevention of Significant Deterioration (PSD) increments, hazardous air pollutant (HAP) thresholds, and AQRV impacts (impacts on visibility, atmospheric deposition, and potential increases in acidification to acid-sensitive lakes) were determined and compared to applicable thresholds.

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts within and adjacent to the CD-C project area resulting from project-related development and production emissions. The EPA's Guideline (EPA, 2005) model, AERMOD (version 11353), was used to assess these near-field impacts. The near-field criteria pollutant assessment was performed to estimate maximum impacts of CO, oxides of nitrogen (NOx), SO_2, PM_{10}, and $PM_{2.5}$ from project emissions sources that are likely to operate during the development and production phases of the Proposed Action and alternatives. Near-field HAP (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde) concentrations were 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.

A far-field ambient air quality impact assessment was carried out to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of CO, NOx, SO_2, PM_{10},

$PM_{2.5}$, and volatile organic compounds (VOCs) expected to result from the development of the CD-C project as well as the combined effects of the CD-C project and other new sources of emissions in the region.

The far-field analysis described in this document differs significantly from previous natural gas development EIS air quality analyses performed for the BLM in Wyoming. Previous BLM analyses used the CALPUFF dispersion model to assess AQRV impacts in nearby PSD Class I Areas and sensitive PSD Class II Wilderness Areas from project and cumulative source emissions. For the CD-C impact analysis, the BLM and Wyoming Department of Environmental Quality Air Quality Division (WDEQ-AQD) elected to use the CAMx (Comprehensive Air quality Model with Extensions; ENVIRON 2010) photochemical grid model (PGM), which is a type of computer model that simulates the formation, transport, and fate of ozone and other pollutants in the atmosphere. PGMs represent the "state of the science" in tools and methods for both air quality (including ozone) and AQRV analyses. CAMx was used to predict maximum potential ambient air quality and AQRV impacts at mandatory federal PSD Class I and other sensitive PSD Class II areas, as well as designated acid-sensitive lakes. The CAMx analysis includes mid-field analyses which quantify impacts within the CD-C project area. Mid-field air quality impacts are compared to applicable ambient air quality standards.

The far-field modeling approach was determined by ozone air quality levels in Wyoming. Recent high levels of observed ozone dictated the choice of far-field modeling tools and methods. Ozone (O_3) is an important component of photochemical smog. Ozone is not emitted directly into the atmosphere, but is formed from photochemical reactions of precursor species in the presence of sunlight. The most important precursors are NO_x and VOCs. High ozone episodes occur most typically in urban areas during summer. Under these conditions, there is an abundance of ozone precursors from human activities and the high angle of the summer sun means there is sufficient sunlight available to drive the photochemical reactions which produce ozone. High summer temperatures enhance VOC emissions and speed the chemical reactions which produce ozone from its precursors.

In 2005, high ozone was measured in Sublette County, WY during winter. The phenomenon of winter high ozone under conditions with low sun angles and cold temperatures was novel, particularly because Sublette County is a relatively rural area whose main source of emissions is oil and gas exploration and production. High ozone levels were recorded again in Sublette County in 2006, 2008, and 2011. High winter ozone has also been measured in the Uinta Basin region in rural eastern Utah in recent years. Oil and gas production also occurs in the Uinta Basin.

In March 2009 the Governor of Wyoming recommended to the EPA that Sublette County and parts of northeastern Lincoln and northwestern Sweetwater Counties be designated ozone non-attainment areas under the 2008 75 parts per billion (ppb) ozone standard. Because of the importance of ozone as an air quality issue in Wyoming, the CD-C air quality impact analysis included evaluation of the effects of emissions from the Proposed Action on ozone throughout the study area (**Map 3.5-1**)..

The CD-C project area is located in eastern Sweetwater and western Carbon Counties. Although the project does not lie within the area proposed for non-attainment designation, the CD-C impact analysis evaluated potential ozone impacts from the Proposed Action emissions on ozone in Sublette, northeastern Lincoln, and northwestern Sweetwater Counties as well as the rest of the study area.

An emission inventory was developed for the Proposed Action and alternatives for each year over the expected life of the project. This emission inventory was used in the near-field, mid-field and far-field analyses. Emission inventories for all regional emissions sources from human activities and natural sources (e.g. wildfires) were compiled for use in the far-field modeling. In the following sections, the emission inventory development is described. Next, the modeling approaches for both near- and far-field analyses are detailed, and finally, the results of the analyses are given.

4.5.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives and impact significance criteria associated with air quality:

Management Objectives

1. Maintain concentrations of criteria pollutants associated with management actions in compliance with applicable state and federal ambient air quality standards.
2. Maintain concentrations of PSD pollutants associated with management actions in compliance with the applicable increment.
3. Reduce visibility-impairing pollutants in accordance with the reasonable progress goals and time frames established within the State of Wyoming's Regional Haze State Implementation Plan (SIP).
4. Reduce atmospheric deposition pollutants to levels below generally accepted Levels of Concern and Limits of Acceptable Change.

Significance Criteria

If and when specific activities are proposed at the implementation stage requiring quantitative analysis, impacts to air quality would be compared to the following significance criteria:

- The National Ambient Air Quality Standards (NAAQS) or Wyoming Ambient Air Quality Standards (WAAQS)
- The applicable PSD increments
- Federal guidelines for visibility impairment and atmospheric deposition.

More detailed information on the significance criteria is included in **Section 3.5.2**.

4.5.3 Emission Inventory Development

4.5.3.1 CD-C Project Alternative Emission Inventory Development

Emission inventories for CD-C project area development and production activities were compiled for the air quality impact assessment for all existing sources and for all new sources associated with the Proposed Action and alternatives.

There are two different types of activities (field development and production) associated with the CD-C project for which emission inventories were compiled. Emission-generating activities during field development include well pad and access road construction, drilling, fracking/completion, vehicle travel during the drilling and completion phase, and construction and vehicle travel during installation of gathering and sales pipeline systems. Production emissions were calculated for dehydration units, separators, gathering pipelines, blowdown tanks, and water/condensate storage tanks. Ancillary facilities included new compressor engines at current and proposed sites as well as central gas processing facilities. The specific components of field development and production emissions and total field-wide emissions are discussed in the Air Quality Technical Support Document (AQTSD) and its Appendices (available on the CD-C Natural Gas Development Project EIS website).

The CD-C project emission inventory was developed using data from the CD-C Operators as the primary source of information. The inventory accounted for all applicable emissions controls such as New Source Performance Standards (NSPS) and new Tier standards for non-road engines. The most important of these emissions controls are those specifically targeted at Wyoming oil and gas sources.

The WDEQ-AQD regulates emissions from oil and gas sources through the Oil and Gas Permitting Guidance (WDEQ-AQD, 2010). Different regulations apply in different regions of the state, with the most stringent level of controls applied to the areas with highest measured ambient ozone concentrations that occur in the Jonah-Pinedale Anticline Development (JPAD) area shown in **Figure 4.5-1**. The CD-C project lies within a region of intensive oil and gas development known as the Concentrated Development Area (CDA). Under the WDEQ-AQD 2010 guidance, emissions controls are required in the CDA for the following source categories:

- Tank flashing
- Dehydration units
- Pneumatic pumps
- Pneumatic controllers
- Produced-water tanks
- Blow-down / venting

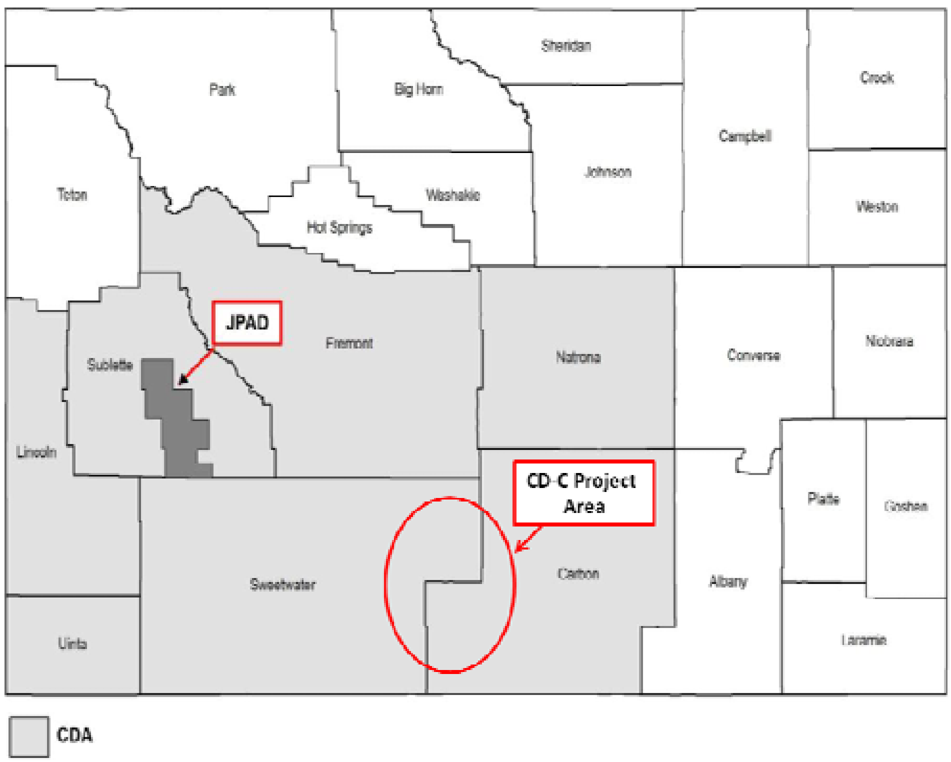


Figure 4.5-1. The Concentrated Development Area (CDA)

Source: WDEQ-AQD, 2010

These control measures were taken into account in the development of the CD-C project emission inventory. **Table 4.5-1** shows the emissions control measures for each emissions source category modeled in this analysis.

Table 4.5-1. Modeled CD-C project emissions control measures

CD-C Project Emissions Source Category	Type of Control Applied
Well Pad Const Equipment (diesel ICE)	Change in fuel sulfur content
Completion Equipment (diesel ICE)	Change in fuel sulfur content
Construction Traffic, Road and Well Pad	Change in emissions due to fleet turnover
Construction Traffic, Road and Well Pad – Fugitive Dust	Watering
Drilling Equipment (diesel ICE)	Change in fuel sulfur content and emission reductions due to Tier 2 engine technology
Drilling Traffic	Change in emissions due to fleet turnover
Drilling Traffic – Fugitive Dust	Watering
Completion Traffic	Change in emissions due to fleet turnover
Completion Traffic – Fugitive Dust	Watering
Completion Venting	96% of Gas to Green Completions and 4% of Gas Flared
Completion Flaring	N/A
Well Pad and Access Road Construction – Fugitive Dust	Watering
Construction Wind Erosion – Fugitive Dust	None
Workover Equipment (diesel ICE)	Change in fuel sulfur content
Workover Rig Traffic	Change in emissions due to fleet turnover
Workover Rig Traffic – Fugitive Dust	Watering
Heaters	None
Fugitives	None
Pneumatic Devices	No bleed devices
Pneumatic Pump	WDEQ BACT
Dehydrator Venting	WDEQ BACT
Tank Loadout (vapor losses)	None
Well Venting	None
Production Traffic	Change in emissions due to fleet turnover
Production Traffic - Fugitive Dust	Watering
Condensate Tank Flashing Losses	WDEQ BACT
Condensate Tank Working Losses	WDEQ BACT
Condensate Tank Breathing Losses	WDEQ BACT
Production Flaring	--
Compressor Station	WDEQ BACT assumed to limit NO_x and CO emissions for reciprocating engines
Gas Plant	WDEQ BACT assumed to limit NO_x and CO emissions for reciprocating engines
Evaporation Ponds	None

The field-wide emissions for the Proposed Action and alternatives are summarized in **Table 4.5-2**. The first column shows emissions for existing project area sources in the year 2008. The second column shows emissions from these 2008 sources within the project area forecast to the year 2022. These emissions represent the No Action Alternative in which the CD-C project is not developed. The Proposed Action column shows emissions from Proposed Action sources in the year 2022, and the total project area emissions in year 2022 gives the sum of emissions from existing sources and Proposed Action sources within the CD-C project area. The column furthest to the right shows the difference in emissions between the total CD-C field wide emissions in 2022 and year 2008 field-wide emissions. Year 2022 emissions are shown since the peak emissions for the Proposed Action alternative are estimated to occur during 2022.

Table 4.5-2. CD-C project alternative emission summary (tpy)

Pollutant	2008 Existing Project	No Action 2022	Proposed Action 2022	Total Project Area 2022	2008 to 2022 Increase in Emissions Resulting from Proposed Action and No Action Alternatives
NO_x	3,587	1,757	4,959	6,715	3,129
CO	3,185	1,852	8,621	10,473	7,289
SO_2	135	2	2	4	-131
PM_{10}	1,352	498	2,255	2,753	1,401
$PM_{2.5}$	403	203	475	678	275
VOC	58,672	42,249	14,791	57,039	-1,633

4.5.4 Greenhouse Gases

The U.S. Supreme Court ruled in 2007 that the EPA has the authority to regulate greenhouse gases (GHGs) such as methane (CH_4) and carbon dioxide (CO_2) as air pollutants under the Clean Air Act; however, there are currently no ambient air quality standards for GHGs, nor are there currently any emissions limits on GHGs that would apply to sources developed under the Proposed Action and alternatives. There are, however, applicable reporting requirements under the EPA's Greenhouse Gas Reporting Program. These GHG emission reporting requirements, finalized in 2010 under 40 CFR Part 98, will require the CD-C project proponents to develop and report annual methane and CO_2 emissions from equipment leaks and venting, and emissions of CO_2, methane and nitrous oxide from flaring, onshore production stationary and portable combustion emissions, and combustion emissions from stationary equipment. At present, there are no rules related to GHG emissions or impacts that would affect development of the Proposed Action and action alternatives, besides these GHG reporting requirements.

Both the exploration/construction and production phases of the Proposed Action and the development alternatives will cause emissions of GHGs. Methane comprises much of the chemical composition of natural gas, and nitrous oxide, CO_2, and methane are emitted by engines used for drill rigs, compressor engines, etc. As part of the development of the CD-C project emission inventory, an inventory of CO_2, methane, and nitrous oxide was prepared for all emissions source categories. GHGs were not modeled in either the near-field or far-field impact analyses, but the GHG inventory is presented here for informational purposes and is compared to other U.S. GHG emission inventories in order to provide context for the CD-C project GHG emissions. This inventory is presented in the AQTSD, Section 2.1.6.

In the CD-C project emission inventory, emissions of the greenhouse gases CO_2, CH_4, and N_2O from new and existing sources are quantified in terms of CO_2 equivalents. Measuring emissions in terms of CO_2 equivalents allows for the comparison of emissions from different GHGs based on their Global Warming Potential (GWP). GWP is defined as the cumulative radiative forcing of a gas over a specified time horizon relative to a reference gas resulting from the emission of a unit mass of gas. The reference gas is taken to be CO_2. The CO_2 equivalent emissions for a greenhouse gas are derived by multiplying the emissions of the gas by the associated GWP. The GWPs for the inventoried GHGs are CO_2:1, CH_4:21, N_2O:310 (EPA, 2011). Details of the greenhouse gas emissions calculations are provided in the AQTSD (greenhouse gas emissions over the life of the project are shown in AQTSD Figure 2-13.) The CD-C project's peak CO_2 equivalent emissions year will be 2022. Field-wide GHG emissions for the existing project in year 2008, the existing 2008 project projected for year 2022 (No Action Alternative), the CD-C Proposed Action in year 2022, the total project area emissions in year 2022 (existing sources taken together with the Proposed Action), and the difference in emissions between the total CD-C field emissions (including the Proposed Action emissions) and year 2008 field-wide emissions are summarized in **Table 4.5-3**.

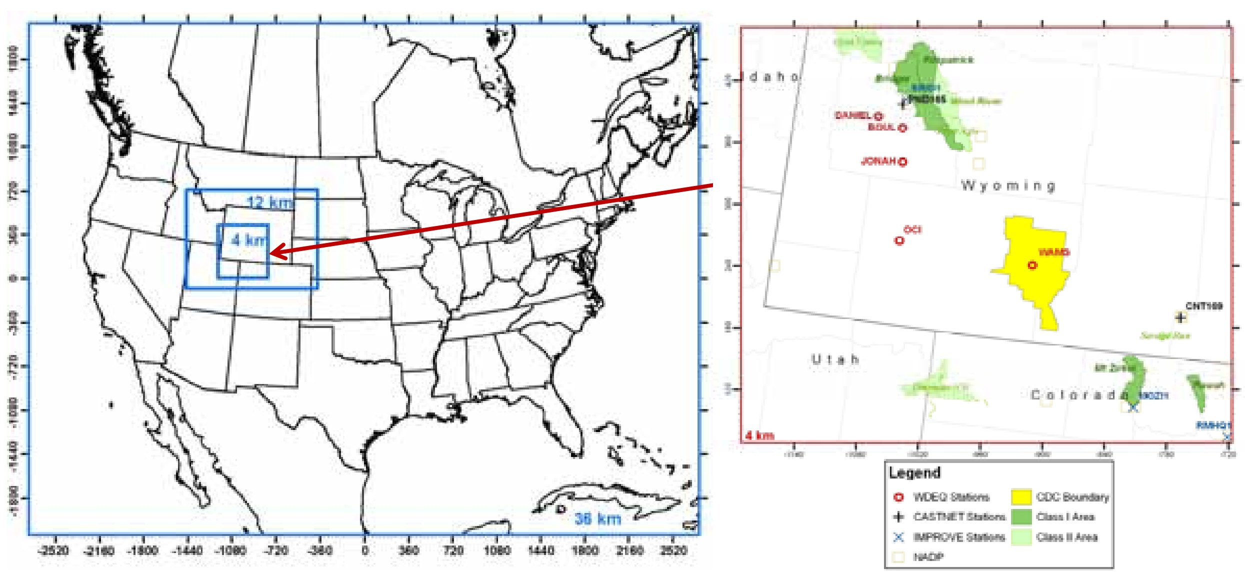
Table 4.5-3. CD-C project alternative GHG emission summary (metric tpy)

Pollutant	2008 Existing Project	No Action 2022	Proposed Action 2022	Total Project Area 2022	2022-2008 Increase in Emissions Resulting from Proposed Action and No Action Alternatives
CO_2	3,396,718	3,155,654	4,328,247	7,483,901	4,087,183
CH_4	89,165	76,097	38,291	114,388	25,223
N_2O	91	75	67	142	51
CO_2e*	5,298,295	4,777,792	5,153,746	9,931,538	4,633,242

* *CO_2 equivalent*

4.5.5 Regional Emission Inventory Development

In addition to the CD-C project emissions, emission inventories for other regional existing and proposed emissions sources within a continental-scale modeling domain (**Map 4.5-1**) were constructed and used for cumulative modeling analyses. Emission inventories prepared by the Western Regional Air Partnership (WRAP), Carter Lake, and BP and other Operators formed the basis for the regional emission inventories for the CD-C project far-field air quality impact analysis. Sources of PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2, and VOC emissions within the study area were inventoried. Emission inventories and projections from various state and federal agencies were used to update the WRAP analyses as appropriate for each of the years modeled. Three categories of regional emissions inventories were compiled: two base case years (2005-6), a baseline year (2008), and a future year (2022). These inventories are described in detail in the AQTSD and its Appendices. The project and regional emissions were used in air quality modeling analysis of near-field and far-field impacts.



Map 4.5-1. Study area showing 36/12/4 kilometer (km) nested modeling grid used for photochemical grid modeling (left panel) and expanded view of the 4-km domain that was the focus of the far-field modeling impact analysis showing boundary of CD-C project area (yellow) and nearby Class I/sensitive Class II areas.

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

4.5.6 Air Quality Modeling

4.5.6.1 Near-Field Modeling

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts within and adjacent to the CD-C project area resulting from the Proposed Action and alternative development and production emissions. AERMOD (version 11353), combined with three years (2008-2010) of hourly meteorological data collected near Wamsutter, Wyoming were used in the analysis to assess these near-field impacts. The near-field criteria pollutant assessment was performed to estimate maximum potential impacts of CO, NOx, SO_2, PM_{10}, and $PM_{2.5}$ from project emissions sources that are likely to operate during the development and production phases of the Proposed Action and action alternatives. Production activities include well production, expanded field compression and a new gas processing facility. Well field development activities that were modeled included well pad and access road construction, and well drilling. Modeling scenarios were also developed that included wells in production in close proximity to well pads where well drilling operations are occurring.

For 1-hour NO_2 NAAQS compliance demonstrations, where 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 2 years during the 3-year averaging period. Since drill rigs move to different locations during field development, it is not likely that a drilling operation would occur over 3 consecutive years in the same location.

For all criteria pollutant modeling scenarios, two model receptor grids were used for disclosing modeled impacts: one assuming a 100-meter distance from project sources, and another using a 250-meter distance from project sources. Representative background pollutant concentrations were added to modeled impacts and the total impacts compared to applicable Wyoming and National Ambient Air Quality Standards (WAAQS and NAAQS). Direct modeled pollutant impacts from project emission were compared with applicable PSD Class II 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.

Near-field HAP (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde) concentrations were calculated for assessing impacts both in the immediate vicinity of project alternative sources for short-term (acute) exposure assessment and for calculation of long-term risk. Short-term (1-hour) HAP concentrations were compared to acute Reference Exposure Levels (RELs). Long-term exposures to HAPs emitted by project alternative sources were compared to Reference Concentrations for Chronic Inhalation (RfCs), and were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. Two estimates of cancer risk were made: one that corresponds to a most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The cancer risks for all constituents were then summed to provide an estimate of the total inhalation cancer risk.

For all HAP modeling scenarios, 100-meter and 250-meter receptor distances from project sources were used. In addition, for risk assessments the distance from a source where the cancer risk is expected to fall below the level of one in one million is disclosed.

4.5.6.1 Far-Field Modeling

The purpose of the far-field modeling was to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of NOx, SO_2, PM_{10}, $PM_{2.5}$, VOC, and CO expected to result from the development of the CD-C project as well as the combined effects of the CD-C project and other new sources of emissions in the region. The CAMx model was used to estimate impacts throughout the study area shown in the right-hand panel of **Map 4.5-1**. Impacts were estimated using two meteorological modeling years (2005 and 2006). Wind fields for these two meteorology years were developed using the PSU/NCAR Mesoscale Model version 5 (MM5; Anthes and Warner 1978; Dudhia 1993).

The PSD Class I areas and sensitive PSD Class II areas analyzed in the far-field analyses include the following:

- Bridger Wilderness Area, Wyoming (Class I);
- Fitzpatrick Wilderness Area, Wyoming (Class I);
- Savage Run Wilderness Area, Wyoming (Federal Class II, Wyoming Class I)
- Mount Zirkel Wilderness Area, Colorado (Class I);
- Rawah Wilderness Area, Colorado (Class I);
- Popo Agie Wilderness Area , Wyoming (Class II);
- Wind River Roadless Area, Wyoming (Class II); and
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I (SO2 only).

Twelve lakes within the Class I and sensitive Class II areas were identified as being sensitive to atmospheric deposition, as follows:

Bridger Wilderness Area, Wyoming

- Black Joe Lake
- Deep Lake
- Hobbs Lake
- Upper Frozen Lake
- Lazy Boy Lake

Fitzpatrick Wilderness Area, Wyoming

- Ross Lake

Popo Agie Wilderness Area, Wyoming

- Lower Saddlebag Lake

Mount Zirkel Wilderness Area, Colorado

- Lake Elbert
- Seven Lakes
- Summit Lake

Rawah Wilderness Area, Colorado

- Island Lake
- Rawah Lake #

The CAMx model was used to estimate ambient air quality impacts of CO, NO_2, SO_2, O_3, PM_{10}, and $PM_{2.5}$ throughout the study area, and to estimate nitrogen and sulfur deposition at the Class I and sensitive Class II areas. CAMx concentration estimates were used to calculate visibility impacts at the Class I and sensitive Class II areas. Impacts to potential sensitive lake acidification were calculated using CAMx estimated sulfur and nitrogen deposition values.

The impact analysis includes an assessment of CD-C project source contributions to regional ozone formation, comparisons of modeled criteria pollutant impacts to applicable Class I and Class II increments at the Class I and sensitive Class Il areas, and assessments of project impacts to AQRVs (visibility, atmospheric deposition, and sensitive lake acidification) at the Class I and sensitive Class II areas compared with applicable threshold values. The far-field analysis includes mid-field criteria pollutant analyses which compare CAMx-estimated criteria pollutant levels within the CD-C project area to applicable ambient air quality standards.

Far-Field Modeling Approach

The basic modeling strategy used in any analysis that employs a photochemical grid model, such as CAMx, is to first evaluate the ability of the model to reproduce ambient observations of trace pollutants during a recent historical episode (the “current year” or “base case year”); then, once confidence in the model is established, a future year case can be run and the potential impacts of the project evaluated.

A current year base case is simulated using a comprehensive regional emission inventory of actual emissions from all sources (including motor vehicles, power plants, oil and gas exploration and production sources, biogenic sources, etc.). It is preferable to run the model for more than one year so that as many different meteorological regimes as possible are simulated. Pollutants emitted from project sources may only influence a particular sensitive receptor under certain conditions (wind direction, atmospheric stability) and a conservative estimate of AQ and AQRV impacts requires that those conditions be simulated. While it is not possible to ensure that all possible meteorological conditions that might lead to transport of pollutants from project sources to sensitive receptors are simulated, modeling two full years increases the likelihood that the relevant conditions would occur.

The base case simulation is evaluated with respect to ambient air quality measurements. If the base case simulation reproduces concentrations of observed species with reasonable accuracy, then the model can be used in the future year impact assessment. The next step is to prepare a baseline model for use in future year projections. The only difference between the base case model and the baseline model is that the baseline model uses typical emissions while the base case model uses actual emissions. An example of an emissions source category for which the base case and baseline emissions are different is electrical generating units (EGUs). The base case emission inventory uses hourly EGU emissions derived from continuous emissions monitoring (CEM) data because the base case model is evaluated against concurrent observations to determine whether the model provides a realistic simulation of atmospheric processes. The purpose of the baseline model, on the other hand, is to serve as the base year from which future year projections are made. The baseline EGU emissions are used to represent typical conditions (no shutdowns for maintenance, for example) in order to be consistent with the future year emissions, which also represent typical conditions. The baseline emission inventory, therefore, is usually identical to the base case emission inventory, except for the difference in emissions from EGUs and other source categories with large variability in time, such as drill rigs.

The future year modeling involves development of a future year project emission inventory as well as a future year regional emission inventory. In the future year regional emission inventory, the emissions from human activities are projected from the base year to the future year and changes such as population growth and planned emissions controls (such as controls on motor vehicle emissions) are accounted for. Emissions that are not controllable, such as biogenics and wildfire emissions, are held fixed. The project emissions are included in the future year emission inventory. The model is run using the future year regional emission inventory with the rest of the model (meteorological fields, boundary conditions, model settings, etc.) in the same configuration as in the base case. If multiple years were simulated in the base case, then the meteorological conditions for those same years are used together with the future year emissions scenario in the future year modeling. Project AQ and AQRV impacts are determined from the future year simulations.

In the CD-C analysis, CAMx was used to perform modeling of the base case years (2005-6), the baseline year (2008), and the future year (2022).

4.5.7 Direct and Indirect Impacts

Direct, indirect, and cumulative air quality impacts were analyzed to predict maximum potential near-field (surrounding the CD-C project area), mid-field (within the CD-C project area) and far-field (regional and PSD Class I and sensitive PSD Class II areas) ambient air pollutant concentrations, as well as maximum impacts to visibility (regional haze), and atmospheric deposition (acid rain) impacts. Analyses were also performed to predict maximum mid-field (within the CDC-project area) pollutant concentrations. Summaries of the impacts for each of the Proposed Action and alternatives are provided below.

4.5.7.1 Proposed Action

The Proposed Action includes the construction and operation of 8,950 natural gas wells, associated roads and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled either conventionally (with a single vertical well bore on each well pad) or with multiple directional well bores from a single pad.

Near-Field Modeling

Near-field modeling analyses were performed for the Proposed Action production and well field development activities. Criteria pollutant impacts were evaluated for both production and construction activities; however, HAP pollutant impacts were evaluated for only production activities since HAP emissions result primarily from well production activities. Production activities include well production, expanded field compression and a new gas processing facility. Well field development activities that were modeled included well pad and access road construction, and well drilling. Modeling scenarios were also developed that included wells in production in close proximity to well pads where well drilling operations are occurring, including a case where four drill rigs are operating within one land section. Two model receptor grids were used for disclosing modeled impacts; one assuming a 100-meter distance from project sources, and another using a 250-meter distance from project sources.

For 1-hour NO_2 NAAQS compliance demonstrations, all modeled impacts 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 2 years during the 3-year averaging period. Since drill rigs move to different locations during field development, it is not likely that a drilling operation would occur over 3 consecutive years in the same location. The yearly maximum eighth-highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.

For 24-hour $PM_{2.5}$ NAAQS compliance demonstrations from well pad and access road construction, all modeled impacts represent the 3-year average of the maximum 24-hour concentrations from three separate activities, assuming well pad and access road construction occurs over 1 year, drilling operations occur for 1 year and well production activities occur for 1 year. Since well pad and access road construction would be temporary (occurring over a 5 –7 day period) and in isolation, this scenario represents a conservative estimate of $PM_{2.5}$ concentrations in the vicinity of a well pad. The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.

The maximum modeled criteria pollutant impacts from any of the production activities associated with the Proposed Action are shown in **Tables 4.5-4a** and **4.5-4b**. Table 4.5-4a presents the model results at the 100-meter distance from project sources and Table 4.5-4b presents the results for the 250-meter receptor distance. As indicated in Tables 4.5-4a and 4.5-4b, impacts from Proposed Action production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Table 4.5-4a. Production sources, criteria pollutant modeling results: 100-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour	514.1	n/a	1,026.0	1,540.1	40,000	40,000
		8-hour	315.8	n/a	798.0	1,113.8	10,000	10,000
Gas Plant	NO_2	1-hour	105.6[2]	n/a	75.0	180.6	n/a	188
		Annual	11.9	25	9.1	21.0	100	100
Well Production (16 well pad)	NO_2	1-hour	112.6[2]	n/a	75.0	187.6	n/a	188
		Annual	7.3	25	9.1	16.4	100	100
Gas Plant	SO_2	1-hour	0.6[3]	n/a	19.7	20.3	n/a	196
		3-hour	0.6	512	11.5	12.1	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.03	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	11.5	30	56.0	67.5	150	n/a
		Annual	1.4	17	13.5	14.9	50	50
Gas Plant	$PM_{2.5}$	24-hour	7.9[4]	9	9.2	17.1	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations.*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[4] *$PM_{2.5}$ 24-hour concentration is calculated as the 3-year average of the highest 24-hour concentrations.*

Table 4.5-4b. Production sources, criteria pollutant modeling results: 250-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour	388.2	n/a	1,026.0	1,414.2	40,000	40,000
		8-hour	236.2	n/a	798.0	1,034.2	10,000	10,000
Gas Plant	NO_2	1-hour	99.5[2]	n/a	75.0	174.5	n/a	188
		Annual	8.3	25	9.1	17.4	100	100
Well Production (16 well pad)	NO_2	1-hour	101.4[2]	n/a	75.0	176.4	n/a	188
		Annual	3.5	25	9.1	12.6	100	100
Gas Plant	SO_2	1-hour	0.4[3]	n/a	19.7	20.1	n/a	196
		3-hour	0.4	512	11.5	11.9	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.02	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	7.2	30	56.0	63.2	150	n/a
		Annual	0.9	17	13.5	14.4	50	50
Gas Plant	$PM_{2.5}$	24-hour	5.6[4]	9	9.2	14.8	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations.*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[4] *$PM_{2.5}$ 24-hour concentration is calculated as the 3-year average of the highest 24-hour concentrations.*

The maximum modeled criteria pollutant impacts from well development activities associated with the Proposed Action are shown in **Tables 4.5-5a and 4.5-5b** for both the 100-meter and 250-meter receptor distances from project sources. As described earlier in this section, the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling the Proposed Action field development and field production sources of air emissions. The scenarios modeled for determining air quality impacts from NO_x emission sources included Tier 2 drill rig operation and multi-well pads with 16 wells in production. For $PM_{2.5}$ emission sources, the scenario modeled includes the emissions from 4 single well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4 single wells in production. As indicated in T**ables 4.5-5a and 4.5-5b** the Proposed Action field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through the application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation** could be implemented.

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.

Additional details on the near-field criteria pollutant modeling impact assessment are provided in Section 3.5 of the AQTSD.

Table 4.5-5a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	123.5[1] 23.7	75.0 9.1	198.5 32.8	n/a 100	188 100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	125.6[1] 25.6	75.0 9.1	200.6 34.7	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	27.6[2] 17.5 9.9 1.4	19.7 11.5 4.2 3.8	47.3 29.0 14.1 5.2	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	123.2 7.5	56.0 13.5	179.2 21.0	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	31.4[3] 4.8	9.2 4.2	40.6 9.0	n/a n/a	35 15

1 NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 8 wells in production)

2 SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.

3 $PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities)

Table 4.5-5b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m³)	Background (μg/m³)	Total Predicted (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	102.0[1] 12.0	75.0 9.1	177.0 21.1	n/a 100	188 100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	101.1[1] 14.8	75.0 9.1	176.1 23.9	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	14.8[2] 8.2 3.1 0.5	19.7 11.5 4.2 3.8	34.5 19.7 7.3 4.3	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	76.2 3.0	56.0 13.5	132.3 16.5	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	23.7[3] 2.4	9.2 4.2	32.9 6.6	n/a n/a	35 15

1 *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 8 wells in production)*

2 *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

3 *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities)*

The maximum predicted acute and chronic (long-term) HAP impacts from production activities compared with applicable REL and RfC exposure thresholds are shown in **Tables 4.5-6** through **4.5-7**. **Tables 4.5-6a and 4.5-6b** present the acute impacts for both and 100-meter and 250-meter receptor distances, and **Tables 4.5-7a and 4.5-7b** present the long-term impacts for both receptor distances. As indicated in these tables, HAP emissions resulting for Proposed Action production activities would result in impacts that are below the HAP threshold exposure levels.

Table 4.5-6a. Production sources, maximum long-term (1-hour) HAP modeling results: 100-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (μg/m³)	REL or IDLH (μg/m³)
16 Well Pad Production	Benzene	6.2	1,300[1]
16 Well Pad Production	Toluene	8.4	37,000[1]
16 Well Pad Production	Ethylbenzene	0.2	350,000[2]
16 Well Pad Production	Xylene	3.8	22,000[1]
16 Well Pad Production	n-Hexane	33.6	390,000[2]
16 Well Pad Production	Formaldehyde	47.3	55[1]
Gas Plant	Formaldehyde	5.8	55[1]

1 *Reference Exposure Level*

2 *Immediately Dangerous to Life or Health value divided by 10.*

Table 4.5-6b. Production sources, maximum long-term (1-hour) HAP modeling results: 250-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m^3)	REL or IDLH (µg/m^3)
16 Well Pad Production	Benzene	5.5	1,300[1]
16 Well Pad Production	Toluene	7.4	37,000[1]
16 Well Pad Production	Ethylbenzene	0.2	350,000[2]
16 Well Pad Production	Xylene	3.2	22,000[1]
16 Well Pad Production	n-Hexane	29.6	390,000[2]
16 Well Pad Production	Formaldehyde	41.6	55[1]
Gas Plant	Formaldehyde	5.3	55[1]

[1] *Reference Exposure Level*

[2] *Immediately Dangerous to Life or Health value divided by 10.*

Table 4.5-7a. Production sources, maximum long-term (annual) HAP modeling results: 100-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m^3)	Non-carcinogenic RfC (µg/m^3)
16 Well Pad Production	Benzene	0.2	30
16 Well Pad Production	Toluene	0.3	5,000
16 Well Pad Production	Ethylbenzene	0.01	1,000
16 Well Pad Production	Xylene	0.1	100
16 Well Pad Production	n-Hexane	1.2	700
16 Well Pad Production	Formaldehyde	1.7	9.8
Gas Plant	Formaldehyde	0.4	9.8

Table 4.5-7b. Production sources, maximum long-term (annual) HAP modeling results: 250-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m3)	Non-carcinogenic RfC (µg/m3)
16 Well Pad Production	Benzene	0.1	30
16 Well Pad Production	Toluene	0.1	5,000
16 Well Pad Production	Ethylbenzene	0.003	1,000
16 Well Pad Production	Xylene	0.06	100
16 Well Pad Production	n-Hexane	0.6	700
16 Well Pad Production	Formaldehyde	0.8	9.8
Gas Plant	Formaldehyde	0.4	9.8

Two estimates of cancer risk were made: one that corresponds to most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The cancer risks for all constituents were then summed to provide an estimate of the total inhalation cancer risk.

Near-field modeling was also performed to estimate the long-term risk, for both the most-likely-exposure (MLE) and maximally-exposed-individual (MEI) scenarios, from benzene, ethyl benzene, and formaldehyde emissions resulting from production activities. **Table 4.5-8** presents the cancer risk estimates for the proposed compression and gas plant facilities, for both the 100-meter and 250-meter receptor cases, and at the distance required to be below a one-in-one-million cancer risk level for either the MLE or MEI analysis. The modeling results indicate that for the MLE analysis the cancer risk is below one-in-one-million at the 100-meter distance for both the proposed compression and gas plant facilities. For the MEI analysis the distance where the cancer risk would fall below a one-in-one-million cancer risk level is 0.25 miles for the proposed compression facility, and 1.0 miles for the proposed gas plant. Note that the risk estimates for the compression and gas plant facilities only considered formaldehyde emissions, since benzene and ethyl benzene emissions for these facilities would be negligible.

Table 4.5-8. Long-term modeled formaldehyde MLE and MEI cancer risk analyses for proposed compression and gas plant, Proposed Action

Modeling Scenario	Receptor Distance	Analysis	Modeled Concentration ($\mu g/m^3$)	Unit Risk Factor $1/(\mu g/m^3)$	Exposure Adjustment Factor	Cancer Risk
Compression	100 meters	MLE	0.19	1.3×10^{-5}	0.0949	0.2×10^{-6}
Compression	100 meters	MEI	0.19	1.3×10^{-5}	0.86	2.1×10^{-6}
Gas Plant	100 meters	MLE	0.36	1.3×10^{-5}	0.0949	0.4×10^{-6}
Gas Plant	100 meters	MEI	0.36	1.3×10^{-5}	0.86	4.0×10^{-6}
Compression	250 meters	MLE	0.14	1.3×10^{-5}	0.0949	0.2×10^{-6}
Compression	250 meters	MEI	0.14	1.3×10^{-5}	0.86	1.6×10^{-6}
Gas Plant	250 meters	MLE	0.36	1.3×10^{-5}	0.0949	0.4×10^{-6}
Gas Plant	250 meters	MEI	0.36	1.3×10^{-5}	0.86	4.0×10^{-6}
Compression	0.25 miles	MLE	0.08	1.3×10^{-5}	0.0949	0.1×10^{-6}
Compression	0.25 miles	MEI	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}
Gas Plant	1.0 miles	MLE	0.08	1.3×10^{-5}	0.0949	0.1×10^{-6}
Gas Plant	1.0 miles	MEI	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}

Table 4.5-9 presents the cancer risk estimates for a multi-well pad, with 16 wells in production, for both the 100-meter and 250-meter receptor cases, and at the distance required to be below a one-in-one-million cancer risk level for either the MLE or MEI analysis. The modeling results indicate that for the MLE analysis the cancer risk is one-in-one-million at the 250-meter distance. For the MEI analysis the distance where the cancer risk would fall below a one-in-one-million cancer risk level is 1.25 miles. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Additional details on the near-field HAP modeling impact assessment are provided in Section 3.6 of the AQTSD.

Table 4.5-9. Long-term modeled MLE and MEI cancer risk analyses for production well case: 16 wells, 1 multi-well pad, Proposed Action

Receptor Distance	Analysis	HAP Constituent	Modeled Concentration ($\mu g/m^3$)	Unit Risk Factor $1/(\mu g/m^3)$	Exposure Adjustment Factor	Cancer Risk
100 meters	MLE	Benzene	0.23	7.8×10^{-6}	0.0949	0.2×10^{-6}
		Ethyl Benzene	0.007	2.5×10^{-6}	0.0949	0.001×10^{-6}
		Formaldehyde	1.7	1.3×10^{-5}	0.0949	2.1×10^{-6}
					Total Combined[1]	2.3×10^{-6}
100 meters	MEI	Benzene	0.23	7.8×10^{-6}	0.86	1.5×10^{-6}
		Ethyl Benzene	0.007	2.5×10^{-6}	0.86	0.01×10^{-6}
		Formaldehyde	1.7	1.3×10^{-5}	0.86	19.1×10^{-6}
					Total Combined[1]	20.7×10^{-6}
250 meters	MLE	Benzene	0.10	7.8×10^{-6}	0.0949	0.08×10^{-6}
		Ethyl Benzene	0.003	2.5×10^{-6}	0.0949	0.001×10^{-6}
		Formaldehyde	0.79	1.3×10^{-5}	0.0949	1.0×10^{-6}
					Total Combined[1]	1.0×10^{-6}
250 meters	MEI	Benzene	0.10	7.8×10^{-6}	0.86	0.7×10^{-6}
		Ethyl Benzene	0.003	2.5×10^{-6}	0.86	0.006×10^{-6}
		Formaldehyde	0.79	1.3×10^{-5}	0.86	8.8×10^{-6}
					Total Combined[1]	9.5×10^{-6}
1.25 miles	MLE	Benzene	0.01	7.8×10^{-6}	0.0949	0.008×10^{-6}
		Ethyl Benzene	0.0003	2.5×10^{-6}	0.0949	0.00001×10^{-6}
		Formaldehyde	0.08	1.3×10^{-5}	0.0949	0.09×10^{-6}
					Total Combined[1]	0.1×10^{-6}
1.25 miles	MEI	Benzene	0.01	7.8×10^{-6}	0.86	0.07×10^{-6}
		Ethyl Benzene	0.0003	2.5×10^{-6}	0.86	0.001×10^{-6}
		Formaldehyde	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}
					Total Combined[1]	0.9×10^{-6}

[1] *Total risk is calculated here; however, the additive effects of multiple chemicals are not fully understood and this should be taken into account when viewing these results.*

Far-Field Modeling

Far-field modeling using the CAMx model was performed to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, VOC, and CO expected to result from the development of the Proposed Action as well as the combined effects of the CD-C project and other new sources of emissions in the region. Key results of the analysis of the air quality and AQRV impacts of the Proposed Action are described below. Additional detail is provided in Section 4.5 of the AQTSD.

Criteria Pollutants Including Ozone

The results of the far-field modeling showed that the Proposed Action would make no significant contribution to modeled exceedances of the NAAQS, WAAQS or Colorado Ambient Air Quality Standards (CAAQS) for ozone (see AQTSD Section 4.5.4) or any other criteria pollutant (see AQTSD Section 4.5.3).

The Proposed Action source contribution to future year ozone formation was assessed using two methods: the EPA's Modeled Attainment Test Software (MATS; Abt, 2009) and absolute modeled concentrations. The MATS-estimated Proposed Action maximum impact on future year 8-hour average ozone concentrations would be less than or equal to 0.8 ppb. The two-year approximation to future-year 8-hour average ozone concentrations estimated using absolute CAMx model concentrations shows the Proposed

Action maximum ozone impact would be 1.6 ppb or less. For both the absolute modeled concentration and MATS results, the largest ozone impacts due to the Proposed Action emissions were in the vicinity of the CD-C project area. In Sublette County, where the only MATS-projected exceedances of the 75 ppb NAAQS within the study area would occur, ozone impacts due to the Proposed Action were extremely small, and were less than or equal to 0.04 ppb. The highest CD-C ozone contributions to ozone in the study area occurred on days when regional 8-hour ozone would be low (<60ppb).

PSD increments were not exceeded at any Class I or sensitive Class II area within the study area.

Mid-Field Impacts

CAMx estimated criteria pollutant impacts from Proposed Action sources and from Proposed Action sources and regional sources, within and near the CD-C project area are shown in **Table 4.5-10**. As indicated in Table 4.5-10 the cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II Increments.

Table 4.5-10. Mid-Field criteria pollutant modeling results, Proposed Action

Pollutant	Averaging Time	Modeled Concentration from CD-C Project Sources (μg/m^3)	Modeled Concentration from All Sources (μg/m^3)	PSD Class II Increment[1] (μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
CO[4]	1-hour	--	491.3	n/a	40,000	40,000
	8-hour	--	357.0	n/a	10,000	10,000
NO_2	1-hour	47.1	81.4[2]	n/a	n/a	188
	Annual	6.6	17.1	25	100	100
O_3	8-hour	4.3	142.4	n/a	147	147
SO2	1-hour	0.02	30.8[3]	n/a	n/a	196
	3-hour	0.02	30.0	512	1,300	1,300
	24-hour	0.01	11.3	91	260	365
	Annual	0.003	3.1	20	60	80
PM_{10}	24-hour	7.3	55.8	30	150	n/a
	Annual	2.5	7.5	17	50	50
$PM_{2.5}$	24-hour	2.4	18.7	9	n/a	35
	Annual	0.6	3.8	4	n/a	15

1 The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis

2 NO_2 1-hour concentration is 8^{th} highest daily maximum 1-hour concentration. Value includes contribution from NO.

3 SO_2 1-hour concentration is 4^{th} highest daily maximum 1-hour concentration.

4 No value is given for the CD-C project CO concentration contribution because the CAMx source apportionment tool does not track CO.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Proposed Action source emissions are shown in **Table 4.5-11**. An additional method (BLM method) was used to evaluate visibility impacts and the results are presented in the AQTSD, Section 4.6.1.

The visibility analysis indicated a maximum of 5 days with CD-C project emissions resulting in impacts greater than the 0.5 delta-deciviews (Δdv) threshold at any of the Class I and sensitive Class II areas analyzed for both the 2005 and 2006 meteorological data. Using the 98^{th} percentile or eighth-highest value as a threshold (as recommended in the FLAG 2010 document) there would be zero days above the 0.5 Δdv threshold at any of the Class I or sensitive Class II areas.

Table 4.5-11. Visibility impacts using FLAG 2010 screening method, Proposed Action

Class I or Sensitive Class II Area	Number of Days > 0.5 Δdv	Maximum Δdv	98th Percentile Maximum Δdv
Bridger Wilderness Area	0	0.20	0.03
Fitzpatrick Wilderness Area	0	0.16	0.03
Savage Run Wilderness Area	1	0.61	0.20
Mount Zirkel Wilderness Area	1	0.65	0.24
Rawah Wilderness Area	0	0.24	0.12
Popo Agie Wilderness Area	0	0.22	0.03
Wind River Roadless Area	0	0.14	0.04
Dinosaur National Monument	5	0.85	0.34

Deposition Impacts

Modeling results for Proposed Action source emissions indicated that there were no nitrogen or sulfur deposition impacts that exceeded the BLM critical load values at any Class I/sensitive Class II area; however, the deposition analysis threshold (DAT) for nitrogen was exceeded at several Class I areas near/downwind of CD-C project area. Deposition impacts are summarized in Section 4.6.2 of the AQTSD.

Acidification at Sensitive Lakes. Modeling results for Proposed Action sources indicated that there would be no ANC changes at any of the 12 analyzed lakes that exceeded the 10-percent threshold or the ΔANC<1 μeq/L threshold for the two extremely sensitive lakes. Lake ANC impacts are summarized in Section 4.6.3 of the AQTSD.

Regional Climate Change and Greenhouse Gas Emissions

The current scientific consensus is that the warming of the climate system is "unequivocal" and "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century." (IPCC, 2007). Specific regional effects of climate change are highly uncertain (see section **3.5 Air Quality**), but may include extreme weather, adverse health impacts due to increased intensity and duration of heat waves, and seasonally decreasing water supplies that exacerbate competition for over-allocated water resources. As discussed in Chapter 3, it is not possible to attribute emissions of GHGs from any particular source as having a specific climate impact, globally or regionally, due to the longevity of GHGs in the atmosphere. GHG emissions from all sources contribute to increased incremental concentrations in the earth's atmosphere and to the global climate response.

The maximum greenhouse gas emissions resulting from the Proposed Action source emissions are estimated at 5.2 tg/yr of CO_2 equivalent emissions. The CD-C project's peak CO_2 equivalent emissions year is 2022, in which the combined emissions from new Proposed Action sources and existing sources would be approximately 10 tg/year. To place the CD-C project's GHG emissions in context, the GHG emissions from the top four emitting coal-fired power plants in Wyoming range from 3-15 tg/year (data from <http://epa.gov/-climatechange/emissions/ghgdata/2010data.html>). CD-C project GHGs would be comparable to the total GHG emissions from the City of San Francisco (10 tg/year; <http://www.sfenvironment.org/-downloads/library/climateactionplan.pdf>) during the year 2000).

4.5.7.2 Alternative A: 100-Percent Vertical Drilling

Alternative A includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. All the proposed natural gas wells would be drilled conventionally, with a single vertical well bore on each well pad.

Near-Field Modeling

The maximum modeled criteria pollutant impacts from any of the production activities associated with Alternative A production facilities would be similar to the Proposed Action; however, pollutant impacts from individual well sites would be less given the wells would be drilled on single well pads. The impacts for Alternative A production facilities are shown in **Tables 4.5-12a and 4.5-12b**. As indicated in these tables, impacts from Alternative A production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Table 4.5-12a. Production sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	PSD Class II Increment[1] ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Gas Plant	CO	1-hour 8-hour	514.1 315.8	n/a n/a	1,026.0 798.0	1,540.1 1,113.8	40,000 10,000	40,000 10,000
Gas Plant	NO_2	1-hour Annual	105.6[2] 11.9	n/a 25	75.0 9.1	180.6 21.0	n/a 100	188 100
Single well pad production	NO_2	1-hour Annual	18.1[2] 0.9	n/a 25	75.0 9.1	93.1 10.0	n/a 100	188 100
Gas Plant	SO_2	1-hour 3-hour 24-hour Annual	0.6[3] 0.6 0.2 0.03	n/a 512 91 20	19.7 11.5 4.2 3.8	20.3 12.1 4.4 3.8	n/a 1,300 260 60	196 1,300 365 80
Gas Plant	PM_{10}	24-hour Annual	11.5 1.4	30 17	56.0 13.5	67.5 14.9	150 50	n/a 50
Gas Plant	$PM_{2.5}$	24-hour Annual	7.9 1.4	9 4	9.2 4.2	17.1 5.6	n/a n/a	35 15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

Table 4.5-12b. Production sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m³)	PSD Class II Increment[1] (µg/m³)	Background (µg/m³)	Total Predicted (µg/m³)	WAAQS (µg/m³)	NAAQS (µg/m³)
Gas Plant	CO	1-hour	388.2	n/a	1,026.0	1,414.2	40,000	40,000
		8-hour	236.2	n/a	798.0	1,034.2	10,000	10,000
Gas Plant	NO_2	1-hour	99.5[2]	n/a	75.0	174.5	n/a	188
		Annual	8.3	25	9.1	17.4	100	100
Single well pad production	NO_2	1-hour	12.0[2]	n/a	75.0	87.0	n/a	188
		Annual	0.4	25	9.1	9.5	100	100
Gas Plant	SO_2	1-hour	0.4[3]	n/a	19.7	20.1	n/a	196
		3-hour	0.4	512	11.5	11.9	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.02	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	7.2	30	56.0	63.2	150	n/a
		Annual	0.9	17	13.5	14.4	50	50
Gas Plant	$PM_{2.5}$	24-hour	5.6[4]	9	9.2	14.8	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

1 *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

2 *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

3 *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

The maximum modeled criteria pollutant impacts from well development activities associated with Alternative A would differ slightly from the Proposed Action, given Alternative A is a vertical well drilling alternative. The maximum modeled criteria pollutant impacts from well development activities are shown in **Tables 4.5-13a and 4.5-13b** for both the 100-meter and 250-meter receptor distances from project sources. As described in **Section 4.5.7,1** the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling Alternative A field development and field production sources of air emissions. The scenarios used for modeling air quality impacts from NO_x emission sources included Tier 2 drill rig operation and single wells in production. For $PM_{2.5}$ emission sources, the scenario modeled includes the emissions from a 4 single-well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4 single wells in production. As indicated in T**ables 4.5-13a and 4.5-13b,** Alternative A field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS, additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

Note that the emissions from field development activities are temporary and do not consume PSD increment, and as a result are excluded from increment comparisons.

Additional detail on near-field modeling methods and results is provided in Section 3.5 of the AQTSD.

Table 4.5-13a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m^3)	Background (μg/m^3)	Total Predicted (μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	105.4[1] 25.1	75.0 9.1	180.4 34.2	n/a 100	188 100
4, Single Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	133.6[1] 27.3	75.0 9.1	208.6 36.4	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	27.6[2] 17.5 9.9 1.4	19.7 11.5 4.2 3.8	47.3 29.0 14.1 5.2	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	123.2 7.5	56.0 13.5	179.2 21.0	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	31.4[3] 4.8	9.2 4.2	40.6 9.0	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (Single well pad case includes 2 years of drill rig operation concurrent with 4 wells in production, and 1 year with 5 wells in production),4, single-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 2 wells in production). (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

Table 4.5-13b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m³)	Background (μg/m³)	Total Predicted (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
Single Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	78.0[1] 13.3	75.0 9.1	153.0 22.4	n/a 100	188 100
4, Single Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	101.5[1] 15.8	75.0 9.1	176.5 24.9	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	14.8[2] 8.2 3.1 0.5	19.7 11.5 4.2 3.8	34.5 19.7 7.3 4.3	n/a 1,300 260 60	196 1,300 365 80
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	76.2 3.0	56.0 13.5	132.3 16.5	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	23.7[3] 2.4	9.2 4.2	32.9 6.6	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (Single well pad case includes 2 years of drill rig operation concurrent with 4 wells in production, and 1 year with 5 wells in production), 4, single-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 2 wells in production). (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad andaccess road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be less than the impacts presented in **Section 4.5.4** for the Proposed Action since there would be no multi-well pads developed. HAP impacts for the proposed compression and gas plant facilities would be the same as the Proposed Action. HAP impacts under Alternative A would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or MEI analysis would be 1.0 miles as a result of the gas plant emissions. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact associated with formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative A sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative A criteria pollutant impacts from project sources and regional sources, within and near the CD-C project area, would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II Increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative A emissions would be the similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative A would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Potential sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative A would be similar to the impacts for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative A sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.3 Alternative B: Enhanced Resource Protection

Alternative B includes the construction and operation of 8,950 natural gas wells, associated roads and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled using a combination of vertical and directional drilling techniques.

Near-Field Modeling

Near-field modeling impacts for Alternative B would be similar to those presented in **Section 4.5.4** for the Proposed Action. Impacts from Alternative B production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Alternative B field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS, additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Additional Mitigation**.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts for the Proposed Action. HAP impacts under Alternative B would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those presented in **Section 4.5.4.1** for the Proposed Action. Alternative B sources would not contribute to modeled exceedances of the NAAQS, WAAQS or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative B criteria pollutant impacts from project sources and regional sources, within and near the CD-C project area would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources are below the applicable ambient air quality standards and the direct project impacts are below the PSD Class II Increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative B emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative B would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Potential sensitive lake acidification resulted from nitrogen and sulfur deposition impacts under Alternative B would be similar to the impacts for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative B sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.4 Alternative C: Cap on Surface Disturbance for High and Low-Density Development Areas

Alternative C includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled using a combination of vertical and directional drilling techniques.

Near-Field Modeling

Near-field modeling impacts for Alternative C would be similar to those presented in **Section 4.5.4** for the Proposed Action. Impacts from Alternative C production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Alternative C field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Additional Mitigation**.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts presented in **Section 4.5.4.1** for the Proposed Action. HAP impacts under Alternative C would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative C sources would not contribute to modeled exceedances of the NAAQS, WAAQS or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

CD-C Alternative C criteria pollutant impacts from project sources and regional sources within and near the CD-C project area would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative C emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative C would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative C would be similar to the impacts presented in **Section 4.4.1** for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceed threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative B sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.5 Alternative D: Directional Drilling

Alternative D includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled either conventionally, with a single vertical well bore on each well pad, or with multiple directional well bores from a single pad; however, the majority of the wells would be directional.

Near-Field Modeling

Near-field modeling impacts for Alternative D production facilities would be similar to those presented in **Section 4.5.4.1** (**Tables 4.5-4a and 4.5-4b**) for the Proposed Action. Impacts from Alternative D production sources would below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

The maximum modeled criteria pollutant impacts from well development activities associated with Alternative D would be similar to the Proposed Action; however, given that Alternative D is mainly a directional well drilling alternative, additional modeling scenarios are presented in this section for only multi-well cases. The maximum modeled criteria pollutant impacts from well development activities are shown in **Tables 4.5-14a and 4.5-14b** for both the 100-meter and 250-meter receptor distances from project sources.

As described earlier in **Section 4.5.7.1**, the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling Alterative D field development and field production sources of air emissions. The scenarios modeled for determining air quality impacts from NO_x emission sources included Tier 2 drill rig operation and multi-well pads with 16 wells in production. For $PM_{2.5}$ emission sources, the scenario modeled includes the emissions from 4 multi-well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4, 4-well pads in production. As indicated in T**ables 4.5-14a and 4.5-14b** Alternative D field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

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.

Additional detail on near-field modeling methods and results is provided in Section 3.5 of the AQTSD.

Table 4.5-14a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative D

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m³)	Background (µg/m³)	Total Predicted (µg/m³)	WAAQS (µg/m³)	NAAQS (µg/m³)
4 Tier 2 Drill Rigs	CO	1-hour	585.6	1,026.0	1,611.6	40,000	40,000
		8-hour	311.3	798.0	1,109.3	10,000	10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour	123.5[1]	75.0	198.5	n/a	188
		Annual	23.7	9.1	32.8	100	100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour	125.6[1]	75.0	200.6	n/a	188
		Annual	25.6	9.1	34.7	100	100
4 Tier 2 Drill Rigs	SO_2	1-hour	24.6[2]	19.7	44.3	n/a	196
		3-hour	15.9	11.5	27.4	1,300	1,300
		24-hour	8.2	4.2	12.4	260	365
		Annual	1.2	3.8	5.0	60	80
Multi-Well Pad and Access Road Construction	PM_{10}	24-hour	83.3	56.0	139.3	150	n/a
		Annual	4.9	13.5	18.4	50	50
	$PM_{2.5}$	24-hour	23.9[3]	9.2	33.1	n/a	35
		Annual	3.1	4.2	7.3	n/a	15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rig operation and 2 years with 2 drill rigs operation and 8 wells in production). The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

[2] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

Table 4.5-14b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative D

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m³)	Background (μg/m³)	Total Predicted (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
4 Tier 2 Drill Rigs	CO	1-hour	287.5	1,026.0	1,313.5	40,000	40,000
		8-hour	119.3	798.0	917.3	10,000	10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour	102.0[1]	75.0	177.0	n/a	188
		Annual	12.0	9.1	21.1	100	100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour	101.1[1]	75.0	176.1	n/a	188
		Annual	14.8	9.1	23.9	100	100
4 Tier 2 Drill Rigs	SO_2	1-hour	13.1[2]	19.7	32.8	n/a	196
		3-hour	6.9	11.5	18.4	1,300	1,300
		24-hour	2.8	4.2	7.0	260	365
		Annual	0.5	3.8	4.3	60	80
Multi-Well Pad and Access Road Construction	PM_{10}	24-hour	60.1	56.0	116.1	150	n/a
		Annual	2.5	13.5	16.0	50	50
	$PM_{2.5}$	24-hour	15.8[3]	9.2	25.0	n/a	35
		Annual	1.6	4.2	5.8	n/a	15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rig operation and 2 years with 2 drill rigs operation and 8 wells in production). The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

[2] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts presented in **Section 4.5.4.1** for the Proposed Action. HAP impacts under Alternative D would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single-well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts andAdditional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative D sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative D criteria pollutant impacts from project sources and regional sources within and near the CD-C project area would be similar to results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative D emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative D would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative D would be similar to the impacts presented for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative D sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.6 Alternative E: No Action

Under the No Action Alternative, it is assumed that no new natural gas wells would be developed. Air pollutant concentration impacts would remain near current levels as a result of existing development.

Near-Field Modeling

There would be no new development under Alternative E (No Action). Therefore there would be no increase in ambient air concentrations and the existing project impacts would be below the NAAQS, WAAQS, and PSD Class II increments. There would be no change in current criteria pollutant and HAP concentrations impacts resulting from existing project area sources.

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be less than the impacts presented in **Section 4.5.4** for the Proposed Action, since there would be no new sources proposed under Alternative E. The existing CD-C project area sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative E criteria pollutant impacts from existing project sources and regional sources within and near the CD-C project area are shown in **Table 4.5-15**. The cumulative impacts resulting from existing CD-C project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

Table 4.5-15. Mid-Field criteria pollutant modeling results, Alternative E

Pollutant	Averaging Time	Modeled Concentration from CD-C Project Sources (μg/m³)	Modeled Concentration from All Sources (μg/m³)	PSD Class II Increment[1] (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
CO[4]	1-hour 8-hour	-- --	492.7 357.6	n/a n/a	40,000 10,000	40,000 10,000
NO_2	1-hour Annual	47.6 9.9	44.1[2] 11.5	n/a 25	n/a 100	188 100
O_3	8-hour	3.3	142.4	n/a	147	147
SO_2	1-hour 3-hour 24-hour Annual	0.08 0.08 0.03 0.01	30.8[3] 30.0 11.3 3.1	n/a 512 91 20	n/a 1,300 260 60	196 1,300 365 80
PM_{10}	24-hour Annual	1.9 0.8	54.9 7.4	30 17	150 50	n/a 50
$PM_{2.5}$	24-hour Annual	1.4 0.5	17.9 3.7	9 4	n/a n/a	35 15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentration is 8th highest daily maximum 1-hour concentration. Value includes contribution from NO.*

[3] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

[4] *No value is given for the CD-C Project CO concentration contribution because the CAMx source apportionment tool does not track CO.*

AQRV Impacts

Visibility Impacts. Visibility impacts for Alternative E source emissions, estimated using both the FLAG 2010 and BLM methods, would be below the 0.5 Δdv threshold at all of the Class I and sensitive Class II areas analyzed for both the 2005 and 2006 meteorological data. Visibility results are summarized in Section 4.6.1 of the AQTSD.

Deposition Impacts. Modeling results for Alternative E source emissions indicated that there would be no nitrogen or sulfur deposition impacts that exceeded the BLM critical load values at any Class I or sensitive Class II area. Deposition impacts would be below the DAT for all Class I and sensitive Class II areas, with the exception of the Savage Run Wilderness Area, where impacts are above the DAT for nitrogen. Deposition impacts are summarized in Section 4.6.2 of the AQTSD.

Acidification at Sensitive Lakes. Modeling results for Alternative E sources indicated that there would be no ANC changes at any of the 12 analyzed lakes that exceed the 10-percent threshold or the ΔANC<1 μeq/L threshold for the two extremely sensitive lakes. Lake ANC impacts are summarized in Section 4.6.3 of the AQTSD.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative E source emissions in year 2022 (the peak emissions year for the Proposed Action and for any of the action alternatives) are estimated at 4.8 tg/yr of CO_2 equivalent emissions. This represents a 0.5 tg/yr reduction in GHG emissions from year 2008 CD-C existing project emissions levels. To place the Alternative E GHG emissions in context, the GHG emissions from the top five emitting coal-fired power plants in Wyoming range from 3 to 15 tg/year (data from <http://epa.gov/climatechange/emissions/ghgdata/-2010data.html>).

4.5.8 Impact Summary

4.5.8.1 Summary of Near-Field Modeling Results

Air pollutant impacts resulting from production activities associated with any of the CD-C Project alternatives over the life of the project would be below the NAAQS and WAAQS, and would not exceed the PSD Class II Increments.

Well field development activities from the Proposed Action and project development alternatives (Alternatives A through D) including well pad construction and well drilling would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through the application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

There would be no new development under Alternative E (No Action). Therefore there would be no increase in ambient air concentrations and the existing project impacts would be below the NAAQS, WAAQS, and PSD Class II Increments.

The maximum predicted acute and chronic (long-term) HAP impacts from well field production for all project alternatives would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

4.5.8.2 Summary of Far-Field Modeling Results

Air pollutant emissions resulting from any of the CD-C project alternatives would make no significant contribution to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant in the 2022 future year. The PSD increments would not be exceeded at any Class I or sensitive Class II area within the 4-km domain.

The far-field assessment was performed using the Proposed Action emissions. The impacts resulting from all project development alternatives (Alternatives A through D) would be similar to impacts of the Proposed Action. Under Alternative E (No Action Alternative) there would be no additional impacts to air quality or AQRVs.

For all pollutants except ozone, the modeling results show attainment throughout the 4-km domain except in the immediate vicinity of point sources unrelated to the CD-C project sources. Modeled exceedances of the CO, PM_{10} and $PM_{2.5}$ standards are the result of impacts from a 2005 fire in Lincoln County, and the lone SO_2 exceedance is highly localized and due to emissions from a Fremont County source. An ozone exceedance occurs at Boulder, Colorado, where CD-C has no significant contribution to ozone concentrations.

Examination of the spatial scale and magnitude of the CD-C project contribution to criteria pollutant concentrations within the 4-km grid shows that exceedances of the ambient air quality standards in the 2022 future year modeling would not be related to emissions from the CD-C project.

The MATS-estimated maximum impact of the CD-C project on the 2022 future year 8-hour ozone Design Value is less than or equal to 0.8 ppb for both meteorological years. The two-year approximation to a 2022 design value obtained using absolute model concentrations shows the CD-C project maximum ozone impact would be 1.6 ppb. For both the absolute modeled concentration and MATS results, the largest ozone impacts due to the CD-C project emissions would be in the vicinity of the project area. In Sublette County, where the only modeled exceedances of the 75 ppb NAAQS occurred, ozone impacts due to the CD-C project would be less than or equal to 0.04 ppb. The highest CD-C ozone contributions to ozone at Southwest Wyoming monitors would occur on days when modeled regional 8-hour ozone was low (<60 ppb).

The visibility analysis showed 1 to 5 days with CD-C project visibility impacts greater than 0.5 dv at Class I and sensitive Class II areas over the course of the 2-year simulation of the future year emissions scenario. The simulation showed 1 day with CD-C project visibility impacts >1.0 dv during this period. The largest visibility impacts would occur at the Savage Run, Dinosaur, and Mount Zirkel areas. No other Class I or sensitive Class II areas had any day with visibility impacts >0.5 dv as a result of the CD-C project emissions.

There would be no nitrogen or sulfur deposition impacts from any of the CD-C project alternatives exceeding BLM critical load values at any Class I/sensitive Class II areas; however, the DAT for nitrogen could be exceeded at several Class I areas near or downwind of the project area under the Proposed Action and action alternatives.

There would be no ANC changes exceeding the 10-percent threshold or sensitive lake impacts where ΔANC<1 µeq/L due to emissions from any of the CD-C project alternatives.

4.5.9 Unavoidable Adverse Impacts and Additional Mitigation Measures

Substantial mitigation of air quality impacts from CD-C project NO_x, CO, PM_{10}, $PM_{2.5}$, VOC, and HAP emissions would be achieved by the uniform application of WDEQ BACT and the Presumptive BACT permitting requirements following the WDEQ Oil and Gas Permitting Guidance. The Operators' commitment to use only Tier 2 or better drill rigs (**Section 2.2.1.7 Operator-Committed Practices**) would further mitigate project impacts, reducing emissions of NO_x, CO, PM_{10}, $PM_{2.5}$, and VOCs.

Additional mitigation of predicted air quality impacts could be implemented by the following control measures:

- Use of Tier 4 or equivalent drill rig engines, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.
- Use of Tier 2 or better construction equipment, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.
- Application of chemical suppressant on unpaved roads and additional watering during construction activities to minimize fugitive dust, reducing particulate (PM_{10} and $PM_{2.5}$) impacts.
- Centralization of well pad production facilities (e.g., heaters, flares, dehydration units), reducing NO_x, CO, PM_{10}, $PM_{2.5}$, VOC, and HAP emissions and reducing truck traffic.
- Field electrification, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.

These and other mitigation options or control measures may already be in practice in the CD-C project area to varying degrees. The reduction in emissions brought about by application of any of these measures could be estimated with additional modeling based on more detailed descriptions of the actual drilling and production processes used by the Operators. However, additional and more detailed information related to those practices would be needed from the Operators. This information will be gathered, and additional modeling analyses will be performed, during preparation of the FEIS. The results of the revised modeling analyses based on the selection of mitigation measures will be presented in the FEIS. Mitigation measures determined to be necessary to demonstrate compliance with the applicable NAAQS and WAAQS, as predicted in the revised modeling analyses, will be a required condition in the Record of Decision.

■ BIOLOGICAL ENVIRONMENT

4.6 VEGETATION

4.6.1 Introduction

Direct impacts to existing native shrub/grassland communities on the CD-C project area resulting from project implementation include a short-term reduction of herbaceous vegetation and a long-term loss of shrubs due to soil disturbance and related construction activities. Indirect impacts to the vegetation resource may occur as a result of damage to biological soil crusts (BSCs); soil compaction; mixing of soil horizons; loss of topsoil productivity; increased soil-surface exposure; soil loss due to wind and water erosion; short- to long-term increased potential for invasive weed introduction and establishment; shifts in plant species composition and density; a potential reduction of livestock, wild-horse, and wildlife habitat quantity and/or quality; and changes in visual aesthetics.

4.6.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes management objectives associated with vegetation. Those applicable to the CD-C project are:

1. Maintain, restore, and enhance vegetation communities to facilitate a healthy mix of successional stages (identified in activity plans) that incorporate age class, structure, and species composition into each vegetation type, consistent with site potential.
2. Control the introduction and proliferation of noxious and invasive species and reduce established populations to acceptable levels determined through cooperation, consultation, and coordination with local, state, other federal plans, policies, and agency agreements.
3. Maintain, restore, and enhance the health and diversity of plant communities through the use of management prescriptions (such as prescribed natural fire, burning, planting, seeding, and chemical, mechanical, biological, and grazing treatments or other treatments) in coordination with local, state, and federal management plans and policies.
4. Maintain, restore, and enhance riparian, wetland, and upland vegetation to meet the Wyoming Standards for Healthy Rangelands.
5. Maintain, restore, and enhance Special Status Plant Species (Threatened, Endangered, and BLM State Sensitive plant species) and unique plant communities.
6. Utilize inventory and monitoring data to support vegetation management.
7. Maintain connectivity between large, contiguous blocks of federal land by minimizing fragmentation of vegetative communities.

The following criteria were considered in the assessment of impacts associated with the Proposed Action and alternatives and are the same as those contained in the Rawlins RMP FEIS (BLM 2008b). The impact on vegetation would be considered significant if any of the following were to occur:

1. Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or corrective actions that were beyond the scope of this document.
2. The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under the ESA.
3. Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.

4. Reclaimed areas do not attain adequate vegetation groundcover and species composition to stabilize the site within five years from disturbance, or there is invasion and establishment of noxious or invasive weeds that contribute to unsuccessful reclamation.
5. Introduction of noxious and invasive weeds into areas considered weed-free, or an increase in weeds where they already exist.

4.6.3 Direct and Indirect Impacts

Direct impacts to the vegetation resource would principally occur during the construction phase of the proposed project and would include removal of existing native vegetation and removal of topsoil and BSCs. To some extent, these impacts could be mitigated by successful implementation of reclamation practices, but about 40 percent of the disturbance would remain in an unvegetated state for the life of the project—30 to 50 years at each individual well site—while in use for access roads and well pad facilities. The remaining 60 percent would have reduced productivity while reclamation is in progress and would have an altered species composition and density for the life of the project and beyond, including a long-term loss of shrubs.

Vegetation could be impacted indirectly as a result of soil and BSC compaction, mixing of soil horizons, loss of topsoil productivity, and increased soil-surface exposure resulting in soil loss due to wind and water erosion. Other indirect impacts could occur as a result of altered runoff hydrology due to roads, well pads, and other facilities, particularly on moderate to steep slopes. These sites reduce natural runoff to downslope locations and increase channelization of flows and gullying, which results in desertification effects including a lower water table, lower productivity and cover, and altered species composition below these facilities.

Additional indirect impacts would occur due to deposition of dust on vegetation near roads and construction sites, reducing plant productivity and vitality. The increased surface disturbance as a result of project implementation would also provide opportunities for invasive plant species to establish and spread (See **Section 4.7 Invasive, Non-Native Plant Species**).

4.6.3.1 Proposed Action

Under the Proposed Action (**Section 2.2.1**), 8,950 new natural gas wells and construction of required ancillary facilities would be anticipated over the course of 15 years (development phase) within the project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the estimated 10- to 15-year development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1**), which represents about 4.4 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres depending upon time required for successful reclamation, future land uses, and future climatic conditions. Construction and installation of well pads, access roads, and ancillary facilities (compressors, pipelines, and other required features.) would directly reduce the extent of vegetation cover types.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated 60,176 historic disturbance acres already exist within the project area (**Table 4.0-1**). The addition of historic disturbance to Proposed Action disturbance would result in a grand total of 107,376 acres or about 10 percent of the total project area. Much of that earlier disturbance remains unvegetated and in use, an estimated 17,663 acres. Together with long-term disturbance from the Proposed Action, up to 36,524 acres, or about 3.4 percent of the total project area would remain in an unvegetated state.

The time required to achieve successful reclamation of disturbed areas is largely dependent upon Operator commitment, compliance with BLM reclamation guidelines and recommendations, future land uses, and environmental variables, especially the timing and amount of precipitation events. This would hold true for reclamation of herbaceous species, but not necessarily for native shrub establishment, especially in the more xeric portions of the project area—approximately 590,272 acres, representing about 55 percent of the project's land surface area—where Wyoming big sagebrush and saltbush flats and fans are the primary cover types (**Table 3.6-1**).

The majority of development would likely occur in the Wyoming big sagebrush, greasewood flats and fans, and saltbush flats and fans primary cover types, which collectively occupy about 78 percent (**Table 3.6-1**) of the project's land surface area. Wyoming big sagebrush plant communities typically occur on sites with low precipitation and poor soil development, which increases the difficulty of reclamation and makes it likely that only initial shrub re-establishment would occupy disturbed sites during the estimated 45- to 55-year life of the project. Greasewood communities occupy about 246,000 acres (Table 3.6-1) within the project area. They are primarily located within the Muddy Creek drainage in the southern portion of the project area and within several large greasewood-dominated flats in the Red Desert Basin area in the northern portion of the project area. These flats usually have clayey soils with a high salt content which increases the difficulty of reclamation. The saltbush flats and fans cover type occupies about 173,000 acres within the project area. This primary cover type is found on saline soils in small to large openings or can occur as "stringer" inclusions within the ATW or greasewood primary cover types. These saltbush stands are sparsely vegetated and bare soil often exceeds 60 percent of the total ground cover. Reclamation of saltbush/mixed desert-shrub cover type habitats can be difficult and the use of seed mixes with appropriate native, saline, and drought-tolerant plant species is mandatory. The ability to re-establish native vegetation on sensitive soil types (i.e., clayey, sandy, saline/sodic) is not well-documented in this area of Wyoming. Although current technology exists to stabilize these areas and minimize soil erosion as revegetation is being carried out, there is currently a lack of local seed sources for native forb and shrub species, and the recovery rate to restore native shrubs such as saltbush and shadscale to their pre-existing condition is unknown.

Due to the scarcity of wetland/riparian sites in the project area, the probability of well pads, roads, pipelines, and ancillary facilities impacting these resources is low. The Rawlins RMP (BLM 2008a) specifies that a 500-foot buffer be maintained around perennial waters, springs, wells, wetlands, and areas within 100 feet of the inner gorge of ephemeral channels be avoided. These restrictions not only protect perennial water sources and wetland/riparian sites, but basin big sagebrush sites which are often located in or adjacent to ephemeral drainages that provide pygmy rabbit habitat and serve as mid-summer Greater sage-grouse foraging areas. In addition, an applicable Nationwide Permit as authorized by Section 404 of the Clean Water Act would be required from the U.S. Army Corps of Engineers, Wyoming Regulatory Office, for any disturbance activities in wetlands or Waters of the U.S. The probability of removing wetland vegetation or disturbing any Waters of the U.S. is low due to their low occurrence within the project area and existing stringent federal and state laws and regulations providing for their protection.

In general, in addition to the initial area of disturbance, the extent of impacts to all vegetation cover types would be influenced by the success of mitigation and reclamation efforts and the time period required for disturbed areas to return to pre-existing conditions. Reclamation success depends, in part, on the quality of topsoil salvaged, stockpile/redistribution methods in disturbed areas, precipitation, appropriate seed mixes, soil type(s), and soil pre-seeding preparation and moisture availability.

In March 2011, the RFO issued reclamation guidelines for its management area (Instruction Memorandum [IM] WYD-03-2011-002). The guidelines provide direction for implementing the reclamation requirements of the Rawlins RMP and the Wyoming BLM Reclamation Policy (IM WY-2009-022). The reclamation requirements of the RMP are found in Appendix 36 of that document and essentially require a site-specific reclamation plan for any surface-disturbing activity and annual monitoring and reporting of reclamation status. A full description of the new RFO reclamation guidelines and recommendations can be found in **Appendix E** and at <http://www.blm.gov/wy/st/en/field_offices/Rawlins/reclamation.html>.

Indirect impacts to vegetation due to dust from unpaved roads would be variable throughout the project area, depending upon the primary factors cited in **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**.

Project operations could result in increased traffic in the project area with an increased potential to create fugitive dust that could affect vegetation quality and quantity as well as general plant health. Specific plant communities would experience varying degrees of impact depending on location, general abundance, browse use, topography, site reclamation potential, soil type, and precipitation regime. Recommendations to mitigate dust impacts to vegetation and long-term loss of sagebrush habitat would include constructing roads to a 95-percent compaction rating, and instituting an effective dust-suppression program using water and/or periodic applications of BLM-approved dust-suppression chemicals to more heavily traveled roads.

4.6.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the notable exception that the total amount of initial disturbance would increase from 47,200 acres to 61,696 acres, or 31 percent. Long-term disturbance following successful reclamation would increase from a total of 18,861 acres to 24,133 acres. Combined with the present historic disturbed acres, the grand total of disturbance as a result of Alternative A would be 121,872 acres of initial disturbance and 41,796 long-term acres, assuming successful reclamation.

Implementation of Alternative A would affect a greater proportion of the vegetation resource due to the larger area of surface disturbance associated with additional well pads and their associated access road and pipeline rights-of-way. In addition, construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would likely increase the potential for the introduction and spread of invasive weed species and increase the total fugitive dust load within the project area.

4.6.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) identifies those resources that may be more at risk from natural gas development and provides enhanced protections and mitigations for those resources. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts that occur faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs.

Under Alternative B, the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the initial disturbance would encompass 45,516 acres, an approximate 4-percent reduction from the Proposed Action, due largely to an increase in the amount of directional drilling. Assuming successful reclamation efforts, long-term disturbance would decrease to 18,249 acres, a reduction of 612 acres compared to the Proposed Action. Factoring in the existing historic disturbance with future disturbance results in a grand total of 105,692 acres of initial disturbance and 35,912 acres of long-term disturbance.

Although no vegetation communities are specifically targeted in Alternative B, measures that are aimed at protecting wildlife, riparian, and aquatic habitats and minimizing surface disturbance and dust produced by project activity would all benefit vegetation communities. Indirect effects of fugitive dust on sensitive vegetation in or near riparian areas and aquatic habitats are anticipated to be low to none. Avoidance of riparian and aquatic sites (including playas) is an RMP requirement (BLM 2008b). Consequently, most roads and permanent ancillary structures would be constructed outside the 500-foot perennial water buffer and/or the 100-foot ephemeral drainage buffer previously discussed, thus reducing the fugitive dust load in/near these habitats.

4.6.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**). For this alternative, the scope and intensity of the impacts would be less widespread because of the surface-disturbance caps on unreclaimed areas. Maximum surface disturbance for this alternative would represent a decrease of 4,245 acres of initial disturbance and 1,543 acres of long-term disturbance (4 percent and 1.6 percent of the project area, respectively) compared to the Proposed Action.

Under Alternative C, fewer well locations (approximately 5,300) would be developed. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than under the Proposed Action. If development were to occur in the majority of undeveloped areas according to current spacing orders (160-acre well spacing, or four wells per section), then vegetation impacts in these areas that support large tracts of continuous shrub-steppe habitat types would be less than the Proposed Action. If, on the other hand, future development in these areas were to occur at greater densities (80- or 40-acre well spacing), then effects on vegetation would be greater than under the Proposed Action (**Section 4.6.3.1**).

4.6.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action (**Table 2.4-1).** The estimated 14,952 acres of long-term disturbance would be 3,909 acres less than the Proposed Action. The implementation of Alternative D would reduce the number of well locations developed to an estimated 4,032 compared to the estimated 6,126 for the Proposed Action. In addition to not disturbing almost 11,000 acres of native herbaceous and woody vegetation, the 35-percent reduction in well locations associated with this alternative would likely lead to similar reductions in the number of access roads and road miles which would reduce the total fugitive dust load on nearby forage thus increasing its palatability to wildlife and livestock (depending upon the primary factors cited in **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**). Healthy, undisturbed rangeland vegetation is recognized by range managers as the best natural defense against invasive-plant establishment and soil loss due to wind and water erosion.

4.6.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new disturbance to the vegetation resource.

4.6.4 Impact Summary

Direct impacts to existing native shrub/grassland communities within the CD-C project area would be similar under the Proposed Action and all alternatives—an initial reduction of herbaceous vegetation and a long-term loss of shrubs due to soil disturbance and related construction activities. Indirect impacts to the vegetation resource would also be similar under the Proposed Action and all action alternatives. The principal difference in impacts for each alternative is related to the amount of surface disturbance that would occur for each. The Proposed Action would initially disturb 47,200 acres. Alternative A would increase surface disturbance by 31 percent to 61,696 acres. Alternatives B, C, and D would each decrease surface disturbance and hence impacts to vegetation communities: Alternative B by about 4 percent to

45,516 acres, Alternative C by 9 percent to 42,955 acres, and Alternative D by 23 percent to 36,449 acres. Alternative E, because it would have no new development, would not add to surface disturbance. Surface disturbance for the Proposed Action and each alternative would be in addition to 60,176 acres of historic surface disturbance in the project area. **Table 4.0-1** shows in detail the historic and anticipated surface disturbance figures for the Proposed Action and the alternatives.

After initial disturbance, approximately 40 percent of the disturbance would remain in an unvegetated state for the life of the project and the other 60 percent would undergo interim reclamation. Long-term disturbance by action alternative ranges from a high of 24,133 acres for Alternative A to a low of 14,952 acres for Alternative D. The degree of long-term impact on vegetation by any of the alternatives would depend on the success of reclamation. That in turn would depend upon compliance with current BLM reclamation guidelines and recommendations, future land uses, and future climatic conditions. This would be true for reclamation of the faster-growing herbaceous species, but not necessarily for slow-growing shrubs such as Wyoming big sagebrush and Gardner's saltbush that are located in the more xeric portions of the project area. **Appendix E** describes the process by which the BLM intends to direct reclamation efforts and monitor the progress of reclamation.

Initial impacts to the vegetation resource from the action alternatives would include removal of native shrub species and associated understory herbaceous cover, thus decreasing abundance of these native species. Long-term impacts would be positive, assuming successful revegetation of BLM-approved seed mixes which would provide a younger, more vigorous and nutritious food source for wildlife, livestock, and wild horses on reclaimed areas.

4.6.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Vegetation cover would be unavoidably lost on a short-term basis as a result of the surface disturbance related to construction of well sites and associated facilities on public, state, and private lands within the CD-C project area. The losses would be in addition to historical losses of vegetation from prior surface disturbance, together representing 10 percent or more of the surface of the CD-C project area. For the intermediate to long term, grasses and other herbaceous vegetation would recover with the successful implementation of the BLM reclamation guidelines and recommendations described in **Appendix E**. Because of the extended time needed for the recovery of shrubs and other woody vegetation, a long-term loss of such vegetation is unavoidable. No additional mitigation measures beyond those described in **Appendix C** and Appendix E would mitigate these impacts to the vegetation resource. Those alternatives that most reduce surface disturbance—Alternatives C and D—would minimize both the short- and long-term loss of vegetation. Project operations could result in increased traffic in the project area with an increased potential to create fugitive dust that could affect vegetation quality and quantity as well as general plant health. Recommendations to mitigate dust impacts to vegetation would include constructing roads to a 95-percent compaction rating, and instituting an effective dust-suppression program using water and/or periodic applications of BLM-approved dust-suppression chemicals to more heavily traveled roads.

4.7 INVASIVE, NON-NATIVE PLANT SPECIES

4.7.1 Introduction

Impacts to vegetation and rangeland resources due to the infestation and establishment of invasive weeds would result with the implementation of all alternatives. Impacts would be the greatest during the development phase of the action alternatives but would occur throughout the life of the project due to vegetation and soil disturbance associated with energy-related activities such as road construction and maintenance, pipeline installation, and installation of ancillary facilities.

4.7.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes management objectives associated with vegetation (**Section 4.6.2**). Objective 2 applies specifically to invasive, non-native plant species:

1. Control the introduction and proliferation of noxious and invasive species and reduce established populations to acceptable levels determined through cooperation, consultation, and coordination with local, state, other federal plans, policies, and agency agreements.

Impacts due to invasive weed species would be considered significant if the following were to occur:

1. Introduction of invasive weeds into areas considered weed-free, or an increase in invasive weed density where infestations already exist, to include both upland and wetland/riparian sites.
2. An increase in invasive weeds in any grazing allotment that reduces or eliminates the opportunity to run the livestock of choice.
3. The criteria for Wyoming BLM Standards for Healthy Rangelands cannot be met in any grazing allotment due to invasive weed infestations.
4. Non-compliance with long-term reclamation standards and goals for energy-related disturbed sites.
5. Non-compliance with current BLM reclamation guidelines and recommendations (**Appendix E**), or Appendix 36 of the Rawlins RMP (2008b) due to establishment of and failure to control invasive weeds that contribute to non-attainment of these long-term standards and goals.

4.7.3 Direct and Indirect Impacts

Impacts to vegetation and range resources would occur on public lands under the Proposed Action and all action alternatives due to an increase in surface disturbance, which could provide more suitable habitat for invasive weed infestations.

The existing infestation of halogeton and other invasive species described in **Section 3.7** may be increased by project activities. Vehicles and equipment traveling from weed-infested areas, within and outside the project area, could facilitate the spread of invasive weeds into previously weed-free areas in addition to facilitating the spread of seeds of existing invasive populations. Additional surface-disturbing activities would increase the potential for infestation and spread of invasive plant species. Invasive weed species usually thrive on newly disturbed surfaces and out-compete native plant species. Creation of new sites for weed infestations may occur in proximity to roads where fugitive-dust deposition on roadside plants reduces their density due to chronic diseases in photosynthesis and growth, thus providing a suitable habitat for invasive plants to establish.

Annual production of livestock/wildlife forage could also be impacted through the spread of invasive weeds. The introduction, establishment, and spread of these species would reduce rangeland and forage quantity and quality by replacing preferred forage species, leading to a reduction in grazing capacity, and could lead to a greater amount of RFO rangeland acreage not meeting the national and Wyoming BLM Standards and Guidelines for Healthy Rangelands (BLM 1997).

Without proper management and control, invasive plant species may cause widespread infestations. Additionally, some invasive species such as halogeton, black henbane, and houndstongue are poisonous and can kill or impair livestock if ingested.

The continued establishment and spread of halogeton, an invasive, poisonous plant, due to energy-related activities, could lead to an increase in livestock (especially sheep) mortality. This could result in the reduction or elimination of the opportunity to run the livestock of choice, which would be a significant impact. Project implementation would increase the potential for increased invasive plant density in the project area as a result of increased surface disturbance. The potential for increased invasive weed infestation would be the greatest on project-related disturbances but would also likely occur on the 56,647 historic existing disturbed acres due to natural dissemination of seeds, whether by wind, humans, wildlife, or livestock.

As detailed in the Rawlins RMP, Appendix 36 (2008b), the Operators would be responsible for the management and control of all invasive weed species on or related to project-related surface disturbances during the life of the project and would follow an approved BLM Pesticide Use Proposal (PUP) and reporting requirements.

4.7.3.1 Proposed Action

Implementation of the Proposed Action (**Section 2.2.1**) would increase the potential for increased invasive plant density on the project area as a direct result of increased surface disturbance. Construction and installation of well pads, access roads, and ancillary facilities (compressors, pipelines, and other infrastructure) would remove soil and vegetation. Invasive weed species usually thrive on newly disturbed surfaces such as road and pipeline rights-of-way and out-compete the more desirable native plant species. Under the Proposed Action, 8,950 new natural gas wells and construction of required ancillary facilities would be anticipated over the course of 15 years (development phase) within the project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the estimated 10- to 15-year development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres, which represents about 4.4 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres depending upon time required for successful reclamation, future land uses, and future climatic conditions.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated 60,176 acres of historic initial disturbance already exist within the project area (**Table 4.0-1**). The addition of this historic disturbance to new disturbance from the Proposed Action would result in a grand total of 107,376 acres of initial disturbance, or about 10 percent of the total project area. Much of that earlier disturbance (an estimated 17,663 acres) remains unvegetated and in use. Together with the CD-C project long-term disturbance, up to 36,524 acres, or about 3.4 percent of the total land surface of the project area, would remain in an unvegetated state.

The potential for increased invasive weed infestations would be the greatest on project-related disturbances but would also likely occur on the 60,176 acres of historic existing disturbance due to natural dissemination of seeds by wind, humans, wildlife, or livestock.

4.7.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the notable exception that the total amount of short-term disturbed acres would increase from a total of 47,200 acres (Proposed Action) to 61,696 acres (Alternative A) and the long-term disturbed acres following successful reclamation would increase from a total of 18,861 acres (Proposed Action) to 24,133 acres (Alternative A). Combined with the present historic disturbed acres, the grand total of disturbed acres as a result of Alternative A would be 121,872 acres of initial disturbance and 41,796 acres of long-term disturbance, assuming successful reclamation.

Impacts on the spread of invasive plant species would be similar to the Proposed Action but Alternative A would be more likely to affect a greater proportion of the vegetation resource due to the larger area of surface disturbance from additional well pads and their associated access road and pipeline rights-of-way. In addition, construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would increase the potential for introduction and spread of invasive weed species within the project area.

4.7.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) identifies those resources that may be more at risk from natural gas development and provides enhanced protections and mitigations for those resources. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts that occur faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs.

Under Alternative B, impacts from the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but the alternative would create slightly less risk of infestation due to the diminished area of surface disturbance associated with a slight increase in directional drilling. The short-term disturbance acres would be 45,516 acres, an approximate 4 percent reduction from the Proposed Action, due largely to an increase in the amount of directional drilling. Assuming successful reclamation efforts, the long-term disturbance would decrease to 18,249 acres, a reduction of 612 acres. Factoring in the existing historic disturbance acres with future short-term disturbance results in a grand total of 105,692 acres of initial disturbance and 35,912 acres of long-term disturbance.

4.7.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), impacts on the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but implementation of the alternative would affect a smaller proportion of the project area due to the reduced surface disturbance associated with the anticipated increase in directional drilling. The scope and intensity of the impacts would be less widespread because of the surface-disturbance caps on unreclaimed areas. Maximum surface disturbance for this alternative would be decreased initially by 4,245 acres and 1,543 acres in the long term (4 percent and 1.6 percent of the project area, respectively) when compared to the Proposed Action.

With this alternative, fewer well locations (approximately 5,300) would be developed. Therefore fewer access roads would be developed and habitat fragmentation would be less extensive than the Proposed Action. If development were to occur in the majority of undeveloped areas according to current spacing orders (160-acre well spacing, or 4 wells per section), then invasive weed impacts in these areas would be less than the Proposed Action. If on the other hand, future development in these areas were to occur at greater densities (80- or 40-acre well spacing), then effects of invasive weeds would be greater than the Proposed Action (**Section 4.6.3.1**).

4.7.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), impacts from the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but implementation of this alternative would affect a smaller proportion of the project area due to the reduced surface disturbance associated with the anticipated increase in directional drilling (**Table 2.4-1**). The scope and intensity of the impacts would be less widespread because of the reduced density of new surface-disturbing activities per section.

Estimated initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action. With this alternative there would be fewer well locations developed—an estimated 4,032 compared to the 6,126 estimated for the Proposed Action. Compared to the Proposed Action, this alternative would reduce surface disturbance by almost 11,000 acres (17 sections) of potential new habitat for invasive plants. The 35-percent reduction in well locations associated with this alternative would likely lead to similar reductions in the number of access roads and road miles which often serve as primary dispersal corridors for invasive plant seeds. The reduction of road miles would also decrease total fugitive dust load to roadside vegetation which would be beneficial to the prevention of weedy annual establishment (see **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**).

4.7.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities. There would be no risk of direct infestation by invasive plant species as a result of this project, but infestations could still occur because of existing infestations.

4.7.4 Impact Summary

The risk of the infestation and spread of invasive plant species within the CD-C project area would be similar under the Proposed Action and all alternatives as initial surface disturbance would create opportunities for invasive species and development activity would increase the degree to which such species spread throughout the project area. The principal difference in impacts for each action alternative is related to the amount of surface disturbance that would initially occur for each. The Proposed Action would initially disturb 47,200 acres. Alternative A would increase surface disturbance by 31 percent to 61,696 acres. Alternatives B, C, and D would each decrease surface disturbance and hence impacts from the spread of invasive species: Alternative B by approximately 4 percent to 45,516 acres, Alternative C by 9 percent to 42,955 acres, and Alternative D by 23 percent to 36,449 acres. Surface disturbance for the Proposed Action and each alternative would be in addition to the 60,176 acres of historic surface disturbance in the project area. **Table 4.0-1** shows in detail the historic and anticipated surface disturbance figures for the Proposed Action and the alternatives.

After initial disturbance, approximately 40 percent of the disturbance would remain in an unvegetated state for the life of the project and the other 60 percent would undergo interim reclamation. Long-term disturbance by alternative ranges from a high of 24,133 acres for Alternative A to a low of 14,952 acres for Alternative D. The degree of long-term impact on vegetation by any of the alternatives would depend on the success of timely reclamation which in turn would depend upon compliance with current RFO reclamation guidelines and recommendations, future land uses, and future climatic conditions. As discussed in the RMP, Appendix 36 (2008a), the Operators would be responsible for the management and control of all invasive weed species related to project-related surface disturbances during the life of the project and would follow an approved BLM Pesticide Use Proposal (PUP) and reporting requirements.

Chenoweth *et al*. (2010) recently completed a cost analysis for Pioneer Natural Resources in the Raton Basin (Trinidad, CO) and Encana Oil and Gas (Piceance Basin, CO) and concluded that estimated costs of proper site reclamation techniques between the two companies averaged about $16,125 to $22,589 per acre depending upon slope steepness. They also concluded that direct and indirect costs for reclamation failures varied between $20,070 and $43,000 per acre. It is evident that cost on reclamation failure sites can be more than twice the cost of initial proper reclamation, depending on severity of site degradation. It is imperative that Operators understand the importance of minimizing initial surface disturbance and re-establishing a competitive grass/forb cover as soon as feasible after disturbance to prevent successful establishment of invasive weeds at the site.

4.7.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Assuming construction, maintenance, and operation of well sites and associated disturbances on public, state, and private lands within the CD-C project area are in accordance with the BMPs and COAs described in **Appendix C** and assuming successful implementation of BLM reclamation guidelines and recommendations described in **Appendix E**, the infestation and spread of invasive plant species would be contained and there would be no long-term adverse impacts. Only one additional mitigation measure may be warranted:

- To prevent the inadvertent introduction of invasive weeds, the Operators and their sub-contractors would thoroughly power-wash all field vehicles, particularly their undercarriages, before entering the project area.

4.8 WILDLIFE

4.8.1 Introduction

The primary wildlife impacts likely to result from the Proposed Action or alternatives include (1) direct and indirect loss of wildlife habitats, (2) displacement of some wildlife species because of increased human access and activity, (3) an increase in the potential for collisions between wildlife and motor vehicles, (4) an increase in stress to wildlife and (5) disruption of life-history requirements of a species or population segment.

The primary wildlife resources of interest within the project area include big game CWRs; big game migration routes; overlapping crucial habitats (multiple species); raptor nests; small mammals and neotropical birds; and upland game birds. A number of wildlife species, such as sage-grouse and mountain plover, are discussed in **Section 4.9, Special Status Species.**

4.8.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008b) prescribes the following management objectives associated with wildlife and fisheries resources (including Special Status Species):

- Maintain, restore, or enhance wildlife habitat in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements. A full range of mitigation options will be considered when developing mitigation for project-level activities for wildlife and Special Status Species habitats.
- Maintain, restore, or enhance T&E species habitat, in coordination and consultation with the USFWS and other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance designated BLM State Sensitive Species habitat to prevent listing under the ESA, in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance habitat function in crucial winter range.

The following criteria were considered in the assessment of impacts associated with the Proposed Action and alternatives and are from the Rawlins RMP FEIS (BLM 2008a). Impacts to wildlife and fish would be considered significant if any of the following were to occur:

1. Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
2. Management actions that result in substantial disruption or irreplaceable loss of vital and high-value habitats as defined in the Wyoming Game and Fish Commission Mitigation Policy (WGFD 2010a). The policy classifies big game crucial ranges as vital habitat and recommends that habitat function be maintained so that the location, essential features, and species supported by the habitat are unchanged. The policy also defines *Moderate*, *High*, and *Extreme* impact thresholds, of which *High* and *Extreme* impacts will be judged significant.

Additionally, the RFO has determined that the following significance criterion should be included for this project:

3. Any effect, whether direct or indirect, that results in long-term decreases in recruitment and/or survival rates for fish populations.

4.8.3 Direct and Indirect Impacts

4.8.3.1 Proposed Action

The proposed natural gas development would disturb and alter approximately 47,200 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural gas and other development. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery of 18,861 acres of grass-dominated habitat (in one to several years, depending on precipitation and effectiveness of reclamation efforts). Recovery of shrubs to pre-disturbance levels would not occur during the life of the project. As indicated in **Section 4.0.3**, future project surface disturbance is most likely to occur in areas with already moderate to high development as previously developed areas are "filled-in" to the expected 40-acre spacing (16 wells per section). However, some amount of development and surface disturbance can be expected throughout the project area. Depending on the well-spacing orders in an area and the degree to which directional drilling is used, disturbance per section could vary from as low as ten acres (four wells per section, all directionally drilled from one pad) to as high as 100 acres (16 wells, all vertically drilled from individual pads). The 160-acre well spacing orders designated for the undeveloped areas of the project area indicate an expectation of disturbance at the lower end of that spectrum. However, if spacing were to be reduced in any of those areas, the amount of disturbance per section would increase.

Standard environmental protection measures prescribed as Conditions of Approval or used as BMPs (**Appendix C**) would be implemented under the Proposed Action and all alternatives. The Wildlife Monitoring and Protection Plan (**Appendix I**) would be followed to prevent, reduce, and detect impacts to wildlife and fish species throughout the life of the project. This plan serves two purposes: one is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc.; the other is to provide protocols to protect wildlife species and track the effectiveness of the monitoring and mitigation plan. BMPs implemented for other resource concerns may provide indirect protection for a variety of wildlife species.

Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of well pads, roads, pipelines, and production facilities; wildlife habitats indirectly disturbed include areas surrounding directly impacted habitats. Direct habitat loss from construction of the Proposed Action, equal to approximately 4.4 percent of the project area, would be in addition to the 5.6 percent of the project area that has previously been disturbed.

The long-term loss/reduced usability of shrub habitat within a portion of the project area could lead to an increase in use on remaining shrub habitats. This localized increase of use could lead to a long-term reduction of shrub habitats outside of immediate project disturbance areas. Currently, areas dominated by large and continuous stands of shrub communities have relatively low well densities or occur in sections with the lowest (160-acre) well-spacing orders or allowable well density. Timely reclamation of well pads, pipelines, and rights-of-way would provide grass and forb forage within one to several years depending on precipitation and effectiveness of reclamation efforts, while sagebrush and other important shrub species would require longer for re-establishment to pre-disturbance levels. Consequently, the total acres disturbed would constitute a long-term loss of shrubs and would not be fully usable by shrub-dependent species for forage or shelter for over 20 years, although early seral stage shrubs would provide forage and/or shelter for various species in a shorter period of time.

Disturbance during construction and production, such as human presence, dust, and noise may displace or preclude wildlife use during all seasons. Prohibiting construction, drilling, and other activities potentially disruptive to wildlife during sensitive time-periods (e.g. winter, breeding, or nesting) would reduce the probability of displacement during these critical times. The extent of displacement would be related to the duration, magnitude, and visual prominence of the activity, as well as the extent of construction and operational noise levels above existing background levels. Displacement could result in local reductions in wildlife populations if adjacent, undisturbed habitats are at carrying capacity. In this situation animals are either forced into less-optimal habitats or they compete with other animals that already occupy unaffected habitats. Possible consequences of such displacement are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations (WGFD 2010a).

The extent of wildlife displacement is impossible to predict for most species since the response to disturbance varies from species to species and can even vary between different individuals of the same species. After initial avoidance, some species may acclimate to the activity and begin to reoccupy areas previously avoided (Kuck *et al.* 1985). This acclimation and reoccupation may occur following construction and drilling operations when the project moves into the production phases where less noise and human activities would take place. However, there is no guarantee of acclimation, or reoccupation, if the number of roads or level of human activity exceeds tolerance thresholds of the individual animal.

Human-caused surface disturbances such as well pads and roads can reduce use of surrounding habitat by wildlife. There is generally a zone of decreased use surrounding these sites due to the increased human activity. On average this zone extends to approximately 0.7 miles from development for big game species (Hebblewhite 2008). The area of aversion generally is the least for pronghorn and increases for elk and mule deer (Powell 2003, Berger 2006, Sawyer *et al.* 2006a). Consequently, development impacts to wildlife can extend beyond the physically disturbed area.

Habitat fragmentation and isolation are difficult to determine and vary species to species, but they could occur as a result of gas-field developments, which typically are configured as point and linear disturbances scattered throughout broader areas. Although these types of disturbances do not usually create physical barriers to wildlife movement (although in the winter, high snow berms resulting from plowing along multiple access roads may disrupt some wildlife movement), the effective use of adjacent undisturbed habitats could diminish as densities of well pads, ancillary facilities, and roads increase. An increase in habitat fragmentation is not as readily apparent in areas with existing disturbance as in previously undisturbed areas, but adverse effects can be compounded when infill disturbance further reduces available habitat between existing disturbances, effectively eliminating areas of relatively undisturbed habitat to the point that animals are displaced from the general area.

In addition, road/traffic-related dust would likely directly and indirectly impact 24.3 percent of the project area, which may result in some habitat avoidance (**Section 3.6.4**). Indirectly, this may increase inter- and intra-species competition for forage and thermal cover. In areas already at carrying capacity, individuals may be further displaced, possibly outside of the project area. Some animals may be displaced into lower-quality habitats which may lead to a reduction in reproductive rates or an increase in predation. In addition, roads provide access to the general public into areas that were previously undisturbed/ undeveloped. Human encroachment in the form of casual backcountry recreation, hunting, and poaching could occur at higher rates resulting in effects such as disturbance during sensitive periods, displacement, or increased mortality.

Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, species might acclimate to the well-pad production facilities and use habitats adjacent to such sites, particularly at night when facilities-maintenance activities do not occur (Thompson *et al.* 1998, Dzialak *et al.* 2011a; 2011b, Webb *et al.* 2011).

The reaction of individual animals to noise and human presence varies depending on the intensity of the noise source and whether it is continuous or intermittent. Transient loud noises would provoke alarm responses; however, many animals habituate to more constant, lower-level noise sources that are not associated with negative visual stimuli or experiences such as being chased or hunted (reviewed in Busnel and Fletcher 1978; Weisenberger *et al.* 1996). Increased traffic levels on new and existing roads could increase the potential for wildlife/vehicle collisions for the life of the project.

Pronghorn. The impacts with the potential for the greatest negative effects to pronghorn populations would occur in CWR. Pronghorn CWR encompasses 90,310 acres across the central and southeastern portion of the project area (**Map 3.8-2**). Based on habitat assessments conducted in 2007, 2008, and 2010 at seven sites within the project area (**Map 3.8-2**; **Table 3.8-3),** pronghorn CWR is in largely fair condition (BLM unpublished data). Existing long-term disturbance and post-reclamation early-seral-state communities comprise approximately 2.6 percent of pronghorn CWR within the project area (**Table 4.8-1**). Based on current well-spacing orders, as many as 1,232 new wells could be drilled within pronghorn CWR. Initially, an additional 3.6 percent of pronghorn CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action. Assuming successful interim reclamation, as much as 6.2 percent of pronghorn CWR within the project area would remain disturbed for the life of the project.

Table 4.8-1. Affected pronghorn Crucial Winter Range, new and existing surface disturbance

Pronghorn Crucial Winter Ranges = 90,310[1]		Existing and Proposed Disturbance In Crucial Winter Ranges: Acres	Percent
Existing[2]		2,306	2.6%
Proposed Action	New[3]	3,292	3.6%
	Combined[4]	5,598	6.2%
Alternative A	New	7,762	8.6%
	Combined	10,068	11.2%
Alternative B	New	3,175	3.5%
	Combined	5,481	6.1%
Alternative C	New	2,996	3.3%
	Combined	5,302	5.9%
Alternative D	New	2,746	3.0%
	Combined	5,052	5.6%

[1] *Designated CWR within the project area (WGFD 2011b).*
[2] *Based on HWA 2008b.*
[3] *Because the most important constituent vegetation communities within crucial winter ranges would not return to functional condition for the life of the project, anticipated initial disturbance acres are used to represent the effective direct impact on these crucial winter ranges.*
[4] *The combined existing long-term and proposed project initial disturbance represents the worst case scenario for anticipated crucial winter range habitat disturbance.*

The direct loss/reduced usability of sagebrush communities would increase use on remaining shrubs, potentially resulting in shrub health decline outside of the immediate project disturbances. This would have an impact on pronghorn due to their heavy use of sagebrush during winter. Over time, pronghorn habituate to certain disturbances, depending on the spatial relationship (i.e., distance) between these areas of disturbance to available forage, water, and thermal cover; however, Easterly (1991) found that pronghorn density was consistently higher in areas outside of developed areas. Standard mitigations prohibiting construction, drilling, and other activities potentially disruptive to pronghorn within CWR from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, the application of BMPs identified in Appendix 15 of the RMP, if applied, would work to alleviate impacts to the species. This would likely serve to reduce stress, help maintain animal condition, and improve winter survival as the animals travel farther or are displaced to lower-quality range.

Within the project area, pronghorn in the Red Desert herd generally migrate from north to south to CWRs along I-80. Pronghorn in the Bitter Creek and Baggs herds migrate from higher elevations to CWR along Muddy Creek and WY 789. I-80 presents a formidable barrier to north-south migration movements between the Red Desert herd and the Bitter Creek and Baggs herds (**Map 3.8-1**). In addition, fences along

WY 789 create a migration barrier that impedes pronghorn movement across the highway. Pronghorn found east of the highway are generally restricted to crucial winter habitat found along Muddy Creek and against WY 789, creating a trap to animal movement similar to I-80. WGFD (2011) reported, “Direct loss of winter habitat can cause a major impact because of the high sensitivity of pronghorn to wildlife unfriendly fencing, thus possibly causing a situation where pronghorn are trapped on unsuitable habitat increasing winter kill.” This situation occurred during the winter of 2007-2008 in the Baggs Herd Unit, when pronghorn were migrating over fences along WY 789. Numerous rangeland fences throughout the project area also impede the movement of individuals to suitable winter habitat. Fences can prevent the animals from escaping human disturbance associated with field-development activity. For example, animals may have to follow migration barriers such as fences for great distances before finding a way through towards better winter habitat (J. Gregson, pers. com. 2012). Development of the project would compound the impacts of barriers to migrations. The inability to move through the area may force individuals to use less-suitable winter habitats, increase physiological stress, increase potential for starvation, and increase mortality and an overall decline in population size. Surface-disturbing and disruptive activities in big game migration and transitional ranges would be managed on a case-by-case basis, while new fences in migration corridors would only be allowed if they meet BLM standards (Rawlins RMP, p. 2-54).

Increased traffic levels on new and existing roads could increase the potential for wildlife/vehicle collisions. New roads also provide access to the general public into areas that were previously undisturbed/ undeveloped. Human encroachment in the form of casual backcountry recreation, hunting, and poaching could occur at higher rates resulting in effects such as disturbance during sensitive periods, displacement, or increased mortality.

The level of development within pronghorn CWR and migration corridors that would occur as a result of the Proposed Action is expected to exceed the significance criteria and to meet or exceed the WGFD (2010) definition of “High Impact” to pronghorn in crucial seasonal habitats, as follows: “Impairment of habitat function increases – the impact will be more difficult or at times impossible to effectively mitigate within the project area. The impact can be reduced but probably not eliminated through seasonal use restrictions and more intensive management and mitigation practices.” Implementation of the Proposed Action, compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement of pronghorn during development (and to a lesser degree during production) would likely exceed impact Criterion 2 (substantial disruption or irreplaceable loss of vital habitat).

Mule Deer. The impacts with the potential for the greatest negative effects to mule deer populations would occur in CWRs. Mule deer CWRs encompass 17,849 acres within the southeastern part of the project area (**Map 3.8-4).** Based on habitat assessments conducted in 2007, 2008, and 2010 at two sites within the project area (Map 3.8-4; **Table 3.8-4)**, the condition of mule deer CWR appears to have declined, possibly as a result of the severe winter of 2007–2008 (BLM unpublished data, WGFD 2011).

Existing long-term disturbance and post-reclamation early-seral-state communities comprise less than 2.3 percent of mule deer CWR within the project area (**Table 4.8-2**). Based on current well-spacing orders, as many as 298 new wells could be drilled within mule deer CWR. Initially, an additional 4.5 percent of mule deer CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action. Assuming successful interim reclamation, as much as 6.8 percent of mule deer CWR within the project area would remain disturbed for the life of the project.

The impacts of habitat disruption common to all big game species are discussed in detail earlier in this section. Reduction in winter range size and quality of available habitat may decrease the carrying capacity of the overall winter range (Sawyer *et al.* 2006b). In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect the use of the habitat immediately adjacent to these areas. Indirect habitat loss can be substantially greater than the direct loss of habitat to roads and well-pad construction. Sawyer *et al.*

(2006b) found that winter mule-deer habitat selection and distribution patterns have been affected by development, specifically road networks and well pads; mule deer had a higher probability of use in areas farther away from well pads as development progressed. Predictive maps also suggest that some habitats considered “high probability of use” areas prior to development, changed to “low probability of use” areas as development progressed, and vice-versa (Sawyer *et al.* 2006b).

Table 4.8-2. Affected mule deer Crucial Winter Range, new and existing surface disturbance

Mule Deer Crucial Winter Range = 17,8491		Existing and Proposed Disturbance in Crucial Winter Range	
		Acres	%
Existing[2]		404	2.3%
Proposed Action	New[3]	796	4.5%
	Combined[4]	1,200	6.8%
Alternative A	New	1,877	10.5%
	Combined	2,281	12.8%
Alternative B	New	768	4.3%
	Combined	1,172	6.6%
Alternative C	New	724	4.1%
	Combined	1,128	6.4%
Alternative D	New	664	3.7%
	Combined	1,068	6.0%

1 Designated winter and Winter/Yearlong within the project area (WGFD 2011b).

2 Based on HWA 2008b.

3 Because the most important constituent vegetation communities within crucial winter range would not return to functional condition for the life of the project, anticipated initial disturbance acres are used to represent the effective direct impact on these crucial habitats.

4 The combined existing long-term and proposed project initial disturbance represents the worst case scenario for anticipated crucial winter range habitat disturbance.

As discussed above (**Pronghorn**), prohibiting construction, drilling, and other activities potentially disruptive to mule deer within CWR from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, the application of BMPs identified in Appendix 15 of the RMP would help alleviate impacts to the species. This would likely help reduce stress, maintain animal condition, and improve winter survival of the animals as they travel farther or are displaced to lower-quality range. Over time, mule deer habituate to certain disturbances, depending on the spatial relationship (i.e., distance) between these areas of disturbance to available forage, water, and thermal cover; however, Sawyer *et al*. (2006a) found that areas within 2.3 miles of well pads have lower predicted probabilities of use compared to undeveloped areas. Mule deer are adaptable and may adjust to non-threatening, predictable human activity (Irby *et al.* 1988).

Recent research has identified migration routes used by mule deer adjacent to the project area (Sawyer 2007). Mule deer appear to move between the higher elevations of the Atlantic Rim in the east to lower elevations along Red Creek Rim to the southwest, skirting the eastern edge of The Bluffs, a prominent geographic feature in the extreme southern portion of the project area (Sawyer 2007). Research into mule deer migration routes will continue to better inform and refine mapping. Numerous rangeland fences throughout the project area impede the movement of individuals to suitable winter habitat. Fences also prevent the animals from escaping human disturbance associated with field-development activity. For example, animals may have to follow migration barriers such as fences for great distances before finding a way through towards better winter habitat (J. Gregson, pers. com. January 2012). Development of the project would compound the impacts of barriers to migration. The inability to move through the area may force individuals to use less-suitable winter habitats, increase physiological stress, increase potential for starvation, and increase mortality and an overall decline in population size. Surface-disturbing and disruptive activities in big game migration and transitional ranges would be managed on a case-by-case basis, while new fences in migration corridors would only be allowed if they met BLM standards (Rawlins RMP, p. 2-54).

Increased traffic levels on new and existing roads would increase the potential for wildlife/vehicle collisions.

The level of development within mule deer CWR and migration corridors that would occur as a result of the Proposed Action is expected to exceed the significance criteria and to meet or exceed the WGFD (2010) definition of "High Impact" to mule deer in crucial seasonal habitats: "Impairment of habitat function increases – the impact will be more difficult or at times impossible to effectively mitigate within the project area. The impact can be reduced but probably not eliminated through seasonal use restrictions and more intensive management and mitigation practices." Implementation of the Proposed Action, compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement of the mule deer during development, and to a lesser degree during production, would likely exceed impact significance Criterion 2 (substantial disruption or irreplaceable loss of vital habitat).

Application of the same additional mitigation measures described for pronghorn could work toward reducing the impacts of the Proposed Action on mule deer.

Elk. No elk CWR has been identified within the project area (**Map 3.8-6**), and migration routes have not been identified and documented. The majority of the project area is classified as "limited/no importance" and "undetermined/ undocumented" for elk use (WGFD 2010a). Small portions of the area are classified as "yearlong" and "winter" elk habitat (**Map 3.8-6**). Therefore, this project is not expected to alter or block elk movements. However, elk are generally believed to be more sensitive to human activities than pronghorn or mule deer, and they may be displaced in construction areas from 0.6 to 1.2 miles depending on the season (Powell 2003). Elk would likely habituate to the physical presence of gas wells (Van Dyke and Klein 1996); however, elk rarely adjust to the continued human presence required during the production phase of the project (Morrison *et al.* 1995). Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, species might acclimate to the well-pad production facilities and use habitats adjacent to such sites, particularly at night when facilities-maintenance activities do not occur (Thompson *et al.* 1998, Dzialak *et al.* 2011a and 2011b, Webb et al. 2011).

With the increase in roads and potential recreational access to the area, displacement of elk in the limited areas of known elk use is likely during all phases of development. That said, and unless future studies demonstrate otherwise, impacts to elk populations due to habitat removal or modification; displacement, stress, or migration disruption; and increased vehicular collisions are not expected to exceed the impact significance criteria because high-value habitat (CWR and migratory routes) within the project area is very limited.

Application of the same additional mitigation measures described for pronghorn and mule deer would work to reduce the impacts of the Proposed Action on elk.

Overlapping Big Game Crucial Winter Range. Areas of overlapping big game CWR and sage-grouse core population areas are of greater importance because they provide crucial habitat for more than one species (WGFD 2010a); such areas occur within the project area (**Map 3.8-7**). Thirty-eight percent of overlapping big game CWR is on private and state lands where there are no protections against disturbance of animals during crucial time-periods (November 15 – April 30). Indirectly, this may increase inter- and intra-species competition (between different species and among individuals of the same species) for forage and thermal cover. This may force animals to use lower-quality habitats, which may lead to a reduction in reproductive rates or an increase in predation and/or mortality. The level of development of the Proposed Action within big game CWR, compounded by the current condition of the crucial winter habitat (**Tables 3.8-3** and **3.8-4**), would likely exceed impact significance Criterion 2 and meet the WGFD (2010) definition of "High Impact."

Consistent with the WGFD oil and gas development recommendations (WGFD 2010a), the mitigation measures listed for pronghorn and mule deer in the previous narratives would apply as well to the overlapping big game CWR.

Raptors. The impacts with the potential for the greatest negative effects to raptor populations include nest-abandonment and failure due to increased human disturbance, loss of nesting and feeding habitat, and potential for increased vehicle collisions. There are 938 raptor nest sites (known to date) located in or within one mile of the project area. The BLM places year-round buffers around active raptor nest sites, precluding well locations, roads, ancillary facilities, and other surface structures requiring repeated human presence and applies a larger buffer during the nesting period (BLM 2008a). The size of buffers around active nests varies by species, with the largest buffers being one mile for bald eagles, golden eagles, and ferruginous hawks. Surface-disturbing activities would be prohibited from as early as February 1 (e.g. Great Horned Owl) to as late as September 15 (e.g. Burrowing Owl), depending on species. The amount of short-term change in prey-base populations created by construction is expected to be small in comparison to the overall level of small-mammal populations. While prey populations on the project area would likely sustain some reduction during the development phase of the project, most prey species would be expected to rebound to pre-disturbance levels following initial reclamation. Once reclaimed, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas (Hingtgen and Clark 1984).

Some raptors feed on carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed.

Because of the buffers and restriction on activity around raptor nests and the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impact from the Proposed Action is not expected to exceed the significance criteria.

Mitigation could be imposed to reduce the chance of collisions between vehicles and raptors by requiring that drivers undergo training that describes the circumstances under which vehicular collisions are likely to occur and measures that can be taken to minimize them.

Small Mammals and Neotropical Songbirds. Construction disturbances would reduce habitat availability for a variety of small bird and mammal species. The temporary disturbances that would occur during the 15-year construction period would tend to favor early-succession wildlife species such as horned larks and ground squirrels, and would tend to adversely impact mid-to-late-succession species, such as loggerhead shrikes and voles. The long-term disturbance would have a minor effect on wildlife species not dependent upon shrubs. In addition to the direct-disturbance acreage, dust would directly and indirectly impact 24.3 percent of the project area (**Section 3.6.4**). These impacts would include habitat avoidance by birds and small mammals. Indirectly, this could increase inter- and intra-specific competition for nesting and foraging areas. In areas already fully occupied, density-dependent species would be further displaced, possibly outside of the project area.

A variety of shrub-dependent songbirds could be displaced by the reduction in habitat. Although there is no way to accurately quantify these changes, the displacement would be long-term. Birds are highly mobile and would disperse into surrounding areas and use suitable habitats to the extent that they are available. Standard mitigation measures would indirectly help songbirds during critical time-periods, and impacts to nesting and foraging habitats are expected to be minimal. Therefore, impacts from this alternative are not likely to significantly reduce populations within the project area due to the abundance of undisturbed habitat that would remain.

The primary small mammals found in the project area include, but are not limited to, cottontail rabbits, various mouse and vole species, northern pocket gophers, white-tailed jackrabbits, and ground squirrels. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be minor, and the relatively high reproductive rate of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation resulting from reclamation activities.

Development of the project could result in some unintentional, direct mortality of small birds and small mammals from vehicle collisions; however, this mortality is expected to be negligible and is not likely to significantly reduce populations within the project area. Overall, if standard prescribed environmental protection measures and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**) are implemented under the Proposed Action, the impacts on songbird and small-mammal populations are not expected to exceed the impact significance criteria.

Upland Game Birds. Greater sage-grouse, Columbian sharp-tailed grouse, and mourning doves occur or potentially occur within the project area and may be impacted to varying degrees by the project. Mourning doves are highly adaptable habitat generalists; impacts would be negligible and not affect their long-term viability within the project area. Greater sage-grouse is designated as a candidate for listing under the ESA and is discussed in **Section 4.9 Special Status Species**.

Fish. About 10 game-fish species and 20 non-game fish species may occur in the CD-C project area or adjacent to the project area, or in streams upstream or downstream of the project area (**Table 3.8-6**) Of these, 14 species, including six native species, are likely to be present within the project area. Of these 14 species, four are BLM Sensitive Species. All of the 10 species that are not BLM Sensitive Species will be subject to the same types of impacts described in **Section 4.9.3.1, Sensitive Fish Species**. All of the 10 species that are not BLM Sensitive Species, however, have a wide distribution within Wyoming (Baxter and Stone 1995); consequently, the project area and other human activities within the Muddy Creek and Great Basin watersheds may have localized population impacts, but these impacts should not impact their status range-wide. Only one reservoir in the project area has a recreational fishery, and no impacts to that fishery are anticipated.

Part of Muddy Creek within the project area is listed as threatened by WDEQ for water quality (**Section 3.4.2.4**); however, no segments listed as impaired are present within the project area. If any segments were to be classified as impaired, one of the requirements in the RMP is for intensive management of 303(d) listed segments to address the problem.

Refer to **Section 4.9.3.1** for impacts to sensitive fish species.

4.8.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A would proceed with development across the project area similar to the Proposed Action, but would produce greater surface-disturbance due to an increase in the number of well pads, access roads, and pipelines. Initial facility construction within the project area would disturb and alter an estimated 61,696 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural gas and other development. This would be an increase of approximately 31 percent relative to the Proposed Action, and would mean that over 11 percent of the project area surface had been disturbed. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery (in one to several years, depending on precipitation and effectiveness of reclamation efforts) of 24,133 acres of grass-dominated habitat. Recovery of shrubs to pre-disturbance levels would not occur during the life of the project.

The overall increase in the number of well pads and roads and the acreage initially disturbed would substantially increase habitat fragmentation. This would increase the overall habitat loss and displacement effects to wildlife species, as well as increase impediments within movement corridors. An increase in disturbance of wildlife habitat would impact all species and increase the time required, long-term, to return the functionality of the habitat in the project area. The degree of impact would vary by species.

Impacts would be the same for all species as identified in **Section 4.8.3.1** above, except as discussed below.

Pronghorn. Initially, an additional 8.6 percent of pronghorn CWR would be directly impacted by development of well pads and access roads under Alternative A (**Table 4.8-1**). Even assuming successful interim reclamation, 11.2 percent of pronghorn CWR would remain disturbed for the life of the project.

The direct loss/reduced usability of big sagebrush communities (Wyoming and mountain) would increase use on remaining shrubs, resulting in shrub health decline outside of the immediate project disturbances. This would have the greatest impact on pronghorn due to their reliance upon sagebrush habitats during winter. This level of development within pronghorn CWR and migratory routes (half again as much as the Proposed Action), compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement during the production phase, would exceed impact significance Criterion 2 and the WGFD definition of "Extreme Impact," even if standard mitigations are applied.

Mule Deer. Initially, an additional 10.5 percent of mule deer CWR would be directly impacted by development of well pads and access roads under Alternative A (**Table 4.8-2**). Assuming successful interim reclamation, as much as 12.8 percent of mule deer CWR, including migration routes, within the project area would remain disturbed for the life of the project. This level of development within mule deer CWR (almost twice that of the Proposed Action), compounded by the current condition of CWR forage, along with the additional stress and displacement during the production phase, would exceed Criterion 2 and the WGFD definition of "Extreme Impact."

Elk. No elk CWR exists in the project area; therefore, impacts to elk populations, although higher than the Proposed Action, are not expected to exceed the impact significance criteria.

Overlapping Big Game Crucial Winter Range. This alternative would impact additional acreage of overlapping CWR and correspondingly increase the likelihood of exceeding Criterion 2 and the WGFD definition of "Extreme Impact."

Raptors. With the application of the RMP (BLM 2008a) required avoidance and mitigation measures (Section 4.8.3.1), impacts are not expected to exceed the significance criteria.

Small Mammals and Neotropical Songbirds. Under this alternative, an expansion of total acres of disturbance would increase direct and indirect impacts to small birds and mammals relative to the Proposed Action. However, if standard prescribed environmental protection measures and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**) are implemented, and surface-disturbing and disruptive activities are intensively managed as required in the RMP (BLM 2008a, p. 2-53), impacts are not expected to exceed the impact significance criteria.

Fish. The types of impacts to fish would be the same as for the Proposed Action, but because of the larger surface area affected (~14,500 acres more, ~35 percent more, initial; ~5,000 acres more long-term), the magnitude of impacts would be proportionally greater.

4.8.3.3 Alternative B: Enhanced Resource Protection

The Enhanced Resource Protection (ERP) alternative was developed to avoid significant impacts to resources of concern by implementing additional protections and mitigations beyond those normally applied (e.g. BMPs, Wildlife Monitoring and Protection Plan). The enhanced resource protections would go into effect immediately and be applied to all future APDs.

The ERP alternative also recognizes that development may be more intensive than currently expected and may result in impacts occurring on wildlife habitats and populations faster than anticipated. Therefore, this alternative includes surface-disturbance and population thresholds for some specifically designated high-value resources. If these surface-disturbance or population thresholds were reached, additional protection measures would be implemented, specific to each species. The alternative would combine prescriptive and adaptive management approaches that include assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. See **Section 2.2.3** for a detailed description of this alternative.

Three general requirements are applied across the board in this alternative: (1) uniform application of dust-abatement procedures, (2) environmental awareness training for all employees and subcontractors, and (3) the BLM will require remote monitoring at well pads when a surface disturbance threshold of 5 percent is reached for applicable resources.

Under the ERP, initial facility construction within the project area would disturb and alter an estimated 45,516 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural-gas and other development. This would be a slight decrease relative to the Proposed Action. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery (in one to several years, depending on precipitation and effectiveness of reclamation efforts) of 18,249 acres of grass-dominated habitat. Recovery of shrubs to pre-disturbance levels would not occur during the life of the project.

Under this alternative, pronghorn and mule deer CWR and migratory corridors would receive enhanced protections. Enhanced protections for **Special Status Species** are discussed in **Section 4.9**.

Pronghorn and Mule Deer Crucial Winter Range and Migration Corridors. Initially, an additional 3.5 percent of pronghorn and 4.3 percent of mule deer CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action (**Table 4.8-1**). Assuming successful interim reclamation, as much as 6.1 percent of pronghorn and 6.6 percent of mule deer CWR within the project area would remain disturbed for the life of the project.

The enhanced protections for big game would decrease the degree of risk associated with impacts of the Proposed Action (**Section 4.8.3.1**). Under this alternative, APDs that would affect pronghorn and mule deer crucial winter/yearlong range and migration corridors would be submitted with an overall development plan. The development plan would be submitted either for an individual lease or several leases. It should aim at reducing surface disturbance and disturbance associated with vehicle traffic and other human activity (**Section 2.2.3**).

In addition, the following requirements would be implemented throughout mule deer and pronghorn crucial winter range or crucial winter/yearlong range and migration corridors:

- Man camps would be prohibited on BLM land;
- Noise-reduction technology would be required at compressor stations; and
- Migration corridors would be monitored to determine which fences restrict movement.

With these protection measures, the risk of big game displacement and stress from increased human activity would be expected to decrease (especially during winter) compared to the Proposed Action. Dust-abatement programs would also help maintain forage palatability adjacent to roads.

In addition to the measures discussed above, to reduce the human impact on big game in their CWR, this alternative contains surface-disturbance and population thresholds developed to maintain pronghorn and mule deer habitat and populations in the face of increasing development pressure. Surface-disturbance thresholds would reduce the impact of habitat removal and modification in CWR. The surface-disturbance thresholds are intended to reduce the amount of habitat disturbed and to mitigate disturbance through reclamation. When surface disturbance for natural gas access roads, pipelines, well pads or other facilities exceeds 5 percent of a lease within pronghorn or mule deer CWR, the BLM would:

- Evaluate reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of CWR is needed at this time. If so, begin implementation.
- Install remote monitoring at all well pads.

If surface disturbance reached 10 percent of pronghorn or mule deer CWR in a lease, habitat improvement projects would be required in addition to the requirements above. The BLM would establish an interagency CD-C consultation group and consult with them to determine which projects would be beneficial. These projects could include, but would not be limited to:

- Water developments.
- Vegetation treatments such as herbicide treatments, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs or trees, fencing, establishing food plots, etc.

If the WGFD were to express formal written concern that the herd within the project area was declining at an accelerated rate, all new APDs on leases within pronghorn and mule deer CWR in the CD-C project area would require an approved mitigation plan if the population decrease in those Herd Units were attributable in whole or in part to oil and gas development. The plan would include, but not be limited to:

- Evaluation of reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation.
- Implementation of BLM-approved habitat-improvement projects such as water developments or vegetation treatments. (BLM may coordinate habitat improvement projects among multiple Operators.) New well pads would not be authorized without Operator participation in habitat-improvement projects.
- Limitation of the number of well pads to no more than four per section within CWR to maintain habitat effectiveness.

If the population status of a species were to change in the future, additional data would be collected and additional protective measures would be developed.

With these protective measures in place the impact from habitat removal and modification in CWR is expected to decrease compared to the Proposed Action. Monitoring of population numbers would ensure that any population decline is identified early on and mitigation applied. This level of development within big game CWR, including migration routes, compounded by the current condition of CWR forage, along with the additional stress and displacement during the production phase, would exceed the WGFD definition of "High Impact" for both species, with the possibility of exceeding the WGFD definition of "Extreme Impact" and would thus exceed significance Criterion 2.

Overlapping Big Game Crucial Winter Range. As in the discussion of both pronghorn and mule deer, the additional protections available under this alternative would likely reduce the impacts to overlapping big game CWR, including migratory routes, but would still exceed Criterion 3 and the WGFD definition of "High Impact," with the possibility of exceeding the WGFD definition of "Extreme Impact."

Raptors. Under this alternative, no additional species-specific protections beyond those required by the RMP (timing and surface stipulations) and BMPs (**Appendix C**) would apply. Because of the buffers and restrictions on activity around raptor nests and the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impact from Alternative B is not expected to exceed the significance criteria.

Small Mammals and Neotropical Songbird Nests. Under this alternative, no additional species-specific protections beyond those required by the RMP (timing and surface stipulations), BMPs (**Appendix C**) and the Migratory Bird Treaty Act would apply. With the application of these mitigation measures and implementation of timely reclamation activities, it is anticipated that local population productivity would be maintained and the impact from Alternative B is not expected to exceed the significance criteria.

Upland Game Birds. No enhanced protection measures would apply; however, the mourning dove is likely to benefit from protection measures under this alternative. Impacts to greater sage-grouse under this alternative are discussed in detail in **Section 4.9.3.4.**

Fish. The Enhanced Resource Alternative Protections for the Muddy Creek Corridor/Watershed described in **Section 2.2.3.4** could substantially reduce project impacts to fish. The sources of these reductions would include the following protections:

- For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 0.25 mile of Red Wash, springs, wells, and wetlands. The required avoidance distance would be further increased on perennial streams to 0.5 mile. Exceptions would only be granted by the BLM based on environmental analysis and site-specific engineering and mitigation plans. Only actions within areas that could not be avoided and that would provide protection for the resource identified would be approved. In-channel activities would be restricted to the low-flow period.
- Current monitoring on upper Muddy Creek would be extended to Lower Muddy Creek in the CD-C area. This requirement would bring lower Muddy Creek into conformance with the monitoring being done for upper Muddy Creek and other drainages within the Atlantic Rim project area. If results of the monitoring program showed impacts to sensitive fish habitat, the BLM and an interagency CD-C consultation group would determine whether habitat-improvement projects should be implemented. The projects could include, but would not be limited to, increasing the number of drainage features along roads, increasing in-stream cover for fish, and other measures as applicable.
- A monitoring plan for Bitter Creek watershed will be designed.

The following requirements related to **selenium and salinity** for well locations and operations would also be implemented:

- No surface discharge of produced waters within the Muddy Creek and Bitter Creek watersheds.
- Line all reserve pits in the Muddy Creek and Bitter Creek watersheds.

These protections, however, only apply to BLM land and only about 36 percent of Muddy Creek within the project area is on BLM land, while 51 percent and 13 percent are on private and state land, respectively. An unintentional consequence of these protections being applied only to BLM land could be to increase drilling activities on private and state land. Such development on private and State land along Muddy Creek could completely negate the enhanced resource protections on BLM land along Muddy Creek. To preclude this possibility, the Operators and the state should make a commitment to apply these same enhanced resource alternative protections to private and state land along Muddy Creek. Without this commitment, it is possible that the impacts to fish for this alternative would be the same as for the Proposed Action.

4.8.3.4 Alternative C: Surface Disturbance Cap with High and Low Density Development Areas

This alternative designates parts of the project area for high-density development—those areas that have seen the greatest natural-gas development to date (**Map 2-1**). Within the high-density development areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance allowed at any one time in a section of public land. For the remainder of the project area—the low-density development areas—

the cap would be 30 acres per public land section. Once interim reclamation on the development is determined to be successful, the cap would be increased by the number of acres deemed to have achieved successful *interim* reclamation.

Under Alternative C, the types of impacts to wildlife species and their habitats would be similar to those described for the Proposed Action (**Section 4.8.3.1**). The cap, however, places a limit on the amount of unreclaimed surface disturbance at any one time in a section of federal land. This requirement should encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on wildlife and their habitat would be less. Maximum surface disturbance for this alternative is estimated to decrease by 4,245 acres in the short term to 42,955 acres, a 9-percent reduction from the Proposed Action. Long-term disturbance would decrease by 1,543 acres, to 17,318 acres.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 5,299 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of about 13 percent. Therefore, fewer access roads would be developed and habitat fragmentation and other adverse impacts would be less extensive than for the Proposed Action. However, disruptive activities are expected to continue and may increase in high-density development areas, accompanied by associated adverse affects on population productivity and survival in localized areas, when compared to the Proposed Action.

Pronghorn. Initially, an additional 3.3 percent of pronghorn CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action (**Table 4.8-1**). Assuming successful interim reclamation, approximately 6 percent of pronghorn CWR within the project area would remain disturbed for the life of the project.

Of the estimated 90,310 acres of CWR and associated migratory routes in the project area (**Map 3.8-2**), 30 percent would be in the high-density development area and 70 percent outside. Therefore, no more than 30 acres per section could be unreclaimed at any one time in the majority of pronghorn CWR. In the 30 percent of pronghorn CWR located within the high-density development, no more than 60 acres per section could be unreclaimed at any one time. Due to the surface disturbance cap, more directional wells would be drilled, decreasing habitat fragmentation from that of the Proposed Action and also reducing the acreage of indirect impact to pronghorn, especially in the low-density areas. Since private and state lands would not be subject to the cap, surface disturbance in those sections would not be limited, so the benefits of less fragmentation may not be as prevalent at the landscape level. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. In addition, disruptive activities are expected to continue and may increase, in high-density areas, accompanied by associated adverse affects on population productivity and survival in localized areas, when compared to the Proposed Action.

Mule Deer. There are 17,849 acres of mule deer CWR within the project area, located in the southeastern portion (**Map 3.8-4**). Of this acreage, approximately 25 percent is within the high-density development area and 75 percent outside. Initially, an additional 4.1 percent of mule deer CWR and associated migratory routes within the project area would be directly impacted by development of well pads and access roads under Alternative C (**Table 4.8-2**). Assuming successful interim reclamation, approximately 6.4 percent of mule deer CWR within the project area would remain disturbed for the life of the project. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. In addition, disruptive activities are expected to continue and may increase in high-density areas, accompanied by associated adverse affects on population productivity and survival in localized areas when compared to the Proposed Action.

Alternative C is expected to exceed significance Criterion 2 (substantial disruption or irreplaceable loss of vital and high-value habitats) and the WGFD definition of "High Impact" for pronghorn and mule deer CWR and associated migration routes in high-density development areas.

Overlapping Big Game Crucial Winter Range. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. However, disruptive activities are expected to continue and may increase if high-density development were to occur in CWR.

Raptors, Small Mammals, Upland Game Birds, Neotropical Migratory Birds. In areas of low-density development, impacts to these species should be less than the Proposed Action since the amount of surface disturbance, both initial and long-term, would decrease. In high-density development areas impacts would likely be greater on some species when compared to the Proposed Action. For example, recent research (Gilbert and Chalfoun 2011) found that when natural gas well density reached more than 8 wells per square kilometer (> 20 wells per square mile) the observed numbers of Brewer's sparrow, sage sparrow, and vespers sparrow declined. In the same study, horned lark numbers increased while sage thrashers showed no effect as a result of high-density well development (Gilbert and Chalfoun 2011).

The impact from Alternative C is expected to exceed the significance criteria in high-density areas; however, the application of the RMP general wildlife management action #13 (BLM 2008a, pg. 2-53), "Surface-disturbing activities and disruptive activities will be intensively managed. BMPs (Appendix 14 and 15) will be applied to surface-disturbing and disruptive activities to maintain or enhance upland game bird species, neotropical and other migratory bird species, and their habitats," may serve to reduce these impacts and thus the significance criteria may not be exceeded.

Fish. Within the project area, only a small part of Muddy Creek would be located in the high-density area (**Map 2-1**). Most of Muddy Creek is in the low-density area. In addition, where Muddy Creek is within the high-density areas, it primarily flows through private land. Because surface disturbance would be capped at 30 acres per section in the low-density area and at 60 acres per section in the high-density area, impacts to fish in Muddy Creek derived from surface disturbance should be decreased compared with the Proposed Action. However, without the added types of protections for Muddy Creek discussed in **Section 4.8.3.3** for Alternative B, the types of impacts to fish would be similar to those for the Proposed Action, although the magnitude of impacts should be less.

4.8.3.5 Alternative D: Directional Drilling

Under Alternative D, the types of impacts to wildlife species and their habitats would be similar to those described for the Proposed Action (**Section 4.8.3.1**) though on a more localized level. This alternative requires that all future natural gas wells on federal mineral estate and surface be drilled from multi-well pads. In public land sections that have already had development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted in these leases. In sections in which there is no existing development, one new well pad would be permitted for all future development. One road and pipeline corridor on the lease or section would be permitted. The objective of this alternative is to minimize surface disturbance, thereby reducing habitat loss and wildlife disturbance. This alternative also reduces habitat fragmentation. Total surface disturbance for this alternative would decrease by 10,751 acres to 36,499, a reduction of about 23 percent from the Proposed Action. Long-term disturbance is estimated to decrease by 3,908 acres to 14,952 acres, a reduction of about 21 percent from the Proposed Action.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 4,032 compared to the estimated 6,126 well locations of the Proposed Action for a reduction of about 34 percent. Therefore, fewer access roads and pipelines would be developed and habitat fragmentation and indirect impacts would be less extensive than for the Proposed Action.

Pronghorn. Initially, an additional 3.0 percent of pronghorn CWR and associated migration routes within the project area would be directly impacted by development of well pads and access roads under Alternative D (**Table 4.8-1**). This is a decrease from the 3.6 percent increase in disturbance anticipated under the Proposed Action. As a result of the extended timeframe needed to fully restore the shrub component of the CWR, as much as 5.6 percent of pronghorn CWR within the project area would remain disturbed for the life of the project; however, various seral stages of shrub habitat would be available over the life of the project and would serve as pronghorn forage.

Due to the multi-well pad requirement, fewer well pads would be constructed, decreasing habitat fragmentation as compared to the Proposed Action. Alternative D would also reduce the extent of indirect impacts to pronghorn, especially in the lower-density development areas. Since private and state lands would not be subject to the multi-well pad requirement, surface disturbance in those sections would not be limited, so the benefits of reduced habitat fragmentation may not be as evident at the landscape level. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD definition (WGFD 2010a). The application of mitigation (Timing Stipulations) precluding activity in crucial ranges and associated migration routes during the winter season should serve to minimize impacts to the species from these long-term/long-duration well sites and their noise and enhanced activity levels.

Mule Deer. An additional 3.7 percent of mule deer CWR and associated migration routes within the project area would be directly impacted by development of well pads and access roads under Alternative D (**Table 4.8-2**). Due to the extended timeframe needed to fully restore the shrub component of the CWR, approximately 6.0 percent of mule deer CWR within the project area would remain disturbed for the life of the project; however, various seral stages of shrub habitat would be available over the life of the project and would serve as mule deer forage. The impacts would be similar to those described for pronghorn above. However, a greater percentage of the Mule Deer CWR is outside of the checkerboard, so the landscape-scale benefits of this alternative should be greater for mule deer than for pronghorn. Impacts under this alternative are expected to be less than those of the Proposed Action, and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD (2010) definition. The application of mitigation (Timing Stipulations) precluding activity in crucial ranges and associated migration routes during the winter season should serve to minimize impacts to the species from these long-term/long-duration well sites and their noise and enhanced activity levels.

Overlapping Big Game Crucial Winter Range. Impacts under this alternative are expected to be less than those of the Proposed Action, and would avoid significance under Criterion 2 and meet the WGFD definition of "Moderate Impact" (WGFD 2010a), provided disturbance is limited to less than 20 acres per square mile.

Raptors, Small Mammals, Upland Game Birds, and Neotropical Migratory Birds. Impacts to these species should be less than for the Proposed Action since the amount of surface disturbance, both initial and long-term, would decrease. Noise from drilling and completion activities occurring at long-duration multi-well pads could represent a localized negative impact to a sub-set of sensitive receptors (i.e. nesting raptors, sage-grouse) due to the increased period of time required for drilling at a single location. Reduced surface disturbance and habitat fragmentation resulting from multi-well pads comes with an increase in decibel level and frequency of that noise, as well as the extended period of time over which large haul-truck activity would occur. However, application of the following RMP general wildlife management action #13 (BLM 2008a, p. 2-53) would also serve to provide habitat protection for small mammal species: "Surface-disturbing activities and disruptive activities will be intensively managed. BMPs

(Appendix 14 and 15) will be applied to surface-disturbing and disruptive activities to maintain or enhance upland game bird species, neotropical and other migratory bird species, and their habitats." With the application of these mitigation measures, the impact from Alternative D is not expected to exceed the significance criteria.

Fish. The types of impacts to fish for this alternative would be similar to those for the Proposed Action. Total surface disturbance for this alternative, however, would be about 23 percent lower than for the Proposed Action; therefore, the magnitude of impacts to fish should be proportionately less.

4.8.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new surface disturbance and no new impacts on wildlife habitat. Wildlife would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of browse and forage caused by dust.

4.8.4 Impact Summary

The project, as proposed, would disturb and alter approximately 47,200 acres of wildlife habitat over the 15-year project development phase, in addition to the 60,176 acres previously disturbed by natural gas and other development. Reclamation of disturbed areas should recover to grass-dominated habitats in one to several years, depending on precipitation and effectiveness of reclamation efforts. Shrub habitats would not reach pre-disturbance levels during the life of the project; however, a variety of shrub age classes would be available as forage and cover throughout the project area as reclaimed areas mature. Therefore, wildlife dependent on mature shrub habitats would be impacted most by habitat loss. In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for the critical times of year have been developed for the most sensitive species and are generally implemented during the development phase. During the production phase, the application of BMPs identified in Appendix 15 of the RMP (BLM 2008a) would work to alleviate impacts to the species. This would likely serve to reduce stress and help maintain animal condition and improve winter survival of the animals as they travel farther or are displaced to lower-quality range. Other impacts from natural gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collision between vehicles and wildlife.

The **Proposed Action** is expected to exceed significance under Criterion 2 (substantial disruption or irreplaceable loss of vital and high-value habitats) and the WGFD definition of "High Impact" for pronghorn and mule deer CWR and associated migration routes. Other species (raptors, small mammals, songbirds, and fish) should be protected sufficiently by the COAs, RMP requirements, and BMPs to avoid exceeding the significance level.

Alternative A: 100-percent Vertical Drilling would affect an additional 14,496 acres of habitat compared to the Proposed Action. The impacts described above would be intensified under this alternative; Criterion 2 and the WGFD definition of "Extreme Impact" would likely be exceeded for pronghorn and mule deer CWR, migration routes, and overlapping crucial habitats.

Alternative B: Enhanced Resource Protection was designed to reduce impacts of development on those species or habitats that are most vulnerable to an infill oil and gas project. There would be a slight reduction (1,684 acres, about 3.5 percent) in the amount of habitat disturbed under this alternative compared to the Proposed Action. Anticipated impacts to mule deer and pronghorn CWR and associated migration routes would be reduced compared to the Proposed Action through the application of additional mitigation requirements. That said, impacts to mule deer and pronghorn CWR and migration routes are expected to exceed significance under Criterion 2 and the meet the WGFD definition of "High Impact"

(WGFD 2010a). Other wildlife species would also benefit from this alternative and its additional protection of the Muddy Creek watershed, riparian areas, and playas.

Alternative C: Cap on Surface Disturbance, 60 or 30 Acres per Section seeks to reduce habitat disturbance and reward successful reclamation. This alternative is expected to impact 4,245 fewer acres than the Proposed Action. It should reduce the impacts to all species below those of the Proposed Alternative, but is still expected to exceed the level of significance under Criterion 2 for mule deer and pronghorn CWR. Anticipated impacts would meet the WGFD definition of "High" for both pronghorn and mule deer, as well as "High" for overlapping crucial ranges (WGFD 2010a), primarily in areas of high-density development.

Alternative D: 100 Percent Directional Drilling is expected to reduce surface disturbance by 10,751 acres (about 23 percent) compared to the Proposed Action. Impacts under this alternative are expected to be less than those of the Proposed Action, and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD (2010) definition.

Alternative E: No Action is assumed to result in no new surface disturbance and no new impacts on wildlife habitat because no further natural gas development would occur within the CD-C project area.

4.8.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The amount of wildlife habitat would be unavoidably reduced on a short- to long-term basis as a result of the surface disturbance related to construction of well sites and associated facilities on public, state, and private lands within the CD-C project area. The quality and function of habitat would also be reduced due to intermediate- to long-term alterations in the vegetative composition of habitats and the continuing traffic and human presence associated with natural gas production activities. These impacts would be in addition to historical impacts from prior surface disturbance. Proposed and existing habitat alteration together would represent ten percent or more of the CD-C project area. The impacts on mule deer and pronghorn habitat are expected to exceed significance under Criterion 2—management actions that result in substantial disruption or irreplaceable loss of vital and high-value habitats—for the Proposed Action and all action alternatives except Alternative D.

Application of additional mitigation measures such as those listed below, many of them found as elements of Alternative B, could work toward reducing the impacts of the Proposed Action and the action alternatives. In many circumstances the RFO is already requiring these mitigation measures as standard Conditions of Approval (COAs) (M. Read, pers. com., January 2012).

- Minimizing human presence at well sites after they have been put into production by remote monitoring of project facilities and gating of roads;
- Development planning for an entire lease or several leases;
- Noise-reduction technology, such as hospital grade mufflers, sound walls or soundproof buildings, or adding silencers to cooling fans;
- Monitoring of migration corridors to determine which fences restrict movement and fences modified to reduce impacts to migrating big game species;
- Habitat improvement projects such as water developments and vegetation treatments; and
- Training programs for field workers to raise their awareness of activities that cause stress to big game, times of day when collisions are most likely, and other programs as necessary.

4.9 SPECIAL STATUS SPECIES

4.9.1 Introduction

Special-status species are (1) those listed as Threatened or Endangered by the USFWS under the Endangered Species Act (ESA) of 1973 or those that are candidates or have been petitioned for listing and (2) those designated by the BLM State Director as sensitive (BLM 2010). Species are designated as sensitive if their numbers are declining so rapidly that ESA listing might be necessary, or if they have typically small or dispersed populations or inhabit unique habitats.

Eight species listed by the USFWS as threatened, endangered, proposed, or candidate are present, or potentially are present, within or near the CD-C project area (USFWS 2010; **Table 3.9-1**). Two are mammals, and one is a bird. Four of the species are fish found downstream of the project area in the Colorado River system which may be impacted if water depletions occur or if environmental contaminants are increased within the system. One plant listed as USFWS-threatened (Ute ladies'-tresses) may occur within the project area

Twenty-eight species that have been designated as sensitive by BLM are present or potentially present within or near the project area: eight mammals, 10 birds, two amphibians, four fish, and four plants (**Table 3.9-3**).

A Biological Assessment (BA) will not be included in this draft document. Once a Preferred Alternative is selected, the BA will be finalized and sent to the USFWS for a Biological Opinion (BO).

4.9.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) management objectives for special status wildlife and fish species are the same as those presented for wildlife (**Section 4.8.2**). The RMP also defines the following impact significance criteria that are used in this document to assess the impacts associated with the Proposed Action and alternatives (BLM 2008b). Impacts to special status wildlife and fish species would be considered significant if any of the following were to occur:

- Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
- Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.
- Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status. Habitat function means the arrangement of habitat features and the capability of those features to sustain species, populations, and diversity of wildlife over time (WGFD 2010a).

Impacts to special status plant species would be considered significant if any of the following were to occur:

- Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or if corrective actions were beyond the scope of the RMP.
- The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under ESA.
- Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.

Additionally, the RFO has determined that the following impact significance criterion should be included for this project:

- Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species.

The degree of impact that constitutes "substantial" loss of habitat or disruption of life-history requirements is quantified for some wildlife species in the habitat and population thresholds described in the Enhanced Resource Protection Alternative (Alternative B).

4.9.3 Direct and Indirect Impacts

4.9.3.1 Proposed Action

Habitats directly and indirectly affected by the proposed project are the same as those discussed for general wildlife (**Section 4.8.3**).

Standard environmental protection measures prescribed as Conditions of Approval (COAs) or used as BMPs (**Appendix C**) would be implemented under the Proposed Action and all alternatives. The Wildlife Monitoring and Protection Plan (**Appendix I**) would be followed to detect, prevent, and reduce impacts to wildlife and fish species throughout the life of the project. These protective and mitigative measures would serve to minimize the impacts of development activity on public land managed by the BLM. However, the measures do not apply to private and state lands, which encompass 46 percent of the project area. Therefore, the effectiveness of the mitigation is limited when considering a landscape approach, particularly in the checkerboard section of the project area.

Threatened, Endangered, Proposed or Candidate Wildlife Species

Habitat for **Canada lynx** is not found in the project area and their potential occurrence is described as *Very Unlikely* (**Table 3.9-3**). This species will not be further addressed in this document.

Black-footed ferret. The presence of black-footed ferret in the project area is very unlikely (see **Section 3.9.1.1**). The Proposed Action would likely disturb colonies of white-tailed prairie dogs, which are the black-footed ferret's primary habitat and prey source in this area. Surveys for black-footed ferrets may be required before ground-disturbing activities within mapped prairie-dog colonies located in the Continental Divide, Dad, and Desolation Flats non-block clearance areas. The remaining white-tailed prairie-dog colonies within the CD-C project area are within the USFWS designated block clearance area, where surveys for black-footed ferrets are no longer warranted. The Proposed Action is not expected to exceed the impact significance criteria for black-footed ferret populations.

Greater sage-grouse. The impacts with the potential for the greatest negative effects to greater sage-grouse populations include: loss of nesting or brood-rearing habitat, displacement or additional stress due to increased human activities, excessive noise levels proximal to occupied leks, removal or modification of severe winter habitats, and increased predation due to an increased number of roosting sites for raptors on power poles and other man-made structures.

Approximately 60 percent of the CD-C project area is comprised of sagebrush and other mesic shrub-dominated vegetative classes, which represent identified greater sage-grouse nesting habitat, as defined by the RFO **(Map 3.9-2**). Recovery of shrubs in locations that have been disturbed by development to pre-disturbance levels would not occur during the life of the project. However, younger age classes of sagebrush with grass and forb components may serve as nesting and brood-rearing habitat for grouse. Populations have persisted in many areas where energy development is ongoing, yet research has shown that development can influence declines in lek occupancy, lek attendance, and possibly in population persistence (Braun *et al*. 2002, Aldridge and Boyce 2007, Harju *et al.* 2010, Walker *et al*. 2007). Sage-grouse may repopulate an area following energy development, but may not attain population levels that occurred before development (Braun 1998). Likelihood of abandonment is higher when nests are disturbed early in the incubation period (Remington and Braun 1991).

In the generally accepted body of literature, the following are potential sources of indirect impact to greater sage-grouse and their habitats, all of which could lead to lower productivity and long-term decline in the population of this species in the project area (WGFD 2010a):

- Habitat loss resulting from dust settling on vegetation (**Section 4.6**) and reducing the palatability and production of forbs and shrubs used by grouse.
- Visual intimidation from high-profile structures.
- Potential loss of sagebrush and understory due to over-browsing or grazing by wild ungulates, livestock, and wild horses on ranges shared with grouse, reducing quality and abundance of nesting, brood-rearing and winter habitats, as well as forage.
- In areas of Extreme Impact (more than 3 well pad locations or 60 acres of disturbance per square mile within 2 miles of an occupied lek in non-core population areas; WGFD 2010a), as development becomes more intense, the impact zones surrounding each well pad, production facility, and road corridor begin to overlap, thereby reducing habitat effectiveness over much larger, contiguous areas. Human, equipment, and vehicular activity and noise impacts are also more frequent and intensive (WGFD 2010a).
- Noise levels interfere with bird communication during mating periods resulting in lower bird attendance at leks.
- Disruptive human activities alter normal bird behavior, increase nest abandonment, and may displace birds into less-desirable habitats.
- Construction of facilities and roads creates a long-term loss of grouse habitat and increases fragmentation of remaining habitat.
- Increased predation by raptors and corvids due to facilities such as well houses, compressor stations, and above-ground power lines serving as perches.
- Roads may also serve as travel corridors for some predators.

Refer to **Section 3.9.1.1, Greater sage-grouse,** for a complete discussion of the protective measures in place throughout the project area for the conservation of greater sage-grouse and its seasonal habitats. The conservation strategy for greater sage-grouse continues to evolve and the requirements that would be applied to proposed activities in sage-grouse habitat will change similarly. **Map 3.9-2** shows the core and non-core sage-grouse population areas within and near the project area. Fifty-four of the project area's leks are in non-core areas and 31 are in state-designated core areas.

The Proposed Action and alternatives have been analyzed relative to the requirements of IM WY-2012-019 (BLM 2012c) and the national IM 2012-043 (BLM 2012b) which impose limits for surface-disturbing and disruptive activities in sage-grouse core and non-core areas. The conservation guidelines provided in the WGFD Recommendation for Development of Oil and Gas Resources within Important Wildlife Habitats (WGFD 2010a) were also considered. IM WY-2012-019 (BLM 2012c) calls for consideration and evaluation of greater sage-grouse conservation measures that are the same as or in some cases more stringent than those of the Rawlins RMP. The Rawlins RMP prohibits *surface-disturbing activity* on and within 0.25 mile of the perimeter of an occupied lek year-round in non-core areas and increases the distance to 0.6 of a mile from the perimeter of an occupied lek in designated core. The IM calls for consideration of the same. The RMP has an associated timing limit on *disruptive activities* within 0.25 miles of an occupied lek from 6:00 pm to 9:00 am from March 1 to May 20; IM WY-2012-019 calls for consideration of extending the distance of that timing stipulation to 0.6 mile in core areas. Under the IM, avoidance of surface-disturbing *and/or disruptive activities* within all core area nesting and early brood-rearing habitat (**Map 3.9-2)** from March 1 to July 15 (timing period as found in the RMP) is to be considered. The RMP applies that same level of protection to identified nesting and early brood-rearing habitat, regardless of distance from the lek, in non-core areas from March 1 to July 15 (M. Read, pers.com. February 2012). BLM is currently working to amend the RMP as it relates to greater sage-grouse conservation (BLM 2010c).

IM WY-2012-019 also includes a density goal for core areas that requires maintenance of sagebrush communities by maintaining or reducing the existing level of density of energy production and/or transmission structures on the landscape, **or** not exceeding one energy production location and/or transmission structure per 640 acres. The one location and cumulative value of existing disturbances in the area would not exceed 5 percent (32 acres) of sagebrush habitat within those same 640 acres.

IM WY-2012-019 provides protection for mapped or modeled winter habitat/concentration areas from surface-disturbing activities from November 15 to March 14. Activities would be allowed outside this period and winter habitat could still be affected or removed by surface disturbance outside the timing limitation. Loss of this habitat could lead to lower productivity and long-term decline in the population of this species. As winter concentration areas are identified and mapped in the CD-C project area BLM would apply seasonal stipulations and habitat protection measures (BLM 2008a and 2012b).

Habitat loss would continue around leks outside the 0.25-mile protected buffer in non-core areas and the 0.6-mile buffer in core areas, including within the buffer zones outside the seasonal protection. In non-core areas, application of the standard for avoidance of potential nesting and brood-rearing habitat as well as the BLM standard COAs, BMPs (**Appendix C**), Timing Limitations, and Mitigation (**Appendix I**) would reduce the impact to sage-grouse but impact to those populations (dust, noise, and continued human presence during the drilling and production phase) would still be anticipated. It is expected that greater than three wells or 60 acres of disturbance per square mile could occur within the 2-mile radius of some non-core leks but not all. In some areas this level of disturbance has already been exceeded; this would be considered an "Extreme Impact" relative to those individual leks (WGFD 2010). In core population areas, habitat disturbance would be limited to less than 5 percent of a 640-acre section or one disruption (i.e. well location) per section (square mile), averaged over the specific sage-grouse impact (i.e. DDCT) analysis area. Provided the protections for greater sage-grouse found in IM WY-2012-019 and the Rawlins RMP are applied, it is not expected that the significance criteria would be exceeded in core areas but localized exceedance of Criteria 1, 2, and 4 could occur in non-core areas. Sage-grouse populations in non-core areas may experience localized substantial loss of habitat, biological integrity or function, decreased viability or increased mortality or substantial disruption of life-history requirements. By definition non-core areas are not "critical habitats;" therefore Criteria 3 would not be exceeded.

Threatened and Endangered Fish Species

Four federally Endangered fish species may occur as downstream residents of the Colorado River system: **Colorado pikeminnow** (*Ptychocheilus lucius*), **bonytail** (*Gila elegans*), **humpback chub** (*Gila cypha*), and **razorback sucker** (*Xyrauchen texanus*) (USFWS 2003). Suitable habitat for these species does exist downstream of the project area in the Little Snake, Yampa, and Green Rivers. Because the Colorado pikeminnow is found in the Little Snake River, it could migrate into Muddy Creek. Muddy Creek, however, is not considered suitable habitat for this species. The action alternatives are not expected to affect this habitat, provided that mitigation measures for water resources and soils outlined in this document are implemented. Although they currently exist only downstream of the project area, water draining from the project area affects the downstream habitat for these species. Under the Proposed Action, the sources of risks to these fish species are water depletions, discharges of produced water, and spills of toxic materials.

Water Depletions. The Upper Colorado River Endangered Fish Recovery Program is a partnership working to recover the endangered fish of the Upper Colorado River Basin. The goal of recovery is to achieve natural, self-sustaining populations of the endangered fish so that they no longer require protection under the ESA. Under the Recovery and Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River Basin, "any water depletions from tributary waters within the

Colorado River drainage are considered as jeopardizing the continued existence of these fish." Tributary water is defined as water that contributes to instream flow habitat. Depletion is defined as water which would contribute to the river flow if not intercepted and removed from the system.

The FWS has determined that progress made under the RIP has been sufficient to merit a waiver of the depletion fee, which helps fund the RIP, for depletions of 100 acre-feet per year or less (Memorandum dated March 9, 1995 to Assistant Regional Director, Ecological Services, Region 6, from Regional Director 6, "Intra-Service Section 7 Consultation for Elimination of Fees for Water Depletions of 100 acre-feet or Less from the Upper Colorado River Basin"). The Proposed Action, however, may deplete an average of 510 acre-feet of water per year (**Section 4.4.4.1**) and therefore a one-time depletion fee of approximately $20 per acre foot may be required. The figure of 510 acre-feet is the amount of water estimated to be withdrawn from aquifers in the Wasatch formation that may have contact with and contribute to the Little Snake River and its tributaries, including Muddy Creek. The extent to which the groundwater withdrawals constitute a depletion and any depletion fee will be determined in consultation between BLM and FWS before the Final CD-C EIS.

Discharges of Produced Water and Spills of Toxic Chemicals. Produced water from the project area would not be discharged to Muddy Creek within the Little Snake River drainage; therefore, produced-water discharges will not pose a risk to these species. Accidental releases (e.g., spills) of toxic chemicals also could occur. However, accidental releases of toxic chemicals should become highly diluted before they would reach any downstream waters where these species occur; consequently, the risks from such occurrences are negligible (BLM 2007). For any future proposals involving CBNG, the proposed treatment and disposal of produced water will be analyzed in a separate NEPA document.

Threatened and Endangered Plant Species

The USFWS (2002) determined that the threatened Ute ladies'-tresses (*Spiranthes diluvialis*) may be present within the CD-C project area. However, because extensive surveys failed to document the presence of Ute ladies'-tresses within the project area, impacts to this plant are not anticipated. The possible presence of this federally listed plant species on public lands would be determined by the presence of appropriate riparian habitat. The application of the COA requiring avoidance of riparian areas by 500 feet serves to protect this species. In the unlikely event that the species is found within the project area, potential impacts to the species on public land would be addressed through consultation with the USFWS. In particular, those sites would be avoided to prevent any impacts. Therefore, decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate plant species or adverse alteration of their critical habitats, if identified, on public lands within the project area would not occur with implementation of the Proposed Action. Because the likely presence of this species on private or state lands is low, the likelihood of direct impacts on those lands is also low.

Sensitive Wildlife Species

The following sensitive wildlife species have not been found within the project area and would likely not be impacted by the project: black-tailed prairie dog, fringed myotis, long-eared myotis, spotted bat, Townsend's big-eared bat, Baird's sparrow, Columbian sharp-tailed grouse, northern goshawk, peregrine falcon, and boreal toad. These species will not be discussed further. Nevertheless, should populations be found, mitigation would be applied to avoid disruption of habitat function or of life history requirements. Species that may be affected by the Proposed Action are discussed below.

Sensitive Mammal Species

Fringed myotis, long-eared myotis, spotted bat, and Townsend's big-eared bat have the potential to occur in the project area even though their preferred roosting and hibernation habitats are not found in the project area; however, equipment stack caps would be required as a mitigation for these species in an effort to preclude incidental roosting. No other adverse effects are anticipated at this time, and Criterion 2 would not be exceeded.

Pygmy rabbits are patchily distributed throughout the project area (WYNDD 2007, HWA unpublished data). The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance of some portions of pygmy rabbit habitat and burrow systems. The RFO has a survey and avoidance policy for pygmy rabbit burrow systems. Therefore, direct impacts to pygmy rabbits, in the form of lost burrows and foraging habitat, are not expected to exceed the impact significance criteria.

Swift foxes have been documented within the project area in the past; however, sightings in the area have not occurred in recent years. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to some suitable foraging habitat. Should populations be found, mitigation would be developed to protect them. Therefore, impacts are not expected to exceed the impact significance criteria.

White-tailed prairie-dog colonies covering approximately 8,818 acres have been mapped within the project area to date (BLM unpublished data, HWA unpublished data). The Rawlins RMP requires that development avoid prairie-dog colonies whenever possible. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to some portions of these prairie-dog colonies. Direct impacts to prairie dogs, in the form of lost burrows and foraging habitat, are not expected to exceed the impact significance criteria.

Wyoming pocket gophers are found within the project area. This was established by trapping efforts in 2008–2010 (WYNDD unpublished data, HWA unpublished data). Based on those trapping efforts, the availability of suitable habitat, and the known distribution of the species, Wyoming pocket gophers are likely to be found in additional areas of suitable habitat within the project area. The BLM requires site-specific surveys to determine if a project proposal should be relocated in an effort to avoid Wyoming pocket gopher mounds whenever possible. Therefore, impacts are not expected to exceed the impact significance criteria.

Sensitive Bird Species

Bald eagles have been observed within the project area primarily from November through March (WGFD 2006, HWA unpublished data). No bald eagle nests or nesting habitat occur within the area, and the nearest potential nesting habitat is found along the Little Snake River, approximately 9 miles south of the project area. Bald eagles may forage within the project area during the winter months because of carrion associated with pronghorn, mule deer, and elk winter ranges. The potential for vehicle-animal collisions would increase as a result of greater vehicle traffic associated with the project. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed wildlife on and adjacent to the access roads is an attractant. Eagles feeding on these carcasses are in danger of being struck by moving vehicles. However, such occurrences would be rare and effects on the population are not expected to exceed the impact significance criteria.

Brewer's sparrow, loggerhead shrike, sage sparrow, and **sage thrasher** are the predominant shrub-dependent songbirds that occur within the project area (WGFD 2006, WYNDD 2007, HWA unpublished data). In addition to the removal of habitat, activities under the Proposed Action may displace birds to lower-quality habitats, which could lead to a reduction in reproduction rates or an increase in predation. Recent research (Gilbert and Chalfoun 2011) found that when natural gas well density reached more than eight wells per square kilometer (more than 20 wells per square mile) the observed numbers of Brewer's sparrow, sage sparrow, and vespers sparrow declined. In the same study horned lark numbers increased while sage thrashers showed no effect as a result of high-density well development (Gilbert and Chalfoun 2011).

Burrowing owls are found throughout the project area (WGFD 2006, WYNDD 2007, BLM unpublished data). Surveys for this species should be conducted before construction in prairie-dog colonies during the owl breeding/nesting season. If nesting owls are found, the same measures used for protection of other raptor species (**Appendix I**) will be applied. Given these precautionary measures, the Proposed Action is not expected to exceed the impact significance criteria for this species population.

Ferruginous hawks are the most abundant raptor species nesting within the project area (BLM unpublished data). The primary impact to ferruginous hawks from project activities is disturbance during nesting, which could result in reproductive failure. This impact would be mitigated by implementing measures in **Appendix C,** such as no surface occupancy (i.e. well locations, roads, ancillary facilities, or other surface structures) year-round within 1,200 feet of a ferruginous hawk nest and a seasonal restriction on surface disturbing and other disruptive activity from March 1 to July 31 within 1 mile of a ferruginous hawk nest. Nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone for nesting/foraging ferruginous hawks. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests, but the impacts are not expected to exceed the criterion.

Long-billed curlew is an uncommon summer resident, but may be locally common in suitable habitat (WGFD 2004a). The long-billed curlew has been recorded once within the project area (WGFD 2007) and is not expected to nest within the area due to lack of habitat. No significant impacts to this species are expected with implementation of the Proposed Action.

Mountain plover. The impacts with the potential for the greatest effects to mountain plover populations include: loss of nesting habitat, displacement or additional stress due to increased human activities, and increased potential for vehicular collisions due to higher traffic levels on existing and new roads. Mountain plover breed in suitable habitat throughout the project area (WGFD 2007, BLM unpublished data, HWA unpublished data). Approximately 342,393 acres of occupied or potential mountain plover nesting habitat have been mapped, comprising approximately 32 percent of the project area (**Map 3.9-4**; HWA unpublished data). A substantial portion of this nesting habitat would be disturbed with implementation of the Proposed Action. Impacts of displacement or additional stress from increased human activities should be minimized by avoiding construction activities in potential plover nesting habitat during the nesting period from April 10 to July 10, unless surveys show that no birds were found.

Mountain plovers tend to use the same nesting areas from year to year (Dinsmore 2003), but the exact nest locations change. They often nest near roads and well sites (Manning and White 2001), feed on or near roads, and use roads as travel corridors (USFWS 1999), all of which make them susceptible to being struck by vehicles. In occupied habitat, BLM guidelines call for speed and traffic volume controls during the brood-rearing period. This may modify work schedules and shift changes during the most likely time for plovers to be on the road (Appendix 16 to the RMP). Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, plovers might acclimate to the well pad production facilities and use habitats immediately adjacent to such sites. With the COAs and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**), the impact of the Proposed Action on mountain plover populations would likely not exceed the impact significance criteria.

Trumpeter swans and **white-faced ibis** are uncommon in the project area and are always associated with wetland habitats. Both species have been observed within the project area during migration on only a few occasions (WGFD 2006, WYNDD 2007). Except for a few areas along Muddy Creek, wetlands are very limited within the project area. The Proposed Action is not expected to exceed the impact significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Sensitive Amphibian Species

Great Basin spadefoot have been documented within the project area (WGFD 2006, WYNDD 2007) and occur within sagebrush communities. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to suitable breeding habitat. Development would not be permitted within 500 feet of riparian and wetland habitats; however, and with this protection, significant impacts are not expected.

Northern leopard frog sightings have been documented in all counties of Wyoming and this species has been documented in the project area. Provided that measures are taken to avoid disturbance and contamination of perennial water sources (**Section 4.4**), impacts from the Proposed Action are not expected to exceed the impact significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Sensitive Fish Species

Sources of risks to sensitive fish species are (1) increases in suspended sediments and sedimentation, (2) produced-water discharges, and (3) spills of toxic materials. For any future proposals involving CBNG, the proposed treatment and disposal of produced water will be analyzed in a separate NEPA document.

Increases in Suspended Sediments and Sedimentation. Research conducted during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, including the project area, found the two most consistent habitat associations among sub-adult and adult roundtail chubs, bluehead suckers, and flannelmouth suckers to be positive associations with both rock substrates and deep pools (**Figures 4.9-1 and 4.9-2**; Bower 2005). Under the Proposed Action, the primary impacts to these two habitat features are (1) sedimentation from new construction and project-related land disturbance resulting in decreased availability of rock substrates, and (2) alteration of local hydrologic conditions by new road construction that could lead to sedimentation and channel adjustments resulting in a loss of deep pool habitats. Additionally, fragmentation of aquatic habitats, if any project-related road crossings of Muddy Creek are constructed, could limit access to required habitats or block fish migration.

The impact of new roads and other facilities on fish habitats can be divided into three categories: construction, presence, and urbanization (Angermeyer *et al.* 2004). During the construction phase, prior to interim reclamation, erosion of soils exposed during earth-moving activities accelerates fine-sediment loading in stream channels. Though the biological effects of sedimentation include a variety of ecological interactions (Waters 1995), sedimentation can act to shift habitat structure such as channel depth, pool-to-riffle ratio, percent fines in substrates, and cover availability (Angermeyer *et al.* 2004). This sediment can extend miles downstream of the construction site and persist in stream channels for years (Angermeyer *et al.* 2004).

During the presence phase, impacts are primarily associated with the interception of shallow groundwater flow paths by roads. Water is frequently diverted along the roadway and routed to surface-water drainage networks at drainage crossings. This can, in turn, alter the timing, routing, and magnitude of runoff, triggering geomorphic adjustments through erosion by channel incision, new gully or channel-head formation, or slumping and debris flows (**Figure 4.9-1**; see review in Trombulak and Frissel 2000). Channel incision occurs when the base elevation of the stream channel adjusts to account for an alteration of geomorphic parameters such as sediment supply, flow volume, or channel roughness (e.g., riparian vegetation). Channel incision has been shown to simplify channel geometry and result in the loss of pool habitat (Shields *et al.* 1994). Project-related crossings of Muddy Creek would be required to pass fish and would be mitigated as outlined in the Rawlins RMP. The RMP requires that any road crossing of a stream that may potentially support fish for a portion of the year must be constructed to allow fish passage.

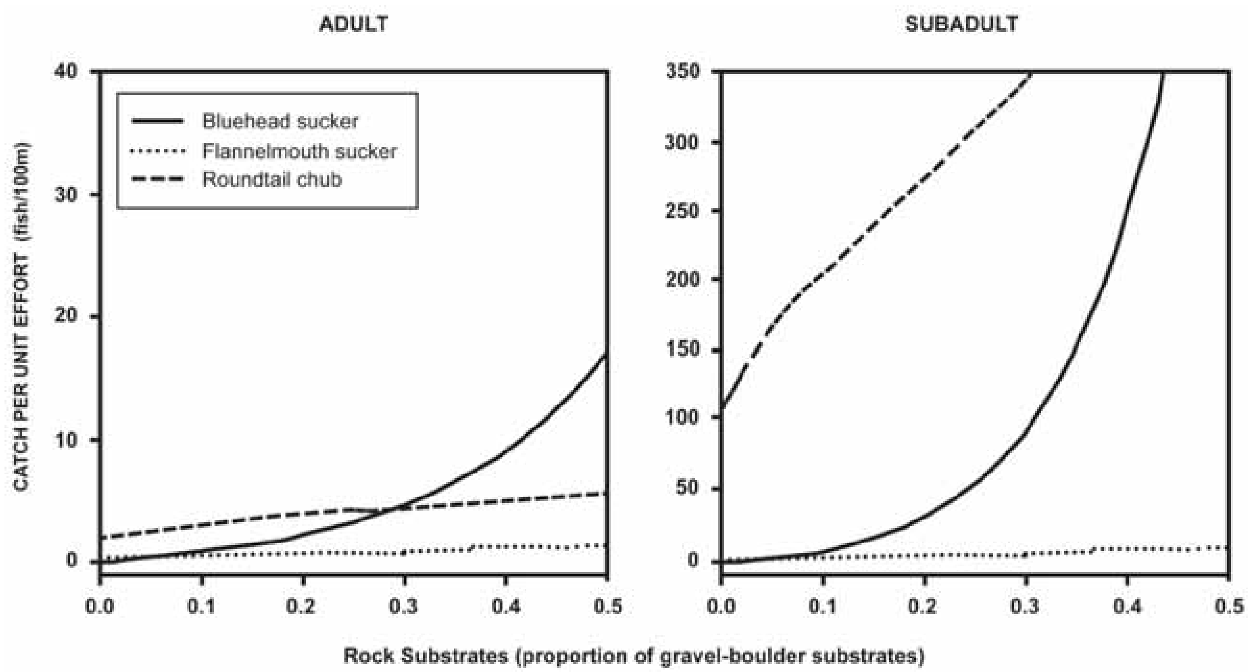


Figure 4.9-1. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of the prevalence of rock substrates at the reach scale from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species.

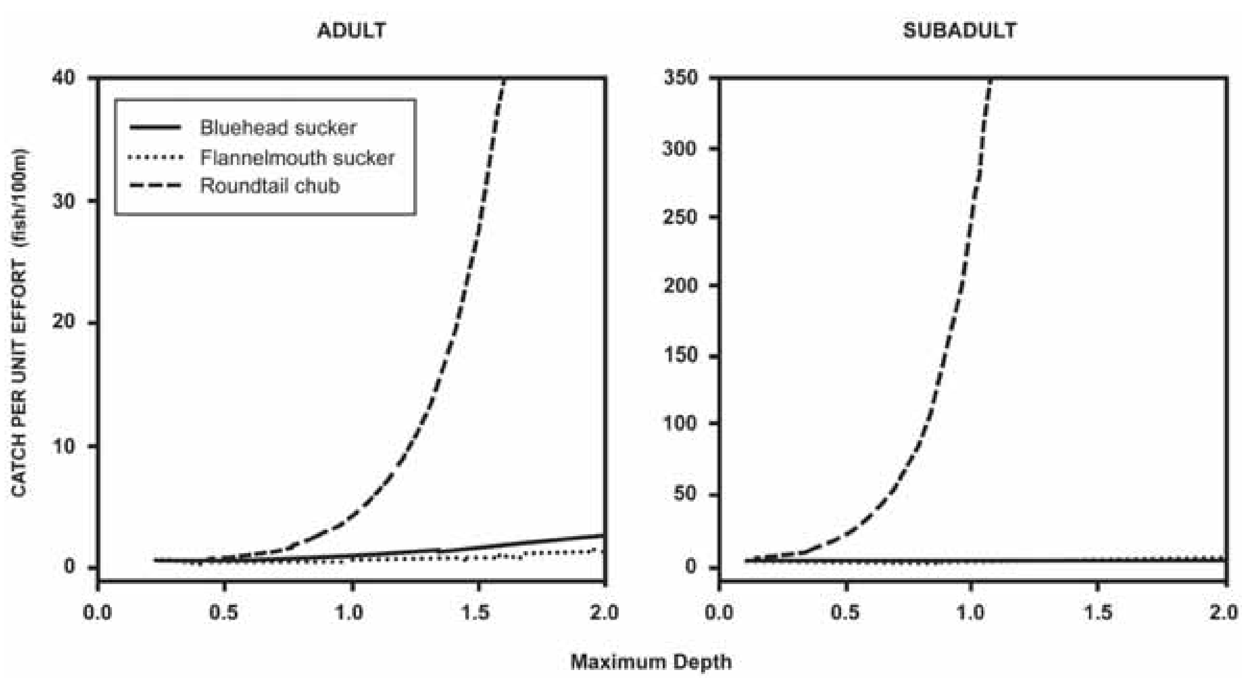


Figure 4.9-2. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of maximum channel unit depth from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species above minimum depth thresholds.

Figure 4.9-3. Example of erosion resulting from concentration of surface runoff at drainage crossings

In the case of the Proposed Action, the effects of urbanization are thought to include the detrimental effects of exotic species introduction and increased human presence within the project area. Roads provide dispersal mechanisms for a variety of exotic upland and riparian plant species. Of particular concern is the spread of tamarisk (*Tamarix* spp., also known as salt cedar) within the upper Muddy Creek watershed. This exotic species has been shown to displace native riparian vegetation while consuming a greater volume of water, resulting in reduced water tables and suitability of aquatic habitats (Graf 1978). Tamarisk is currently known to exist in portions of the project area and its spread is likely a result of dispersal via roadways. Increased human uses of the area are also likely to increase the probability of unsanctioned, illegal, and unintentional introductions of exotic fishes and other aquatic organisms. These introductions have been cited as one of the major threats to fresh-water biodiversity (Allan and Flecker 1993) and warrant careful consideration given the detrimental effects of exotic fishes on native Colorado River Basin fishes present within the upper Muddy Creek watershed.

Stream fishes require habitats for spawning, feeding, rearing, and refuge. The spatial heterogeneity and connectivity of the stream system can necessitate the movement of fishes among these habitats in order to complete their life-cycles (Schlosser 1995). Interruption of movement among required habitats by road crossings can have demographic effects, decreasing population viability (Trombulak and Frissel 2000, Gibson *et al.* 2005). The distributions of the three target species during the summer and fall of 2003 suggest several implications of habitat fragmentation with regard to access to refuge habitats and subsequent ability to recolonize adjacent reaches (Bower 2005). Additionally, movements of the three species observed during 2005 suggests that required habitats exist in spatially distinct portions of the watershed, thus requiring movement of individuals in order to complete their life history requirements (Compton 2007). Eighty-acre spacing of well locations, typical in the high-development parts of the project area, could result in a road density of up to 2.5 mi/mi^2 within the portion of the project along Muddy Creek, including new road construction. Additionally, crossings of Muddy Creek may occur as a result of the Proposed Action, although the number and specific locations of these crossings have not yet been determined. Eighty-acre spacing would result in significance based on Criterion 2.

Research within the Little Robbers Gulch drainage has demonstrated the effects of roads, natural gas drill pads, and pipelines on sediment production and runoff (Wollmer 1994). This work examined the effect of road densities of 2 mi/mi^2, including associated well pad and pipeline facilities, on local sediment production and runoff. A net increase of 1 percent in local sediment production and 0.3 percent in local runoff was found when compared to unaltered rangeland sites. Although this work helps to identify the potentially limited extent of local erosion caused by roads, the study did not address the effects of flow interception which can lead to altered runoff timing, routes, and magnitudes. It is these hydrologic alterations that are most likely to result in geomorphic adjustments through erosion, causing sedimentation or loss of habitat features such as deep pools.

Increased sediment delivery to stream-bottoms can embed gravels and reduce spawning success via decreased embryo survival fill in rearing pools, and reduce complexity of the habitat in stream channels

(Magee *et al.* 1996). Deposition of sediment can also decrease populations and species composition of aquatic macroinvertebrates that are highly dependent on interstitial spaces for different life stages. These community changes can be detrimental to fisheries that depend on macroinvertebrates as primary food supplies and can change the abundance and diversity of the fish population. Loss of these stream attributes would threaten the persistence of BLM sensitive fish species.

In addition to project activities that cause surface disturbance, a major source of sediment input to streams in the project area is wind erosion. Much of the area along Muddy Creek within the project area has a moderate to high wind-erosion potential (**Map 3.3-2**). A moderate potential for wind erosion exists for 80 percent of the total project area or 859,633 acres (**Table 3.3-1**).

Discharges of Produced Water. Produced water from the project area would not be discharged to Muddy Creek within the Little Snake River drainage; therefore, produced-water discharges would not pose a risk to these species

Spills of Toxic Materials. Accidental releases of toxic materials to Muddy Creek would pose a risk to sensitive fish populations. The probability of spills occurring is unknown, but their consequences could be significant if spills occurred. One spill could kill most of the fish in lower Muddy Creek.

Because of the limited distribution in Wyoming and other states of the three sensitive fish species found in the project area—the roundtail chub, the bluehead sucker, and the flannelmouth sucker—the effects of the Proposed Action are considered to be significant. The disturbance created by new roads and facilities would increase suspended sediments and sedimentation, altering habitat features found to be important to the fishes and fragmenting that habitat. These effects would be exacerbated by any accidental discharge of produced water or spills of toxic materials into the watershed. The significant impact on the habitat of the species within the project area may preclude improvement of their status as prescribed in the *Range-wide Conservation Agreement for Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs.* This would be contrary to Criterion 4. Eighty-acre spacing of wells would result in significance based on Criterion 2.

Sensitive Plant Species

The presence of sensitive plant species on public lands would be determined by soil surveys or rare-plant surveys prior to site development. Avoidance and best management practices identified on a case-by-case basis would then be applied to proposed surface-disturbing activities to protect or enhance sensitive plant species and their habitats (BLM 2008a, p. 2-47). Therefore, decreased viability or increased mortality of the Cedar Rim thistle, Gibben's beardtongue, Meadow milkvetch, and persistent sepal yellowcress—or adverse alteration of their critical habitats—would not occur on public lands within the CD-C project area with implementation of the Proposed Action. Meadow milkvetch and persistent sepal yellowcress would be further protected on public lands because development would not be permitted within 500 feet of riparian and wetland habitats (BLM 2008a). Cedar Rim thistle and Gibben's beardtongue could be impacted if their habitats are disturbed by development activity. BLM-designated sensitive plant species are likely to occur on private and state lands within the project area; however, surveys to determine their presence or to locate their habitat would not be required nor would avoidance or other mitigating activity. The impact on private and state lands is thus not known.

Indirect impacts to special status plants and/or their habitats could occur as a result of several natural gas development activities. New invasive weed infestations near well pad locations and other surface disturbances could spread into occupied special status plant species habitat. The effects of fugitive dust created by new access roads and increased vehicle activity could have a detrimental effect on the vigor and survival of special status plant species. Unauthorized off-road vehicle use could negatively impact special status plant species, either by direct destruction or by alteration of their habitats. Indirect impacts to BLM-designated sensitive plants on public lands are anticipated to be either minimal or none due to the required 500-foot setback from riparian areas and the use of soil survey information to locate potential sensitive species habitats. In addition, the RFO staff has information that identifies potential habitats by soil type and known populations of these species.

4.9.3.2 Alternative A: 100-Percent Vertical Drilling

Threatened, Endangered, Proposed, or Candidate Wildlife Species

Under Alternative A, the types of impacts to special status species and their habitats would be similar to those described for the Proposed Action. For this alternative, the scope and intensity of the impacts would be more widespread because of the increased surface disturbance associated with construction of more well pads, roads, and pipelines required for 100-percent vertical drilling. The total number of well pads and access roads would be 8,950, compared to the estimated 6,126 well pads estimated for the Proposed Action. Estimated surface disturbance for this alternative would be 31 percent greater (14,496 acres) than the Proposed Action. Combined with previous surface disturbance, more than 11 percent of the project area would be disturbed at one time or another. After successful reclamation, the project-related acreage that would remain in a non-vegetated state would be 28 percent greater (5,272 acres) than the Proposed Action. Shrub-dominated habitat would not recover during the life of the project. Habitat loss and fragmentation would be comparably more extensive than under the Proposed Action. Impacts to species already likely to exceed significance criteria such as sage-grouse in non-core areas would be increased and are expected to exceed Criteria 2 and 3. Additionally, in the checkerboard portion of the project area, the RMP limitations do not apply to private and state lands, so it is possible that impacts to species with large indirect impact zones, such as nesting/foraging ferruginous hawks, could reduce the effectiveness of the mitigation on BLM land, possibly leading to exceeding impact significance Criterion 4. Although this increase of surface disturbance would increase the impact to shrub dependent bird species such as Brewer's sparrow, loggerhead shrike, sage sparrow, and sage thrasher, it should not reach the level of significance under Criterion 4.

The BLM will seek to apply conservation measures for **greater sage-grouse** in state-designated core population areas consistent with IM WY-2012-019 (BLM 2012c), pending the amendment of the Rawlins RMP. In non-core areas, leks would be protected by the application of the 0.25-mile lek NSO as well as the Rawlins RMP requirement to avoid identified nesting and early brood-rearing habitat, regardless of distance from a lek, from March 1 to July 15. Timing Limitations would provide additional seasonal protection to wintering sage-grouse in non-core areas. It is expected that greater than three wells or 60 acres of disturbance per square mile could occur within the 2-mile radius of some non-core leks but not all; this would be considered an "Extreme Impact" relative to those individual leks (WGFD 2010a).

As discussed in the Proposed Action, **ferruginous hawk** nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests, but the impacts are not expected to exceed the criterion.

Other sensitive species including **mountain plover** and **white-tailed prairie dog** would be provided protections for nest and habitat avoidance, as appropriate, on BLM-managed lands but not on private and state-managed lands. Given the increased acreage anticipated to be disturbed under this Alternative it is expected that Criterion 4 may be exceeded for these species.

Although the increase of surface disturbance anticipated under this alternative would increase the impact to shrub-dependent bird species such as Brewer's sparrow, loggerhead shrike, sage sparrow, and vespers sparrow, it is not likely to reach the level of significance under Criterion 4.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

The types of impacts to sensitive fish species would be the same as for the Proposed Action, but because of the larger surface area affected, the magnitude of the impacts would be proportionally greater.

Special Status Plants

Although the amount of surface disturbance would be greatly increased under Alternative A, the measures to avoid and protect special status plants that would be implemented make it unlikely that special status plants would be more affected by implementation of Alternative A than by the Proposed Action.

4.9.3.3 Alternative B: Enhanced Resource Protection

Threatened, Endangered, Proposed, or Candidate Wildlife Species

The ERP alternative was developedin part to prevent significant impacts to wildlife resources of concern by implementing additional protections and mitigations, when necessary, beyond those normally applied (e.g. BMPs, COAs, Wildlife Monitoring and Protection Plan). The ERP alternative also recognizes that development may be more intensive than currently expected and may result in impacts to wildlife habitats and populations faster than anticipated. This alternative would combine prescriptive and adaptive management approaches, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs and other project-related activities. Should surface disturbance or population thresholds be reached, additional protection measures would also be implemented, specific to each affected species. See **Section 2.23** for a detailed description of this alternative.

The additional restrictions under this alternative are likely to encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on special status species and their habitat would be less. Maximum initial surface disturbance for this alternative is estimated to decrease by 1,684 acres to 45,516 acres, a 3.6 percent reduction from the Proposed Action. Long-term disturbance would decrease by 611 acres, to 18,249 acres.

Because more wells would likely be drilled directionally from multi-well pads under this alternative, fewer well pads overall would be constructed—an estimated 5,798 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of 5.4 percent. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than for the Proposed Action.

The special status species/habitat that would receive enhanced protections under this alternative include greater sage-grouse leks, nesting/brood-rearing habitat, and winter concentration areas, and ferruginous hawk nest habitat. Enhanced protections afforded these species and their habitats would benefit numerous other species. The following additional mitigation measures, along with many others more specific to special status species, are included in this alternative:

- Minimize human presence at well sites after they have been put into production by installing remote monitoring devices on project facilities and gating roads;
- Utilize noise-reduction techniques;
- Timely reclaim well pads, pipelines, and rights-of-way to reduce displacement of wildlife from the well field;
- Provide training programs for field workers to raise awareness of activities that cause stress to wildlife, times of day when collisions are most likely, and other programs as necessary;
- Install devices to preclude raptor-perching near prairie-dog towns and pygmy rabbit burrows; and
- Bury new power lines near sage-grouse leks.

Greater sage-grouse. The enhanced protections for greater sage-grouse would decrease the degree of impact, especially in non-core areas, as compared to the Proposed Action. These enhanced protections would be in addition to protections normally applied (e.g. BMPs, COAs, Wildlife Monitoring and Protection Plan) and protections described in IM WY-2012-019 for sage-grouse core areas. Applications for Permit to Drill (APDs) within greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas would be submitted as part of an overall development plan for an entire lease or several leases. The plan is described previously in the general requirements portion of the alternative.

In addition, the following requirements would be implemented throughout sage-grouse habitat:

- Burying new power lines and using low-profile facilities within 1 mile of an occupied lek or in winter concentration areas;
- Use of noise-reduction technology so that noise would not exceed 49 decibels measured at 30 feet from the source at all drilling, production and compressor sites; and
- No more than one oil and gas or mining location per 640 acres and no more than 5 percent habitat disturbance (related to all programs or applicable sources of disturbance).

Additionally, surface-disturbance and population thresholds have been developed as part of this alternative to maintain sage-grouse habitat and populations in the face of increasing development pressure.

Surface-disturbance thresholds would reduce the risk of impacts of habitat removal and modification in sage-grouse habitats. The surface-disturbance thresholds seek to reduce the amount of habitat disturbed and to mitigate disturbance with reclamation. If surface disturbance for natural gas roads, pipelines, well pads or other facilities has exceeded 5 percent or one oil and gas or mining location per 640 acres within **core areas**, the BLM would:

- Require remote well-monitoring at all well pads;
- Evaluate reclamation success in the section and request from the Operator a revised reclamation plan to address any failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of sage-grouse habitat is needed at that time. If so, begin implementation.

If surface disturbance were to reach 10 percent or 2 oil and gas or mining locations per 640 acres of **non-core** sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas in a lease, habitat improvement projects would be required. Projects could include, but would not be limited to:

- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, and establishment of food plots; and
- Water developments.

Population-level thresholds are intended to maintain sage-grouse population levels within the project area. If WGFD were to express formal written concern that the population of sage-grouse is declining at an accelerated rate, all Operators on public lands within sage-grouse lek, nesting/early brood-rearing habitat or winter concentration areas would implement a mitigation package identified by BLM that would include, but would not be limited to:

- Evaluation of reclamation success in the lease or right-of-way and a request to the Operator to provide a revised reclamation plan to address any failed reclamation.
- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, and establishment of food plots (the BLM may also coordinate habitat improvement projects among multiple Operators); and
- Timing and Distance Restrictions (Non-core areas to conform with core areas):

  - When the threshold is reached, surface-disturbing activity or surface occupancy would be prohibited or restricted on or within a 0.6 mile of the perimeter of occupied sage-grouse leks. In addition, disruptive activities within 0.6 mile of the perimeter of occupied sage-grouse leks are restricted from 6:00 pm to 9:00 am from March 1 – May 15.
  - Avoid surface-disturbing and disruptive activities in suitable greater sage-grouse nesting and early brood rearing habitat within 2.5 miles of the perimeter of an occupied lek from March 15 – June 30.
  - Prohibition of surface-disturbing and disruptive activities within 0.5 mile of non-core sage-grouse winter concentration areas from November 15 – March 14.
- Density Restrictions:
  - Core area APDs would be limited to the density disturbance calculation tool thresholds (see density restrictions in IM 2012-019). When thresholds are exceeded, the BLM would work to colocate or minimize disturbance for valid and existing rights.
  - When the population threshold is reached in non-core areas, strive to maintain <3 pads per square mile within 2 miles of the perimeter of occupied sage-grouse leks

If the population status of the species changes in the future, additional data would be collected and additional protection measures would be developed.

Standard density restrictions in defined core population areas would limit the density of disruptions on the landscape to 1 well pad per 640 acres or the cumulative area of disturbance to less than 5 percent of the suitable sagebrush habitat within the same 640 acres (IM WY-2012-019). In non-core areas the Rawlins RMP provides timing stipulation protection to identified nesting and early brood-rearing habitat regardless of the distance from a lek. With these protection measures, habitat in sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas should be maintained. The risk of a significant population decrease resulting from gas development is expected to decrease under this alternative. Impacts to sage-grouse in both core and non-core areas should not reach the level of significance under this alternative provided the Core Population Area mitigation measures found in the IM, the RMP, and the State Executive Order are applied and the 5 percent surface disturbance trigger is effective at predicting habitat impact issues in advance of Criterion 4 being exceeded.

Ferruginous Hawk Nesting Habitat. Under this alternative, the basic RMP requirements and standard site-specific requirements would apply. Currently, there are 84 known ferruginous hawk territories within the project area. No additional protections would apply to ferruginous hawk nesting habitat unless one of the two following thresholds were reached—a surface disturbance threshold and a population threshold:

In the event that surface disturbance within 1 mile of a ferruginous hawk nest exceeds 10 percent, Operators in all leases within the 1 mile nest radius of would be required to participate in a development/mitigation plan before additional APDs would be issued.

If WGFD were to express formal written concern about the ferruginous hawk population, the following mitigation measures would be implemented immediately:

- All existing development features and facilities (pads, pipelines, roads, holding yards, compressor stations, and other associated infrastructure) within the nesting territories would be inspected to determine reclamation success. If reclamation has been unsuccessful, measures would be taken to improve the reclamation of the facilities.

- Ten man-made[19] nests would be built outside of existing monitoring territories on natural substrates, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following receipt of WGFD's letter of concern.
    - The farther the nest is constructed from existing disturbances the better.
    - These nests would be incorporated into the annual monitoring efforts.
    - Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.
- Two artificial nesting structures [20] would be placed outside of existing monitoring territories, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following receipt of WGFD's letter of concern.
    - Priority for placement of these nests would be determined based on information regarding extant nests located on man-made infrastructure, or where there is known repeated attempts at nesting on man-made infrastructure.
    - These nests would be incorporated into the annual monitoring efforts.
    - Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.

If the species population continues to decline, additional data would be collected and additional protection measures would be developed.

With these protection measures, nesting habitat and fledgling production should be maintained, even in the checkerboard area. The risk of population decrease resulting from gas development is expected to decrease from the Proposed Action and would not be expected to exceed the impact significance criteria.

Under the Enhanced Resource Protection Alternative, other special status species discussed in the Proposed Action (e.g. pygmy rabbit, mountain plover, white-tailed prairie dog, swift fox, long-billed curlew, Great Basin spadefoot, northern leopard frog, etc.) would have no additional specific species protections beyond those required by the RMP (timing and surface stipulations), BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan. However, by implementing the ERP alternative, many of these species would benefit from the additional protections. For example, riparian species and northern leopard frogs would benefit from the enhanced protections of the Muddy Creek corridor/watershed, Chain Lakes wetlands, and playas.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

The Enhanced Resource Alternative Protections for the Muddy Creek and Bitter Creek Corridors/Watersheds described in **Section 2.2.3.4** could significantly reduce project impacts to sensitive fish species. The sources of these reductions would include the following protections:

- For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 0.25 mile of Red Wash, springs, wells, and wetlands would be required. The required avoidance distance would be further increased on perennial streams to 0.5 mile. Exceptions would only be granted by the BLM based on environmental analysis and site-specific engineering and mitigation plans. Only actions within areas that could not be avoided and that would provide

[19] Man-made nests are nests that are built in appropriate habitat and are intended to attract ferruginous hawks.

[20] Artificial nesting structures are built to attract hawks that would build their own nest on the structure.

protection for the resource identified would be approved. In-channel activities would be restricted to the low-flow period.

- Current monitoring on upper Muddy Creek would be extended to lower Muddy Creek in the CD-C project area. This requirement would bring lower Muddy Creek into conformance with the monitoring being done for upper Muddy Creek and other drainages within the Atlantic Rim project area. If results of the monitoring program showed impacts to sensitive fish habitat, the BLM and an interagency CD-C consultation group would determine whether habitat-improvement projects should be implemented. The projects could include, but would not be limited to, increasing the number of drainage features along roads, increasing in-stream cover for fish, and other measures as necessary.
- A monitoring plan for the Bitter Creek watershed will be designed.

The following requirements related to **selenium and salinity** for well locations and operations would also be implemented:

- No surface discharge of produced waters within the Muddy Creek and Bitter Creek watersheds.
- Line all reserve pits in the Muddy Creek and Bitter Creek watersheds.

These protections, however, would only apply to BLM land (an estimated 48 percent of the total area). An unintentional consequence of these protections could be to increase drilling activities on private land and state land. Such development on private and state land along Muddy Creek could completely negate the enhanced resource protections on BLM land along Muddy Creek. To preclude this possibility, the Operators and the state should make a commitment to apply these same enhanced resource protections to private and state land along Muddy Creek. Without this commitment, it is likely that the impacts to sensitive fish species for this alternative would be the same as for the Proposed Action alternative.

Sensitive Plant Species

Special-status plants would receive no added protection under Alternative B. The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would not be affected by implementation of Alternative B any more than they would under the Proposed Action.

4.9.3.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Threatened, Endangered, Proposed, or Candidate Wildlife Species

This alternative differentiates between existing high-density development areas—those areas that have seen the greatest natural-gas development to date—and low-density development areas (**Map 2-1**), placing a higher cap on disturbance in areas that have already undergone considerable development. Within the high-density development areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance allowed at any one time in a section of public land. For the remainder of the project area—the low-density development areas—the cap would be 30 acres per section. All prior surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap. In general, adverse impacts in both areas should be reduced compared to the Proposed Action.

Under Alternative C, the types of impacts to special status wildlife species and their habitats would be similar to those described for the Proposed Action. The cap, however, would place a limit on the amount of unreclaimed surface disturbance at any one time in a section of public land. This requirement should encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on special status species and their habitat would be less. Maximum surface disturbance for this alternative is estimated to decrease by 4,245 acres in the short term to 42,955 acres, a 9 percent reduction from the Proposed Action. Long-term disturbance would decrease by 1,543 acres, to 17,318 acres.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 5,299 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of 13.5 percent. Therefore, fewer access roads would be developed, fewer pipelines would be installed, fewer haul-truck miles would be logged, and habitat fragmentation would be less extensive than for the Proposed Action.

Greater sage-grouse should benefit from fewer wells and disturbance. In the core areas, restrictions found in IM WY-2012-019 and the Greater Sage-grouse Core Area Protection program (SGEO) (SWED 2011) would apply in many instances, so impacts may not exceed the impact significance criteria. In non-core areas, application of RMP and IM timing stipulations in potential nesting and brood-rearing habitat as well as the BLM standard COAs, BMPs, and mitigation would reduce the potential impact to sage-grouse although some impact to those populations would still be anticipated over the long term. The protections found in the SGEO would apply in non-core areas on non-federal lands. Impacts to sage-grouse in both core and non-core areas should not reach the level of significance under this alternative provided the Core Population Area mitigation measures found in the IM, RMP, and SGEO are applied. As discussed in the Proposed Action alternative, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests. Impacts to white-tailed prairie dog and mountain plover are not expected to exceed Criterion 4 as the protection measures found in the RMP would be applied.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

Within the project area, about 59 percent of the Muddy Creek watershed is located in the high-density area and about 41 percent is in the low-density area (**Map 2-1**). Because surface disturbance would be capped at 30 acres per section in the low-density area and at 60 acres per section in the high-density area, impacts to fish in Muddy Creek as a result of surface disturbance should be less under this alternative compared with the Proposed Action. Without the added types of protections for Muddy Creek discussed in **Section 4.8.3.3** for Alternative B, however, the impacts to sensitive fish species could be similar to those for the Proposed Action.

Sensitive Plant Species

The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would be as little affected by implementation of Alternative C as by the Proposed Action. To the extent that surface disturbance decreases and the number of disturbance sites is reduced, the likelihood of adverse impacts is diminished further.

4.9.3.5 Alternative D: Directional Drilling

Threatened, Endangered, Proposed, or Candidate Wildlife Species

Under Alternative D, the types of impacts to special status species and their habitats would be similar to those described for the Proposed Action. This alternative requires that all future natural gas wells on federal mineral estate and surface be drilled from multi-well pads. In sections that have already undergone development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted in these leases. In sections that have not been developed, one new well pad would be permitted for all future development. One road and pipeline corridor on the lease would be permitted. The objective of this alternative is to minimize surface disturbance and to reduce habitat loss and wildlife disturbance. It would also reduce fragmentation of habitat. Total surface disturbance for this alternative would decrease by 10,751 acres to 36,449, a reduction of about 23 percent from the Proposed Action. Long-term disturbance is estimated to decrease by 3,908 acres to 14,952 acres, a reduction of about 21 percent.

Most wells would be drilled from directional well pads under this alternative and fewer well pads overall would be developed—an estimated 4,032 compared to the estimated 6,126 for the Proposed Action, for a reduction of about 34 percent. Therefore, fewer access roads would be constructed and fewer pipelines installed, and habitat fragmentation would be less extensive than for the Proposed Action. However, noise from drilling and completion activities occurring at long-duration multi-well pads could represent a localized negative impact to a sub-set of sensitive receptors (i.e. nesting raptors, lekking or brooding sage-grouse) due to the increased period of time required for drilling and well completion activity at a single location. Reduced surface disturbance and habitat fragmentation resulting from multi-well pads comes with an increase in decibel level and frequency of that noise, as well as the extended period of time over which large haul-truck activity would occur.

Because this alternative reduces the number of active well locations to be drilled along with associated roads and pipelines, impacts to most species would be reduced under this alternative compared to the Proposed Action. Impacts to the habitats of those species that depend on shrubs (sage-grouse and the shrub-dependent songbirds) would be significantly less than the Proposed Action due to the decrease in impacted habitat.

In addition to the reduced surface disturbance and fragmentation resulting from Alternative D, implementation of the BLM IM and State Executive Order sage-grouse protections would reduce impacts to greater sage-grouse in core areas. Mitigations and restrictions applied for protection of sage-grouse in non-core areas (BLM 2012c and WSEO 2010) would apply on all remaining sage-grouse habitat in the project area, regardless of ownership, as appropriate.

As discussed in the Proposed Action, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone; however, the reduced number of well locations on BLM-administered lands should further decrease risks to the species. It is not expected that Criterion 4 would be exceeded as other factors such as topography could decrease the size of the needed buffer around nests.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

Total surface disturbance for this alternative would be about 23 percent lower than for the Proposed Action; therefore, impacts to sensitive fish species should be proportionally less.

Sensitive Plant Species

The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would be as little affected by implementation of Alternative D as by the Proposed Action. To the extent that surface disturbance decreases and the number of disturbance sites are reduced, the likelihood of adverse impact would be diminished even further.

4.9.3.6 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area. There would consequently be no new surface disturbance and no new impacts on special status species or their habitat. These species would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of browse and forage caused by dust.

The Rawlins RMP (BLM 2008b) prescribes the following management objectives associated with wildlife and fisheries resources (including Special Status Species):

- Maintain, restore, or enhance wildlife habitat in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements. A full range of mitigation options will be considered when developing mitigation for project-level activities for wildlife and Special Status Species habitats.
- Maintain, restore, or enhance T&E species habitat, in coordination and consultation with the USFWS and other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance designated BLM State Sensitive Species habitat to prevent listing under the ESA, in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance habitat function in crucial winter range.

The RMP also defines the following impact significance criteria that are used in this document to assess the impacts associated with the Proposed Action and alternatives (BLM 2008b). Impacts to special status wildlife and fish species would be considered significant if any of the following were to occur:

1. Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
2. Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.
3. Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status. Habitat function means the arrangement of habitat features and the capability of those features to sustain species, populations, and diversity of wildlife over time (WGFD 2010a).
4. Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species. (Not in the RMP but added by RFO staff to this list.)

Impacts to special status plant species would be considered significant if any of the following were to occur:

1. Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or if corrective actions were beyond the scope of the RMP.
2. The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under ESA.
3. Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.
4. Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species. (Not in the RMP but added by RFO staff to this list.)

4.9.4 Impact Summary

The project, as proposed, would disturb and alter approximately 47,200 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres already disturbed by natural-gas and other development. Reclamation of disturbed areas should recover grass-dominated habitats in one to several years, depending on precipitation and effectiveness of reclamation efforts. Shrub habitats would not reach pre-disturbance levels during the life of the project. Therefore, shrub-dependent special status species would be impacted most by habitat loss.

In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for the critical times of year have been developed for the most sensitive species and are generally implemented during the development phase, but no restrictions would be in place during the production phase. Other impacts from natural-gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collision between vehicles and wildlife. The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that potential impacts to special status plants would be minimized or eliminated.

Proposed Action. It is expected that for the Proposed Action, Criteria 2 and 3 (*Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.* and *Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status.*) could be exceeded for sage-grouse outside the core area. Additionally, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone but it is not expected that Criterion 4 would be exceeded as other factors, such as topography, could decrease the size of the needed buffer around nests. Other special status species should be protected sufficiently by the COAs, RMP requirements, and BMPs to avoid exceeding the significance level.

The primary source of potential risks to fish species from land disturbance from project activities would be increases in suspended sediments and sedimentation. The intensity of these impacts may decrease with the completion of the construction phase and with the onset of reclamation efforts on disturbed areas.

None of the Threatened and Endangered fish species found downstream of the project area within the Colorado River system are known to occur in the project area; therefore, there would be no direct impacts to these species. Implementation of all mitigation measures for water and soils would help reduce other potential impacts. Accidental releases of produced waters or other materials also could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences would be negligible.

With the implementation of the Proposed Action, direct loss of habitat for sensitive fish species would result from sedimentation associated with the construction of well sites and related access roads and pipelines. Accidental releases of produced waters or other materials could occur. Alteration of sensitive fish habitat suitability from sedimentation would result in significant impacts to sensitive fishes (Criteria 3 and 4).

Alternative A: 100-percent Vertical Drilling would affect an additional 14,496 acres of wildlife habitat (a 30.7-percent increase). The impacts described above would be greatly intensified under this alternative and Criteria 2 and 3 would likely be exceeded for sage-grouse outside the core area. Criterion 4 (*Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species.*) would not be exceeded for ferruginous hawks.

Impacts to threatened and endangered fish species would be the same as for the Proposed Action. Overall, the types of impacts to sensitive fish species would be similar to those described for the Proposed Action; however, the level of impacts would be greater due to increased surface disturbance. Accidental releases of produced waters or other materials also could occur with significant consequences. Alteration of fish habitat suitability from sedimentation would result in significant impacts to sensitive fish species (Criteria 3 and 4).

Alternative B: Enhanced Resource Protection was designed to reduce impacts of development on those species or habitats that are most vulnerable to an infill oil and gas project. There would be a slight reduction (1,684 acres, about 3.5 percent) in the amount of wildlife habitat disturbed under this alternative compared to the Proposed Action, but because of the additional mitigation requirements, impacts to sage-grouse outside core areas and ferruginous hawks should be reduced to a level below significance. Other special status species (white tailed prairie dogs, Wyoming pocket gopher, pygmy rabbits, mountain plovers and neotropical birds) would also benefit from this alternative. The additional protection of the Muddy Creek watershed, riparian areas, and playas would also benefit a number of special status species.

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action. The Enhanced Resource Protections for the Muddy Creek Corridor/Watershed described in **Section 4.2.3.9** could significantly reduce project impacts to sensitive fish species if they were applied to both BLM and private land within the project area. Without the application of these protections to private land, however, the benefits of these enhanced resource protections could be negated by increased drilling activities on private land. Accidental releases of produced waters or other materials also could occur. Without this commitment, alteration of fish habitat suitability from sedimentation could result in significant impacts to sensitive fish species (Criteria 3 and 4). With such a commitment, the project area and other human activities within the Muddy Creek and Great Basin watersheds should not have significant cumulative impacts on the status of their populations within Wyoming.

Alternative C: Surface Disturbance Cap – High and Low Density Development Areas seeks to reduce habitat disturbance and reward successful reclamation. It is expected to impact 4,245 fewer acres than the Proposed Action. It should reduce the impacts to all species below that of the Proposed Alternative, but impacts would still be expected to exceed the significance level for sage-grouse in non-core areas. While fewer wells should help nesting ferruginous hawks, it is still possible the significance level would be reached in the checkerboard area.

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action. Because only a small proportion of Muddy Creek is on BLM land in high-density development areas, impacts to sensitive fish species would be less than under the Proposed Action. Alteration of fish habitat suitability from sedimentation, however, still would result in significant impacts to sensitive fish species (Criteria 3 and 4). Accidental releases of produced waters or other materials also could occur with significant consequences.

Alternative D: Directional Drilling would be expected to reduce surface-disturbance acreage by approximately 23 percent, when compared to the Proposed Action; anticipated impacts to special status species in the project area would be below the point of significance. Impacts to threatened and endangered fish species would be the same as for the Proposed Action. Because the amount of land disturbed under this alternative would be less than for the Proposed Action, impacts to fish should be proportionally less. Accidental releases of produced water or other materials also could occur with significant consequences. Alteration of fish habitat suitability from sedimentation would result in significant impacts to sensitive fish species (Criteria 3 and 4).

Alternative E: No Action is assumed to result in no new surface disturbance and no new impacts on special status species or their habitat because no further natural gas development would occur within the CD-C project area on federal, state, or fee mineral estate.

4.9.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Criterion 1—*Substantial loss of the biological integrity and habitat function that would make a species eligible for listing under the ESA*— is not expected to be exceeded under the Proposed Action or any of the alternatives for any species. Criterion 2— *Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species*—would be exceeded for greater sage-grouse in non-core areas under the Proposed Action and all action alternatives except Alternative B. Criterion 2—*Substantial loss of habitat function or disruption of life-history requirements*—would be exceeded for greater sage-grouse in non-core areas under The Proposed Action and all action alternatives except Alternative B. It would also be exceeded for sensitive fish species. Criterion 4—*Actions that preclude attainment of conservation goals*—may be exceeded for ferruginous hawks under Alternative A and would be exceeded for sensitive fish species under the Proposed Action and all action alternatives. The measures aimed at avoiding and protecting special status plants under the Proposed Action and all alternatives would insure that potential impacts to special status plants would not be exceeded under the Proposed Action or any action alternatives.

The exceedances of Criteria 2 and 3 for greater sage-grouse in non-core areas could be avoided by application of the protections and mitigations for greater sage-grouse found in Alternative B, including:

- Burying new power lines and using low-profile facilities within 1 mile of an occupied lek or in winter concentration areas;
- Use of noise-reduction technology so that noise would not exceed 49 dBa measured at 30 feet from the source at all drilling, production and compressor sites; and
- Enhance timing, distance, and density restrictions within high value habitats.

The exceedances of Criteria 3 and 4 for sensitive fish species under the Proposed Action and all action alternatives could be avoided by application of the increased set-back distances found in the Muddy Creek watershed in Alternative B to private and state lands as well as public lands. Those increased distances are from 500 feet to 0.25 mile of Red Wash, springs, wells, and wetlands and to 0.5 mile from perennial streams.

Additional mitigation measures whose general application would benefit numerous special status species include the following:

- Minimizing human presence at well sites after they have been put into production by remote monitoring of project facilities and gating of roads;
- Development of travel management plans;
- Utilization of noise-reduction techniques;
- Training programs for field workers to raise their awareness of activities that cause stress to wildlife, times of day when collisions are most likely; and
- Installation of devices to preclude raptor-perching near prairie-dog towns and pygmy rabbit burrows.

These additional mitigation measures, along with others more specific to special status species, are included in Alternative B, Enhanced Resource Protection.

4.10 WILD HORSES

4.10.1 Introduction

Surface-disturbing activities associated with the construction of well pads, reserve pits, and roads could adversely affect wild horses. Land-clearing and grading activities necessary for construction remove vegetation, resulting in loss of forage, and create disturbance through increased human activity. Assuming successful reclamation, BLM standards for reclamation of disturbed sites such as linear road and pipeline rights-of-way and well pad sites would be adequate to mitigate any potential adverse effect on wild horses because of forage loss.

Prevention and containment of invasive plant species establishment and spread would have a positive impact to wild horses, wildlife, and livestock by reducing competition with native plants, consequently maximizing forage production.

4.10.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for wild horses:

1. Maintain wild horse populations within the appropriate management levels (AML) of the HMA.
2. Manage wild horses to meet the Wyoming Standards for Healthy Rangelands.
3. Identify existing genotypes and phenotypes through recognized means of genetic evaluation and maintain genetic integrity.
4. Maintain habitat for existing AMLs.
5. Conduct all activities in compliance with relevant court orders and agreements, including the Consent Decree (August 2003).

Impacts to the wild horse resource would be considered significant if any of the following were to occur:

- Resource management actions resulting in greater than a 10-percent permanent reduction in animal unit months (AUMs) available for livestock grazing within a given allotment. In the case of the Lost Creek HMA, this would apply only to the Cyclone Rim allotment as it is the only grazing allotment within the HMA boundary in the CD-C project area (**Map 3.10-1**). The Adobe Town HMA occupies a very small portion of the project area (5,826 acres), primarily located in the Continental, Red Creek, South Flat Top and Willow Creek allotments.
- Available forage, water, or other habitat components are not sufficient to achieve or maintain the appropriate management level (AML) in a given HMA.
- Viability of wild horse populations cannot be maintained.
- The wild, free-roaming character of a wild horse herd in an HMA is lost.
- Wyoming BLM Standards for Healthy Rangelands are not met.
- Vegetation significance criteria are not met (**Section 4.6.2**).
- Non-compliance with any provision of the Free-Roaming Wild Horse and Burro Act of 1971.

4.10.3 Direct and Indirect Impacts

The wild horse resource would be directly impacted by the intensity and timing of development within the affected herd management area (HMA) and indirectly by any quantitative or qualitative changes to the vegetation resource. The primary impact to wild horses would be initial loss of available forage as a result of construction and production-related disturbances. Available forage would be reduced during drilling and field-development and reclaimed as soon as feasible under direction of the current BLM reclamation guidelines and recommendations (**Section 4.6.3.1**). A long-term loss of forage would occur under all alternatives by construction of roads, drill pads, and ancillary facilities that remain in-use during the life of the project. Wild horse management concerns with development of gas resources on public lands in the CD-C project area include control of invasive, non-native weed species, reclamation success, rangeland improvement functionality, and dust from roads. In the past, reclamation efforts within the project area have been hampered by inadequate reclamation techniques and extended drought conditions.

Indirect impacts of natural gas development on wild horses would include increased vehicle activity that could increase the potential for horse/vehicle collisions. If the Operators advise project personnel regarding appropriate speed limits on designated access roads, and these instructions are complied with, the likelihood of horse/vehicle collisions would be minimized. The level of risk for displacement of wild horses from the CD-C project area to areas outside HMA boundaries is unknown at the present time. There is some potential for wild horse conflict with wildlife/livestock.

4.10.3.1 Proposed Action

Under the Proposed Action **(Section 2.2.1**), construction of 8,950 new natural gas wells and required ancillary facilities would be anticipated over the course of the 15 year development phase within the CD-C project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. The Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1**), which represents about 4.4 percent of the total land surface of the project area. Within this total, the initial disturbance acres for the Cyclone Rim allotment in the CD-C project area portion of the Lost Creek HMA is projected to be up to about 2,336 acres. Following successful reclamation, the long-term disturbance would be about 592 acres, representing a forage loss equivalent to approximately 69 AUMs (based on an average stocking ratio of 8.6 acres per AUM), less than 0.2 percent of the total forage in the allotment).

The Proposed Action would also have a small effect on the Adobe Town HMA as the initial disturbed acres for the four allotments within the HMA would total an estimated 385 acres as follows: Continental, 2 acres; Red Creek, 82 acres; South Flat Top, 301 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 101 acres, with an associated forage loss equivalent to 11.7 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage is so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

The level of risk for displacement of wild horses from the CD-C project area to areas outside the HMA boundaries is unknown at the present time. The opportunity for the public to view wild horses would not be affected.

4.10.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the exception that the total amount of initial disturbed acres would increase from a total of 47,200 acres (Proposed Action) to 61,696 acres (Alternative A). Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 3,037 acres. Following successful reclamation, the long-term disturbance would be about 770 acres, with an associated forage loss equivalent to approximately 90.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative A would have a small effect on the Adobe Town HMA as the initial disturbed acres for the four allotments within the CD-C portion of the HMA would total an estimated 503 acres as follows: Continental, 3 acres; Red Creek, 107 acres; South Flat Top, 393 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 107 acres, with an associated forage loss equivalent to 12.4 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage is so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.3 Alternative B: Enhanced Resource Protection

Alternative B was developed to avoid and/or mitigate significant impacts to specified resource values described in **Section 2.2.3** by implementing additional protections and mitigations beyond those normally applied. The wild horse resource is not identified as one that would receive enhanced protection directly. However, the wild horse resource may indirectly benefit because livestock forage would be afforded enhanced protective measures to avoid reaching the significance criteria. These include mitigation of adverse impacts on water features, thorough power-washing of field vehicles to reduce the spread of invasive weeds, and control of fugitive dust from roads and production facilities, along with surface disturbance thresholds which trigger review of reclamation efforts and potentially range improvement projects.

Impacts to wild horses resulting from implementation of Alternative B (**Section 2.2.3)** would be slightly less than the Proposed Action, decreasing from a total initial disturbance of 47,200 acres (Proposed

Action) to 45,516 acres (Alternative B). Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 2,253 acres. Following successful reclamation the long-term disturbance would be about 571 acres, with an associated forage loss equivalent to approximately 66.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative B would have small effect on the Adobe Town HMA as the initial disturbance for the four allotments within the CD-C portion of the HMA would total an estimated 371 acres as follows: Continental, 2 acres; Red Creek, 79 acres; South Flat Top, 290 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 107 acres, with an associated forage loss equivalent to 12.4 AUMs. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the wild horse resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less because of the surface cap restrictions. Total surface disturbance would be reduced from 47,200 acres (Proposed Action) to 42,955 acres (Alternative C), a 9-percent reduction.

Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 2,126 acres. Following successful reclamation, the long-term disturbance would be about 539 acres, with an associated forage loss equivalent to approximately 63.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative C would have a small effect on the Adobe Town HMA as the initial disturbance for the four allotments within the CD-C portion of the HMA would total an estimated 351 acres as follows: Continental, 2 acres; Red Creek, 75 acres; South Flat Top, 274 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 92 acres, with an associated forage loss equivalent to 10.7 AUMs. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the wild horse resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated project-wide, initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action. The initial forage lost under this alternative is estimated to be 1,131 AUMs less than the Proposed Action. The estimated 14,952 acres of long-term disturbance is estimated to be 3,908 acres less than the Proposed Action, representing about 411 fewer AUMs lost than the Proposed Action.

Although it is not known at the present time where future multi-well pads would be located in the Cyclone Rim allotment in the CD-C project area portion of the Lost Creek HMA, the estimated maximum initial disturbance within the Cyclone Rim allotment would be approximately 164 acres, which represents the equivalent of about a 19 AUM loss for the allotment. Following successful reclamation, the long-term disturbance would be about 80 acres, representing a forage loss equivalent to approximately 9 AUMs (based on an average stocking ratio of 8.6 acres per AUM).

It may also be assumed that with fewer well pads developed, there would be similar reductions in the number of access roads and road miles within the allotment which would decrease the potential for wild horse/vehicle collision hazards, as well as reduced human presence and reduced fugitive dust generation.

Alternative D would have a small effect (if any) on the Adobe Town HMA because of the small amount of acreage involved (see **4.10.3.1**). Because the relative loss of forage is so small, none of the four allotments in the Adobe Town HMA or the Lost Creek HMA within the Cyclone Rim allotment would undergo a reduction in the amount of AUMs allocated.

4.10.3.6 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area and there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities.

4.10.4 Impacts Summary

Impacts to wild horses associated with the action alternatives would include disturbed land and associated loss of available forage. Implementation of the Proposed Action would result in an initial loss of forage equivalent to approximately 69 AUMs within the project-area portion of the Lost Creek HMA, less than 0.2 percent of the total forage in the allotment. The Proposed Action would also have only a small effect on the Adobe Town HMA as the forage loss would be equivalent to 11.4 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

The alternatives to the Proposed Action would generally affect wild horses to a greater or lesser degree than the Proposed Action according to the increase or decrease in surface disturbance that would result from the alternative. However, because the relative loss of forage would be so small in each case, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated. The No Action Alternative would have the least impact upon wild horses because virtually none of the land in either HMA would be developed.

Incentives for successful reclamation, which are featured components of Alternative C, would be a positive impact to wild horses because it rewards timely reclamation, which can prevent and contain invasive species, thus reducing competition with native plants and consequently maximizing forage production.

Under Alternative D, it may be assumed that with the fewer well pads developed, there would be similar reductions in the number of access roads and road miles within the affected allotments which would decrease the potential of wild horse/vehicle collision hazards, as well as reduced human presence and reduced fugitive-dust generation, all of which would benefit the wild horse resource.

None of the alternatives would affect the opportunity for the public to view wild horses.

The risk of displacement of wild horses from the CD-C project area to areas outside the HMA boundaries is unknown at the present time.

Wild horse conflict with wildlife and livestock would be minimized provided the current AMLs for both HMAs are closely monitored and regulated by periodic gather-and-removal cycles.

4.10.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

No measurable unavoidable adverse impacts on the area's wild horse herds are expected under the Proposed Action or the other alternatives. However, one additional mitigation measure may further minimize the likelihood of impact on the herds. The Operators could enhance wild horse welfare by addressing the importance of the Wild Free-Roaming Horse and Burro Act of 1971 (Public Law 92-195) at all new-employee orientations. Such orientations would stress the fact that wild horses are federally protected and it is a violation of the Act to harass, injure, or destroy them, and that violations may result in citations being issued as appropriate. In addition, a violation of the Act would be considered a **significant** project impact by the BLM (**Section 4.10.3**). Overall avoidance of wild horses is the best policy to prevent unnecessary displacement and agitation of the horses and potential separation of small foals from their mares during the foaling season.

■ HUMAN ENVIRONMENT

4.11 VISUAL RESOURCES

4.11.1 Introduction

As described in **Chapter 3, Affected Environment**, the BLM manages approximately 60 percent of the CD-C project area as Visual Resource Management (VRM) Class III and approximately 40 percent as VRM Class IV. Chapter 3 identified the management objectives for the VRM class designations found in the project area as the following:

Class III. The objective of Class III is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate. Management activities may attract the attention of the casual observer but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV. The objective of Class IV is to provide for management activities that require major modifications to the existing character of the landscape. The level of change to the landscape can be high. The management activities may dominate the view and may be the major focus of viewer attention. Every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of the basic visual elements of form, line, color, and texture.

In other words, Class III and IV areas are intended for surface-disturbing activities that respectively cause moderate and high levels of landscape alteration. This summarizes the management guidance for VRM that appears in Appendix 25 of the ROD for the Rawlins RMP (BLM 2008b).

4.11.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for visual resources:

1. Establish VRM classes for the RMPPA.
2. Maintain the overall integrity of visual resource classes while allowing for development of existing and future uses.

Impacts to visual resources would be considered significant if the RFO is unable to meet the management objective for VRM established in the approved RMP, namely to "maintain the overall integrity of visual resource classes while allowing for development of existing and future uses" (Record of Decision and Approved Rawlins RMP, p. 2-48). This means that for the BLM to allow oil and gas development and production facilities within VRM Class III, the landscape change introduced by development must be moderate or reduced to moderate by mitigation in the form of BMPs as conditions of approval (Rawlins RMP FEIS, 4-393). Within VRM Class IV, the BLM permits oil and gas development and production facilities without additional mitigation because VRM Class IV allows for major modification of the existing landscape. However, the BLM does review individual permit applications in VRM Class IV and can ask oil and gas operators to voluntarily use the basic visual impact mitigation methods of adjustment in the siting of facilities, painting of facilities to reduce contrast with the natural landscape, and minimizing the amount of surface disturbance caused by construction and operations.

The impact analysis is based on interdisciplinary team knowledge of resources and the project area, review of existing BLM documents, and information provided by other agencies. **Map 3.11-1** presents VRM classes for the project area, and **Table 3.11-1** presents acreages for each VRM class. To compare the alternatives in terms of impact severity, the analysis uses the amount of initial and long-term surface disturbance presented in **Table 2.4-1** as a direct indicator.

4.11.3 Direct and Indirect Impacts

4.11.3.1 Proposed Action

Under the Proposed Action, the RFO would be able to meet its management objective for VRM within the project area. This is based upon the RFO's experience with development that has occurred in the project area to date.

The Proposed Action would create initial surface disturbance of 47,200 acres, or 4.4 percent of the project area. Most of the initial disturbance would be for well pads, structures, and roads. Interim reclamation would reduce surface disturbance to 18,861 acres, or 1.8 percent of the project area, which would remain as open disturbance for the life of the project, after which facilities would be removed and final reclamation would begin.

The RFO approach to mitigating the effects of oil and gas development to visual resources is to first enforce operator commitments to particular BMPs. Additional BMPs may be added as Conditions of Approval (COAs) on a site-specific basis in VRM Class III (**Section 2.2.1.7 Operator-Committed Practices**). This would mitigate the impact to the landscape and keep landscape modification at a moderate level.

As noted in **Appendix C**, BLM may require BMPs as COAs for APDs and other site-specific permits. Requirements or requests for site-specific mitigation occur during the review and NEPA analysis of APDs, right-of-way applications, and other individual permit applications.

As described in **Section 4.11.2**, oil and gas development and production facilities would be compatible with VRM Class III management objectives when the development, including adequate mitigation, yields a moderate level of landscape modification. **Figure 4.11.1** illustrates the moderate contrast introduced by development of a single natural gas production site, viewed in the foreground from a public road. The structures remain below the horizon line and are all painted in one suitable color, and the site and related roads have been reduced to the minimum adequate and safe size.

Figure 4.11.1. Example of existing site in the project area

In its analysis of the RMPPA, BLM anticipated that meeting VRM objectives would affect the placement of facilities associated with minerals exploration and development. This would exert a definite influence on finding acceptable locations where development might occur as well as the size and coloration of facilities depending on the visual class and location (Minerals, Rawlins RMP FEIS p. 4-87).

Since the project is an infill development in an existing natural gas field, new road construction would not be extensive. The primary access to the project area is I-80. Existing arterial roads, including WY 789 and several Sweetwater and Carbon county roads, provide access within the project area. New road construction would primarily be short sections of road from the existing road network to the individual new well sites and support facilities. Some existing access roads may need to be improved to accommodate increased traffic. At the project scale, incremental road development would be low for a project of this size, which means a relatively low level of surface disturbance.

At the site-specific level within VRM Class III, individual facilities may modify the visual character of a view from a given “key observation point” (KOP) such that BMPs other than those explicitly committed to by the Operator may be needed for adequate mitigation (see **Appendix C** for the full list of BMPs). BLM may impose additional BMPs as COAs to site-specific permits. However, some BMPs that involve facility siting, road alignment, and the scale or configuration of equipment would have to be evaluated in each case for consistency with prior terms of valid minerals leases.

Despite operator-committed practices, oil and gas development under the Proposed Action would unavoidably affect the visual resources of the project area by modifying the landscape (**Figure 4.11.1**). Development removes existing vegetation, replacing it with bare ground, graveled roads and pads, and structures related to drilling and production. The “built” forms, lines, colors, and textures contrast with natural landscape elements, though mitigation can reduce the level of contrast.

In addition, as described in **Section 4.11.3,** oil and gas development is compatible *per se* with VRM Class IV management objectives because a designation of VRM Class IV determines that major modification of the existing character of the landscape would be permitted. At the level of a large-scale development such as that proposed for the project area, this is a categorical determination. In effect, the designation of areas as VRM Class III or VRM Class IV reflects a planning level (RMP) decision to allow oil and gas development to affect visual resources, subject to more individualized and site-specific conditions of approval in VRM Class III that can only be determined once site-specific permitting begins.

Operator implementation of BMPs would lower the visual impact of site-specific development even in the VRM Class IV part of the project area. Committed BMPs include interim reclamation of well locations and access roads, painting new facilities with a suitable environmental color, and building new roads to a “no higher than necessary” standard which reduces surface disturbance. Despite the application of committed BMPs, a high level of change could occur under the Proposed Action in the parts of the project area that are in VRM Class IV but are still relatively natural. In such areas, oil and gas facilities could dominate the view of even the casual observer and perhaps discourage or displace activities for which a setting with natural character is desired.

Section 3.11.3 described how, in parts of the project area where public and private land-ownership is intermingled in a “checkerboard” pattern, much of the private land may not be subject to BLM administration. The BLM’s authority over visual resources extends only to where BLM owns the surface or the oil and gas beneath the surface. In the checkerboard specifically and wherever non-BLM in-holdings exist, the BLM would mitigate the visual impact of development on the BLM-administered surface as best it can and would encourage oil and gas developers to apply comparable mitigation to adjacent privately owned surface. Development not managed by the BLM that occurs on non-BLM sections in the checkerboard or other in-holdings may not attain BLM standards and so may indirectly degrade the appearance of the landscape on the BLM land.

Oil and gas development would be quite apparent from the road network in the project area. The road network of the project area is extensive, so any development visible from an established road would be in the foreground to middle ground of the view from (i.e., within 5 miles of) the road (BLM 2011a).

The site-specific analysis called for in permitting APDs and other individual development proposals contained within the Proposed Action would require the selection of KOPs. A KOP is a proxy for the location of a casual viewer sensitive to scenic quality. All KOPs in the project area are likely to be on the state, county, and BLM roads used by hunters, sightseers, and wildlife watchers. **Table 4.11-1** lists the roads in the project area that access Class III areas in the northern and southern part of the project area. BLM would consider the view of a well site, road, or other facility from identifiable KOPs during the site-specific analysis of the application for a permit.

Table 4.11-1. Roads accessing VRM Class III in the CD-C project area where users would likely see oil and gas facilities under the action alternatives

Northern part of project area		Southern part of project area	
Road	**Common Name**	**Road**	**Common Name**
CR 20	Luman Road	WY 789	Baggs–Creston Junction Highway
CR 23N	Wamsutter–Crooks Gap Road	BLM 3216	Robbers Gulch Road
CR 67	Tipton (North) Road	BLM 3321	Little Robbers Gulch Reservoir Road
BLM 3207	Red Desert Road	--	--

Notes:
1. All county roads are in Sweetwater County.
2. All roads would likely access foreground to middle-ground views of facilities within 3 to 5 miles or less of the viewer.

Given successful final reclamation, impacts to visual resources are not irretrievable. However, they are long term. During the process of final reclamation of the Proposed Action, reclaimed land would potentially present evidence of disturbance that would have a residual effect on scenic quality until vegetative treatments mature. The road network would contribute the most to this type of impact; even reclaimed roads may present obviously intrusive linear features on the project area landscape lasting long after the life of the project.

4.11.3.2 Alternative A: 100-Percent Vertical Drilling

Allowing 100-percent vertical drilling (one well per pad) would increase the visual impacts of development. In the short term, Alternative A would disturb 61,696 acres, or 5.8 percent of the project area. This is 31 percent more initial disturbance than would be caused by the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 24,133 acres, or 2.3 percent of the project area, which would remain open for the life of the project under Alternative A, after which facilities would be removed and final reclamation would begin. Alternative A would cause about 28 percent more long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be higher roughly in proportion to the greater amount of disturbance.

The compatibility of Alternative A with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and COAs would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing landscape character. Oil and gas development is compatible *per se* with VRM Class IV, which allows for major modification to existing landscape character.

4.11.3.3 Alternative B: Enhanced Resource Protection

Alternative B would slightly decrease the potential for visual impacts of development compared to the Proposed Action. In the short term, Alternative B would disturb 45,516 acres, or 4.3 percent of the project area. This is 4 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 18,249 acres, or 1.7 percent of the project area, that would remain open for the life of the project under Alternative B, after which facilities would be removed and final reclamation would begin. Alternative B would cause about 3.0 percent less long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be roughly the same for Alternative B as for the Proposed Action.

The compatibility of Alternative B with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and COAs would allow oil and gas development to be compatible with VRM Class III, which allows for moderate change to existing landscape character. Oil and gas development is compatible per se with VRM Class IV, which allows for major modification to existing landscape character.

Under Alternative B, enhanced protection measures for biological resources would reduce impacts to visual resources because of their broad aim to reduce surface disturbance. Measures to minimize biological disturbance of the Chain Lakes Alkaline Wetlands and Other Playas would particularly benefit scenic quality because these features characterize the natural landscape of the northern part of the project area (BLM 2011a).

4.11.3.4 Alternative C: Surface Disturbance Cap, High and Low Density Development Areas

Alternative C would modestly decrease the potential for visual impacts of development, compared to the Proposed Action. In the short term, Alternative C would disturb 42,955 acres, or 4.0 percent of the project area. This is 9.0 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative C would reduce surface disturbance to 17,318 acres, or 1.6 percent of the project area, which would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative C would cause about 8.0 percent less long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be slightly less for Alternative C than for the Proposed Action.

The compatibility of Alternative C with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing landscape character. Oil and gas development is compatible per se with VRM Class IV, which allows for major modification to existing landscape character.

The surface-disturbance caps under Alternative C would put an upper limit on the impact to scenic quality that would occur at points in time during the life of the project.

4.11.3.5 Alternative D: Directional Drilling

Alternative D would decrease the the potential for visual impacts of development, compared to the Proposed Action. In the short term, Alternative D would disturb 36,449 acres, or 3.4 percent of the project area. This is 23 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 14,952 acres, or 1.4 percent of the project area, that would remain open for the life of the project under Alternative D, after which facilities would be removed and final reclamation would begin. Alternative D would cause about 21 percent less long-term disturbance than the Proposed Action.

The compatibility of Alternative D with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing landscape character. Oil and gas development is compatible *per se* with VRM Class IV, which allows for major modifications to existing landscape character.

The likelihood of casual observers encountering visual impacts to views within the project area would be less for Alternative D than for the Proposed Action. In addition, if Alternative D achieves fewer and less densely distributed well pads and fewer associated roads, pipelines, and other facilities, a casual viewer observing from points along the interior road network of the project area may encounter oil and gas related disturbance somewhat less frequently because of the wider distribution of pads and related development.

This would benefit parts of the CD-C project area, especially those located in VRM Class III. When combined with less surface disturbance overall, the probability that a more compact pattern of development would be seen somewhat less often as a visitor moves through the landscape could lead casual viewers to be more accepting of modification to the existing character of the landscape. Thus, development under Alternative D could be more consistent with the management objective of landscape retention in areas now rated VRM Class III.

4.11.3.6 Alternative E: No Action

Under Alternative E, none of the impacts to visual resources described under the Proposed Action or under Alternative A through Alternative D would occur. The key assumption for the analysis of Alternative E is that no further oil and gas development would occur in the project area and there would be no further change to the existing character of the landscape as a result of new oil and gas development. In addition, as oil and gas facilities gradually become obsolete over time, much of the project area now affected by oil and gas development would gradually return to a more natural-appearing scenic quality, assuming the success of past reclamation planning and its implementation in the future.

The likelihood of casual observers encountering visual impacts to views within the project area because of oil and gas development would, over time, gradually become less than today for Alternative E and much less in the long term than for the Proposed Action, because it is assumed that Alternative E would lead to no new oil and gas development and that existing oil and gas facilities would eventually become obsolete and be reclaimed.

4.11.4 Impact Summary

Compared to the Proposed Action,less degradation of landscape quality would occur under Alternatives B, C, and D and more would occur under Alternative A. Under Alternative E, no new oil and gas development would occur, and there would be no further change to the existing character of the landscape because of new development.

The character of the surface disturbance and the character of the impacts to visual resources would be similar under all action alternatives because they would consist in all cases of drill sites and equipment, production pads and facilities, access roads, and utilities. The level of impact to landscape quality would vary roughly in proportion to the difference among the alternatives in terms of the level of development and the resulting amount of initial and long-term surface disturbance. Under Alternative E, No Action, much of the project area now affected by existing oil and gas development would gradually return to a more natural-appearing scenic quality, assuming reclamation success over time.

4.11.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives would create contrasting lines, forms, colors, and textures in the landscape through the removal of existing vegetation and the introduction of drilling and production facilities and access roads. Visual resources would be unavoidably adversely impacted for the life of the project and beyond until the surface has returned to a condition that is comparable to the surrounding natural area. The level of contrast would be more evident in areas with little or no current energy development.

Approximately 60 percent of the project area is managed as VRM Class III, where the level of change must be moderate or reduced to moderate using mitigation measures, operator-committed measures, and BMPs applied at the discretion of the RFO as conditions of approval for site-specific APDs. The remaining 40 percent of the project area is managed as VRM Class IV, where major modifications of the landscape are allowed. Because both VRM Class III and Class IV allow for modification of the landscape, no additional visual mitigation measures would be necessary for the CD-C project.

4.11.6 Effect of the VRM Amendment to the Resource Management Plan

As noted in **Section 3.11.4**, the RFO must use the existing 1990 VRM classifications to manage visual resources in the CD-C project area. However, the BLM has begun the VRM-RMP amendment process and intends to finalize the VRM amendment to the RMP by the end of 2013 (**Section 3.11.5**). A VRM amendment may lead to changes in the classification of land within the CD-C project area, based on the findings of the 2011 visual resource inventory (**Section 3.11.3**).

Changes to the classification of land within the CD-C project area could affect the analysis of impacts to visual resources in terms of how many acres of land are governed by the management objectives of VRM Class III or VRM Class IV. In its decision on the CD-C project, the BLM would seek to attain the management objectives for each VRM class that is in effect.

4.12 RECREATION

4.12.1 Introduction

This section presents impacts to recreation from the Proposed Action and alternatives. Recreational uses on public lands administered by the BLM within the project area include hunting, off-highway vehicle (OHV) use, wildlife viewing, and pleasure driving on public roads. The affected environment for recreation resources is described in **Section 3.12, Recreation**, with recreation features of the project area illustrated in **Map 3.12.1.**

4.12.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for recreation resources:

1. Provide for the health and safety of visitors.
2. Prevent or mitigate resource damage resulting from recreation uses.
3. Coordinate with other programs to minimize conflicts and adverse impacts on recreational opportunities.
4. In the Western Extensive Recreation Management Area (ERMA), consider the above recreation objectives during development involving surface-disturbing or disruptive activity. Consider the Adobe Town Dispersed Recreation Management Area desired future condition during development involving surface-disturbing or disruptive activity.
5. In the Eastern ERMA (RMP Map 2-17), retain the quality of dispersed recreation opportunities and settings (with the exception of isolated development areas, such as coal mines or wind generation facilities) while meeting the above recreation objectives.
6. Provide public education regarding appropriate use of BLM lands.
7. Provide opportunities for public use, interpretation, education, and appreciation of natural and cultural resources.

Impacts to recreation would be considered significant if any of the following were to occur:

1. Management actions result in long-term elimination or reduction of recreation use in any area or compromise public health and safety.
2. Intensity of development is incompatible with the stated objectives of Special Recreation Management Areas (SRMAs).
3. Increases in recreational activity create substantial risks to public health and safety or resource damage.

4.12.3 Direct and Indirect Impacts

4.12.3.1 Proposed Action

Under the Proposed Action, the RFO would be able to meet its management objectives for recreation within the project area. This is because the Operators have incorporated IM WY-2004-194, Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights-of-Way. The Operators cite this IM as prompting their commitment to considering several BMPs in nearly all circumstances during development. Several of the cited BMPs would have the effect of lowering surface disturbance (**Section 2.2.1.7 Operator-Committed Practices**). Lowering surface disturbance would lower impacts to big-game wildlife (see **Section 4.8 Wildlife**), and lower impacts to big game would in turn indirectly lower impacts to hunting, the main recreation activity that currently exists in the project area.

Pursuant to a general agreement with the WGFD, the Approved RMP directs the BLM to intensively manage surface-disturbing and disruptive activities to reduce impacts to wildlife (Rawlins RMP 2-33). Interactions with the WGFD over management of development's impacts to wildlife under the Proposed Action would also indirectly lower impacts to hunting recreation.

In addition, BMPs that lower surface disturbance would reduce impacts to visual resources. Lower impacts to visual resources would indirectly reduce impacts to recreation settings, which in turn would indirectly reduce impacts to hunting and to non-consumptive, dispersed recreation in the project area such as wildlife observation, OHV recreation, and driving for pleasure.

The level of impact to recreation from the Proposed Action would correlate with measures of surface disturbance. The Proposed Action would create initial surface disturbance of 47,200 acres, or 4.4 percent of the project area. Most of the initial disturbance would be for well pads, structures, and roads. Interim reclamation would reduce surface disturbance to 18,861 acres, or 1.8 percent of the project area, which would remain as open disturbance for the life of the project, after which facilities would be removed and final reclamation would begin.

Despite Operator-committed practices, oil and gas development under the Proposed Action would unavoidably affect recreation resources of the project area by modifying supplemental values important for recreation quality. As part of the natural gas development process, new roads could create access to areas that previously were not used for recreation. However, the industrial character associated with oil and gas activity introduces contrasting elements affecting scenic quality, which would displace some recreationists to other areas. Supplemental values and resources such as scenic quality, solitude, and wildlife would be degraded and would interfere with recreationists' goals and experiences. Eventually, successful final reclamation would rehabilitate the recreation settings to be found in the project area. However, the time needed to accomplish this would potentially span more than one generation of recreatoinists.

Overall, the intensity of impacts to recreation under the Proposed Action would vary roughly in proportion to the change in the density of well development. In addition, impact intensity would vary within the project area depending on the extent of new well development as compared to the density of existing development.

Thus, the intensity of impacts to recreation would be highest in the northern part of the project area, where natural gas development is less dense to date and where the Chain Lakes WHMA and the large block of public land northwest of the WHMA are a resource for big game hunting and other wildlife-based recreation. Similarly, impacts to the WGFD Carbon County Walk-In Area #1 would be relatively high because less development has occurred to date in this part of the project area.

Natural gas development raises health and safety issues for the BLM because of conflict that may arise between industrial traffic and recreational traffic. The hazard associated with road use would potentially rise in proportion to the amount of gas development, plus the trend in recreational use.

At Little Robbers Gulch Reservoir in the southern part of the project area, unrestricted surface-disturbing activity nearby would degrade the setting of the undeveloped recreation site. However, low water levels in the agricultural reservoir have already degraded the site's appeal as a fishing hole and group campsite during hunting season, meaning that further degradation of the setting at the reservoir may have less importance to recreationists because of the already declining usage for other reasons.

Recreation use displaced from the project area could find substitute opportunities elsewhere within the RFO or in adjoining BLM field offices. This applies equally to hunting, wildlife viewing, and pleasure driving. However, these resources would likely be farther away for recreationists who now use the CD-C project area; additionally, resources elsewhere may themselves be under increasing pressure from fluid minerals development and development of other resources potentially conflicting with recreation.

4.12.3.2 Alternative A: 100-Percent Vertical Drilling

With 100-percent vertical drilling (one well per pad) there would be no reduction of surface disturbance as there would be from using directional drilling and pads with multiple wells. Alternative A would disturb 61,696 acres in the short term, which is 5.8 percent of the project area. This is 31 percent more initial disturbance than would be caused by the Proposed Action.

Interim reclamation would reduce un-revegetated surface disturbance to 24,133 acres (2.3 percent of the project area); this would remain open for the life of the project under Alternative A, after which facilities would be removed and final reclamation would begin. Alternative A would cause about 28 percent more long-term disturbance than the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

The relative intensity of impacts to recreation would be highest in the parts of the project area where previous well density has been no more than one or two wells per section. The likelihood of impacts to recreation would be higher roughly in proportion to the greater amount of disturbance and rise in well density.

4.12.3.3 Alternative B: Enhanced Resource Protection

Alternative B Enhanced Resource Protection would slightly decrease the potential for impacts to recreation compared to the Proposed Action. In the short term, Alternative B would disturb 45,516 acres, or 4.3 percent of the project area. This is 4 percent less initial disturbance than for the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative B would reduce surface disturbance to 18,249 acres (1.7 percent of the project area); this would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative B would cause about 3 percent less long-term disturbance than the Proposed Action.

Under Alternative B, impacts would be more apparent in the parts of the project area where previous well density has been no more than one or two wells per section. The likelihood of impacts to recreation would be roughly the same for Alternative B as for the Proposed Action. However, specific measures to benefit big game wildlife habitat that are among the enhanced protections included in Alternative B may provide some additional mitigation of impacts to wildlife and in turn reduce impacts to the hunting-based recreation that predominates in the project area.

4.12.3.4 Alternative C: Surface Disturbance Cap, High and Low Density Development Areas

Alternative C would modestly decrease the potential for recreation impacts from development, compared to the Proposed Action. In the short term, Alternative C would disturb 42,955 acres, or 4 percent of the project area. This is 9 percent less initial disturbance than for the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative C would reduce surface disturbance to 17,318 acres, or 1.6 percent of the project area, which would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative C would cause about 8 percent less long-term disturbance than the Proposed Action.

The likelihood of impacts to recreation would be higher roughly in proportion to the greater amount of disturbance. However, the surface disturbance caps under Alternative C would put an upper limit on the impact to recreation that would occur at points in time during the life of the project.

4.12.3.5 Alternative D: Directional Drilling

Alternative D would decrease the potential for recreation impacts, compared to the Proposed Action. In the short term, Alternative D would disturb 36,449 acres, or 3.4 percent of the project area. This is 23 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 14,952 acres, or 1.4 percent of the project area; this would remain open for the life of the project under Alternative D, after which facilities would be removed and final reclamation would begin. Alternative D would cause about 21 percent less long-term disturbance than the Proposed Action.

The likelihood of impacts to recreation within the project area would be somewhat less for Alternative D than for the Proposed Action. Alternative D further lowers surface disturbance and therefore lowers the direct loss of habitat, improving the chance of retaining herd sizes in the CD-C project area. A more compact pattern of development under Alternative D would also benefit big game wildlife management long term by lowering habitat fragmentation and disturbance from human activity because fewer well pad access roads would be constructed. The benefit to big game wildlife management under Alternative D would lower the impact to hunting recreation during the life of the project.

4.12.3.6 Alternative E: No Action

Under Alternative E, none of the impacts to recreation described under the Proposed Action and Alternatives A through D would occur, so there would be no further change to recreation resources in the CD-C project area because of new oil and gas development. In addition, as existing oil and gas facilities gradually become obsolete over time, those parts of the project area now affected by oil and gas development could gradually return to a reclaimed condition that is intended to attain a more natural-functioning character. The effect of reclaiming obsolete oil and gas facilities could be positive for the recreation resource if the current trend toward habitat loss, degradation of recreation settings, and growth in human intrusion is stabilized for a number of years or perhaps reversed to some degree.

4.12.4 Impact Summary

Under the Proposed Action, the RFO would be able to meet its management objective for recreation within the project area because the project area is within the RFO's Western ERMA, where restriction or avoidance of surface-disturbing and disruptive activities to protect recreation is not required by the Rawlins RMP. Consistent with the RMP's management prescription for the Western ERMA, the Operators have incorporated BLM IM 2004-194, Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights-of-Way. Operator-committed practices noted in **Section 2.2.1.7 Operator-Committed Practices** would lower surface disturbance, impacts to big game, and indirectly the impacts to hunting, the main recreation activity in the project area.

The intensity of impacts to recreation from the Proposed Action and other action alternatives would correlate to the variation in long-term surface disturbance by alternative:

- Proposed Action—18,861 acres (1.8 percent of the project area)
- Alternative A: 100-Percent Vertical Drilling—24,133 acres (2.3 percent of the project area)
- Alternative B: Enhanced Resource Protection—18,249 acres (1.7 percent of the project area)
- Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section —17,318 acres (1.6 percent of the project area)
- Alternative D: Directional Drilling—14,952 acres (1.4 percent of the project area)

Under Alternative E, none of the impacts to recreation described under the Proposed Action and Alternatives A through D would occur. Thus, there would be no further change to recreation resources in the CD-C project area because of new oil and gas development. As existing oil and gas facilities gradually become obsolete over time and are reclaimed, the effect could be positive for the quality of the recreation resource.

4.12.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives may result in a reduction or long-term elimination of recreation—most notably hunting—within portions of the project area that are directly affected by short-term or long-term surface disturbance. Impacts to big game as a result of the Proposed Action and alternatives may also indirectly impact hunting and wildlife viewing. However, because the project area lies entirely within the RFO's Western ERMA, the Rawlins RMP does not require restrictions or avoidance of surface-disturbing or disruptive activities to protect recreation. No additional mitigation would be required beyond Operator-committed measures and BMPs.

4.13 LANDS WITH WILDERNESS CHARACTERISTICS

No Lands with Wilderness Characteristics (LWCs) are located within the boundaries of the CD-C project area. Therefore, the Proposed Action and alternatives are in compliance with the RMP, which provides for oil and gas development on multiple-use lands within the RFO, subject to BLM approval and permitting.

As directed by BLM Manual Sections 6310 and 6320 (BLM 2012f, 2012g),[21] and in compliance with FLPMA Sections 201 and 202, the RFO will maintain the inventory of LWCs on a continuing basis and

[21] Instruction Memorandum (IM) No. 2011-154 , dated July 25, 2011, and transmitted July 26,2011, directs offices to continue to conduct and maintain inventories regarding the presence or absence of wilderness characteristics, and to consider identified lands with wilderness characteristics in land use plans and when analyzing projects under NEPA. The IM places BLM Manuals 6301, 6302, and 6303, dated February 25, 2011, into abeyance until further notice. The policy expressed in the IM was developed by the Division of the National Landscape Conservation System and the Division of Decision Support, Planning and NEPA of the BLM.

rely on its inventory of LWCs in the development and revision of land use plans and when making subsequent project level-decisions.

4.14 CULTURAL AND HISTORICAL RESOURCES

4.14.1 Introduction

Cultural resources on public lands, including archaeological sites and historic properties, are protected by various laws and regulations, for example the National Historic Preservation Act of 1966 (NHPA), Governing Regulations, and 36 CFR Part 800. The specific directives can be found in "Archaeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines" (Federal Register 1983). Laws and regulations concerning cultural resources stipulate that the proposed undertaking take into consideration the effects of the action to significant cultural resources. This requires that cultural resources within the proposed area of potential effect (APE) be identified and evaluated. Measures must be taken to mitigate or minimize any adverse effects to those historic properties included in, or eligible for, the National Register of Historic Places (NRHP). The Wyoming Cultural Records Office documents 4,860 sites in the project area, as summarized in **Section 3.14.3**. **Appendix J, Cultural Resources Management**, describes how the BLM applies cultural laws and regulations to the inventory, classification, protection, and mitigation of cultural resources located on public lands.

Many of the historic and prehistoric sites within the project area are located in eolian sand deposits with increased site density near playa lakes and springs. An extensive sand dune complex is located within the CD-C project area which has been designated Site 48CR5784. This area differs from other eolian sand dunes in the project area in that the eolian deposits are relatively stable and continuous for a nine-square-mile area. Very little development has occurred in this sand dune complex and the integrity of any cultural deposits has not been assessed. Soils mapping and a site-specific treatment plan were completed for the EIS.

The BLM has designated a quarter-mile buffer surrounding the contributing segments of the historic trails and associated sites as highly sensitive. These eligible linear resources include the Overland and Cherokee Trails, the 1868 Union Pacific Railroad Grade, and the Lincoln Highway. All but the Cherokee Trail are located in the checkerboard land pattern; however, for the basis of this analysis, the calculations include both the public and private land. For management purposes, the BLM has established a two-mile analysis area around the trails for consideration of the elements of setting, defined as those elements of integrity of location, feeling, and association that contribute to the eligibility of the trails or associated sites. Although 2 miles is the standard distance for consideration of setting, it does not preclude the consideration of a larger area, depending on the circumstances.

4.14.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management goals associated with cultural resources:

1. Develop management plans for special areas or cultural resources (e.g., Aimee Eaton site, Powder Wash, Robbers Gulch, and Muddy Creek site complex) in areas of high risk for development or at high risk for adverse effects.
2. Maintain setting for those contributing portions of historic properties where setting is an aspect of integrity by utilizing viewshed management tools (e.g., sacred sites, Lincoln Highway, Union Pacific Railroad [UPRR], and associated sites).
3. Monitor the condition of historic properties that are known to be under threat from development or vandalism.

4. Identify cultural resources in the RMPPA by defining priority geographic areas for new field inventory, based on probability for unrecorded significant cultural resources.
5. Develop a public outreach and education program to instill a conservation ethic in the public regarding cultural resources.
6. Develop and maintain interpretation of cultural resources in areas of high public interest and access.
7. Consult proactively with Native American tribes as appropriate to identify resource types or places that may be affected by BLM authorizations or actions.
8. Seek opportunities for cooperation with tribal governments for management of cultural resources and public education.
9. Maintain an inventory and evaluate historic transportation routes for contributing or noncontributing status (Appendix 5).

The RMP also prescribes the following management goals for Historic Trails (Cherokee, Overland, Rawlins to Baggs, etc):

1. Develop management plans for historic trails or segments of historic trails in areas of high risk for development or at high risk for adverse effects.
2. Maintain setting for those contributing portions of historic trails where setting is an important aspect of integrity by utilizing viewshed management tools.
3. Monitor the condition of contributing portions of historic trails that are known to be under threat from development.
4. Maintain an inventory and evaluate trail segments and associated sites for contributing or noncontributing status.
5. Provide educational opportunities and public outreach programs.
6. Develop and maintain interpretation of historic trails in areas of high public interest and access.
7. Manage historic trails and other resources for long-term heritage, recreational, and educational values.

Impacts would be considered significant if management actions result in adverse effects to properties listed or determined eligible for listing on the NRHP or considered important to Native American groups as measured by:

- Destruction or alteration of all or part of a property.
- Isolation of a cultural resource from, or alteration of, its surrounding environment.
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting.
- Neglect and subsequent deterioration.

The criteria for evaluating cultural resource significance are described in the Code of Federal Regulations (36 CFR 60.4):

> “The quality of significance in American history, architecture, archaeology, engineering, and culture present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:

1. that are associated with events that have made a significant contribution to the broad patterns of our history; or
2. that are associated with the lives of persons significant in our past; or
3. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

4. that have yielded, or may be likely to yield, information important in prehistory or history."

For cultural sites, both prehistoric and historic, significance is primarily judged either by the site's ability or potential to yield information important in prehistory or history (Criterion D) or the site's association with events that have made a significant contribution to the broad patterns of our history (Criterion A). Each site's importance, however, is determined individually, so the existence of sites eligible under Criteria B or C must not be discounted.

The BLM meets its responsibilities under Section 106 of the NHPA through implementation of a national Programmatic Agreement among the BLM, the Advisory Council on Historic Preservation (ACHP), the National Conference of State Historic Preservation Officers, and a state protocol with the Wyoming State Historic Preservation Office (SHPO) rather than by following the procedures set forth in the ACHP's regulations (36 CFR Part 800).

The preferred strategy of cultural resource management is avoidance of effect to those elements that contribute to the eligibility of a historic property. If this strategy cannot be implemented, mitigation of effects by project redesign, data recovery, project cancellation, or numerous other mitigation options should be implemented.

4.14.3 Direct and Indirect impacts

4.14.3.1 Proposed Action

Eleven percent of the project area has been subject to Class III cultural resource inventory as a result of previous development. These inventories indicated a cultural site density of 0.04 sites per acre. Of the total sites within the project area, 23 percent on average could be expected to be eligible for the NRHP. These calculations assume that the area-wide site density is equal across the project area and that the 11 percent of the area inventoried is a valid sample. With an estimated surface disturbance of 47,200 acres, the Proposed Action could affect an estimated 1,888 sites. Of these, 434 could be eligible for nomination to the NRHP.

Gauging the effect of any impact depends on the level of information available for that particular property provided by inventory and/or testing data. In compliance with Section 106 of the NHPA, a Class III cultural resource inventory would be conducted for the proposed area of disturbance associated with each APD or other proposed project activity. The inventory would identify cultural resources either eligible or ineligible for inclusion on the NRHP and whether any of the NRHP-eligible sites would be adversely affected. The values that render a cultural resource eligible for the NRHP would dictate what type and kind of impacts are of concern. If a cultural resource is not listed on the NRHP or is determined by the BLM and SHPO as not eligible for listing on the NRHP, it is not a historic property for purposes of the NHPA and does not need to be considered under Section 106.

For NRHP-eligible sites located in proposed disturbance areas, site avoidance is the preferred method of mitigation. However, when avoidance is not feasible, if any cultural resources listed on or eligible to the NRHP would be adversely affected by the Proposed Action, adverse effects would be appropriately mitigated as directed in Section 106. The Operator, in consultation with the BLM and the SHPO and with input from other interested parties per 36 CFR Part 800.6 and the Statewide Protocol Section VII, shall develop a mitigation plan designed to eliminate the adverse effects. These additional mitigation measures would be developed in accordance with BMPs and COAs outlined in **Appendix C**. Construction would not proceed until the terms of the mitigation plan were satisfied. Impacts to historic properties from projects occurring in the absence of a federal undertaking (federal authorization) would be beyond federal control. Data recovery (i.e., archaeological excavation), photo-documentation, additional archival research, or any other form of mitigation would be identified as part of the APD process and implemented prior to ground-disturbing activities associated with the Proposed Action. Implementation of appropriate mitigation measures would eliminate or minimize project-related adverse effects, and required additional mitigation measures would meet or exceed these criteria. Data derived through mitigation could provide beneficial information on prehistoric and historic use in the CD-C project area, as well as contribute to the regional database for cultural resources.

Direct impacts would primarily take the form of alteration or disturbance of previously unidentified sites. Physical disturbance of eligible sites could result from construction activities and associated operations and could adversely affect undiscovered archaeological sites. Cultural resource inventories may not locate all significant sites. Buried sites—in particular, burials—may be missed in the course of field investigations. If construction or other project personnel discover what may be human remains, funerary objects, or items of cultural patrimony on federal land, construction would cease within the vicinity of the discovery, and the Authorized Officer (AO) would be notified of the find. The AO would notify the appropriate County Sheriff and state medical examiner. Any discovered Native American human remains, funerary objects, or items of cultural patrimony found on federal land would be handled in accordance with the Native American Graves Repatriation Act. Non-Native American human remains would be handled in accordance with Wyoming law. Construction would not resume in the area of the discovery until the AO has issued a notice to proceed.

Iincreased indirect impacts to archaeological sites could result from increased access within the project area, as well as increases in both surface activities and number of workers during construction associated with the Proposed Action. Potential indirect effects would include changes in erosion patterns due to construction, soil compaction, or vegetation removal; fugitive dust; off-road vehicle traffic associated with construction or maintenance activities; and increased vandalism, including illegal artifact collection, due to increased access. Where the setting of historic trails and associated sites contributes to NRHP eligibility, actions resulting in the introduction of visual elements that diminish the integrity of the property's significant historic features must be mitigated. Best management practices to reduce visual impacts such as consolidation of facilities, low-profile tanks, and paint that blends with terrain would be implemented.

4.14.3.2 Alternative A: 100-Percent Vertical Drilling

Impacts to prehistoric and historic properties under Alternative A would be the greatest. With an estimated surface disturbance of 61,696 acres, an estimated 2,467 sites could be affected, of which 568 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.3 Alternative B: Enhanced Resource Protection

Under Alternative B, with an estimated surface disturbance of 45,516 acres, an estimated 1,821 sites could be affected, of which 418 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.4 Alternative C: Surface Disturbance Cap with High and Low Density Development Areas

Under Alternative C, with an estimated surface disturbance of 42,955 acres, an estimated 1,718 sites could be affected, of which 395 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.5 Alternative D: Directional Drilling

Under Alternative D, with an estimated surface disturbance of 36,449 acres, an estimated 1,458 sites could be affected, of which 335 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.6 Alternative E: No Action

Under Alternative E, because there would be no new natural gas development and no new surface disturbance, no sites would be affected and no cultural studies would be required as a result of this project. Impacts to historic properties from activities occurring in the absence of federal authorization would be beyond the oversight of the BLM.

4.14.5 Impact Summary

Impacts to cultural resources are assumed to be proportional to the amount of new surface disturbance for each alternative (i.e., increased disturbance would result in a proportionately increased potential for adverse impacts to prehistoric and historic resources). Impacts under Alternative A would be the greatest, with an estimated 2,467 sites that could be affected. Impacts would decrease proportionately for the Proposed Action (1,888 potentially affected sites), followed by Alternatives B (1,821 potentially affected sites), C (1,718 potentially affected sites), and D (1,458 potentially affected sites). No impacts would occur under Alternative E, No Action, because there would be no new natural gas development and no new surface disturbance. Avoidance and mitigation would remove the potential for significant impacts on public lands for all alternatives.

4.14.6 Unavoidable Adverse Impacts and Additional Mitigation Measures

Cultural resource inventories may not locate all significant sites—especially burials or other buried sites—resulting in unintentional destruction, alteration, or disturbance of artifacts or sites during construction and associated operations. Cultural resources may also become isolated from their surroundings if they are not discovered prior to project development, and/or the character or physical components of their settings may be altered by the introduction of visual, audible, or atmospheric elements. **Appendix C** describes mitigation measures for the inventory and protection of cultural sites discovered during project operations. No additional mitigation measures would reduce or eliminate impacts to undiscovered sites.

Mitigation measures that would affect Historic Properties for which setting is an Aspect of Integrity, including visual, auditory, and atmospheric impacts, are described in **Appendix C**. The following additional mitigation measures would apply to all development activities under all alternatives that would affect those elements of a setting:

- Begin reclamation at the time most optimal to regenerate the native species.
- Replace native shrubs to decrease visibility.
- Construct roads in minimally visible areas.
- Relocate project or hide disturbance.
- Use matting on rights-of-way during construction to minimize surface disturbance and visibility.
- Allow no surface disturbance within a quarter-mile or the visual horizon, whichever is closer, of contributing segments of historic trails or trail-associated sites.
- Limit trail crossings to existing disturbance corridors or non-contributing segments, unless otherwise determined by BLM in consultation with the SHPO.

An additional mitigation measure that may serve to minimize visual impacts to the setting of Historic Properties is the use of low-profile tanks.

Direct impacts to other cultural resources would be further minimized by any mitigation measures that reduce the amount of surface disturbance using modified construction techniques.

4.15 SOCIOECONOMICS

This section provides an assessment of social and economic effects of the Proposed Action and Alternatives.

4.15.1 Planning Documents and Regulations

4.15.1.1 Rawlins RMP

The Rawlins RMP (BLM 2008a) provides the following management goals and objectives for socioeconomics.

Management Goals

1. Provide opportunities to develop national energy resources on BLM-administered lands within the RMP project area.
2. Provide opportunities to develop resources other than those related to energy (e.g., grazing, recreation, wildlife, fisheries, and tourism) on BLM-administered lands within the RMP project area.
3. Provide opportunities to sustain the cultural, social, and economic viability of local and regional communities by using decision review processes that include considerations of various potential impacts of BLM decisions, including: housing, employment, population, fiscal impacts, social services, cultural character, and municipal utilities.

Management Objectives

1. Work cooperatively with private and community groups and local government to provide for customary uses consistent with other resource objectives and to sustain or improve local, regional, and national economies.
2. Maintain and promote the cultural, economic, ecological, and social health within the RMP project area.

4.15.1.2 County Land Use Plans

Carbon County

The Carbon County Land Use Plan (CCLUP) (Carbon County Board of Commissioners and Carbon County Planning Commission 2010) was adopted in November of 2010. Although the CCLUP does not outline goals and objectives for natural resources development, it does specify recommended areas for oil and gas industry expansion and for an oil and gas industry processing and transportation corridor. The CD-C project area lies within the CCLUP's recommended area for oil and gas exploration and production.

The CCLUP contains the following goals, strategies and actions relative to energy development:

Goal 1. Achieve a sustainable balance between energy development, agriculture, and the environment.

Strategies and Actions:

Encourage a steady, paced development of the gas and oilfields.

- Participate in comment periods of the federal environmental impact statement process.
- Attend meetings and hearings of the Industrial Siting Council.

Enhance the County government's capacity to monitor, comment on, and influence state and federal decisions on energy development projects.

- Conduct regular meetings between Board of County Commissioners, BLM, DEQ, USDA Forest Service, and other governmental bodies to share information about pending energy projects.
- Participate in comment periods for environmental impact statements.

Limit residential development-related impacts on resource extraction, irrigated lands, and agriculture in general.

- Create zoning incentives that encourage residential development in areas not suited for irrigation, agriculture, or resource extraction.

Support mitigation of impacts created by energy industries where available science supports mitigation.

- Maintain dialog with energy industries by regular meetings to keep communication current.
- Identify issues that need mitigation and develop solutions for resolution with industry leaders.
- If available science indicates a proposed energy project cannot mitigate its impacts, Carbon County should either not approve the project or else recommend that it be located in a more suitable location (Ibid, pps. 89–90).

Sweetwater County

Sweetwater County adopted the Sweetwater County Comprehensive Plan (SCCP) (Sweetwater County Board of Commissioners and Sweetwater County Planning Commission 2002) in the fall of 2002. The SCCP contains the following goals and objectives relevant to this assessment.

Sensitive Areas and Resources

Coordinate and cooperate with the appropriate federal, state, and local organizations, governments, and agencies to:

- Identify and protect the county's natural environment and resources.
- Recognize and protect the county's unique cultural, recreational, environmental, and historical resources.
- Identify areas suitable/desirable for open space preservation. (These areas may include stream corridors, recreation areas, and wildlife habitat.) Explore alternative preservation strategies (Ibid, p. 2.6).

Planning Coordination/Cooperation with Other Entities

- Support and participate in federal and state land-use planning activities.

Natural Resources

- Encourage and support environmentally responsible resource exploration/development within the region. This includes encouraging associated industries and businesses to locate within Sweetwater County communities.
- Anticipate and plan for resource development impacts. Proactively address associated infrastructure, housing, and service needs.

- Encourage a balance between resource development and environmental protection.
- Evaluate natural resource development proposals (and the associated land uses) for their effects on air, water, and environmental quality.
- Encourage/support public land uses consistent with orderly development and efficient use of renewable and non-renewable resources.
- Encourage the location of associated worker housing within existing communities where services are/can be provided.
- Work with resource managers to ensure adequate access to natural resources.
- Work with property owners and lessees to preserve adequate public access.

Public Lands and Resources

- Encourage/support proactive county participation in relevant public land and resource planning and decision-making processes.
- Encourage/support cooperative interaction between local, state, and federal agencies and private land owners.
- Promote agency awareness of county issues and interests. These include, but are not limited to: natural resource exploration and development, multiple-use land and resource management practices, agriculture/ranching and recreation, and adequate public access to and across public lands.
- Continue county support for resource-based industries including mineral exploration/development and ranching.
- Promote local (private) concerns and interests as an integral part of public land management decisions. County officials and plans will provide the foundation to address/protect to private interests related to public lands and resources.
- Support, where appropriate, the transfer of suitable federal lands and resources to private interests.
- Encourage/support public land uses consistent with orderly development and efficient use of renewable and non-renewable resources.
- Prepare county policy positions for relevant federal and state land and resource issues.
- Conduct county plan “consistency and coordination” reviews for/on all relevant public land management agency plans and decisions.
- Develop/implement appropriate county/agency Memoranda of Understanding (MOUs) and agreements.
- Coordinate with public land management agencies to exchange resource and mapping information/expertise.

4.15.1.3 Impact Significance Criteria

The following criteria are used to assess the significance of the anticipated socioeconomic impacts of the Proposed Action and Alternatives and the No Action Alternative:

- An increase in a county’s or community’s resident and temporary populations that would substantially strain the ability of affected communities to provide housing and public services or otherwise adapt to growth-related social and economic changes
- An aggregate change in public revenue and expenditure flows likely to result in an inability on the part of affected units of government to maintain public services and facilities at acceptable or pre-established service levels
- Permanent displacement of residents or users of affected areas resulting from project-related changes in or conflicts with existing uses or ways of life

- Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population, which appreciably exceed those to the general population in and around the project area

4.15.2 Direct and Indirect Impacts

Three key considerations shape this assessment:

- **Ongoing Development in the CD-C project area—** Oil and gas drilling, field development, and production activities have occurred within the project area for over 50 years and the pace of drilling has accelerated over the last decade. An average of 289 wells per year have been drilled in the project area over the last five years and at the beginning of 2011 there were an estimated 3,738 producing wells within the project area.

  For all action alternatives, this assessment considers the effects of increased drilling, field development, and production activities. Thus, while the Proposed Action assumes annual drilling of an average of approximately 600 wells, the socioeconomic assessment considers the incremental socioeconomic impacts associated with the Proposed Action to be those associated with the drilling of roughly 300 additional new wells per year, along with subsequent completions and production. This approach acknowledges that the industrial and community infrastructure associated with the historic development of approximately 300 wells per year is already in place and local communities have addressed many of the socioeconomic effects associated with that pace of development. At the same time, the recent economic recession triggered a slowdown in pace of development that in turn resulted in an outmigration of non-resident oil and gas workers from the region. Consequently, the initiation of drilling at levels assumed for all action alternatives would result in a substantial influx of workers. Conversely, the No Action alternative would result in further outmigration of oil and gas workers from the region.

- **Uncertainty**—The socioeconomic assessment assumes a sustained, relatively high level of new well development over time. However, the actual pace of natural gas drilling has been and will continue to be variable and unpredictable because development decisions are dependent on a variety of factors including natural gas demand, pricing, regulatory approvals, rig and manpower availability, transmission pipeline capacity, weather, and the overall investment and development strategies of individual energy companies. For example, during the assessment period for this EIS, global energy demand and prices rose to historic levels and then declined precipitously. This decline was accompanied by a concurrent crisis affecting the availability of development capital, which hampered expansion and operations for some Operators and service companies. Although less affected than many other areas of the country, Carbon and Sweetwater counties each experienced economic slowdowns in the 2008 through 2010 period.

  To acknowledge this uncertainty, the assessment provides a discussion of the effects of higher and lower annual rates of drilling for certain social and economic conditions.

- **Regional Context**—Cumulative effects are analyzed in a separate section of this document, but for socioeconomics, cumulative influences must be considered in the assessment of impacts for the Proposed Action and alternatives. The natural gas reserves in the project area are part of a regional natural gas resource. Consequently, periods of expansion and decline in the project area would generally occur in the context of regional energy development expansion and decline in southwest Wyoming and indeed throughout much of the Rocky Mountain west. This means that extended periods of elevated demand for natural gas and resultant high gas sales prices would generate not only periods of accelerated activity in the project area but in other natural gas fields in Carbon, Sweetwater, and adjacent counties. Conversely, extended periods of lower natural gas demand would result in regional slowdowns in development activity.

4.15.2.1 Impacts Common to the Action Alternatives

Natural gas development can have a variety of effects on social and economic conditions. These effects can be both beneficial and adverse and can include:

- **Employment**—effects on direct employment in the natural gas industry, induced employment in businesses that support the natural gas industry, and indirect effects on other sectors of the economy, including those sectors affected by changes in industry and employee spending and sectors that could be directly affected by development including outdoor recreation and ranching. Natural gas development can also affect community and regional economic diversity.
- **Income**—effects on income of direct, indirect, and induced businesses and their employees; on other sectors of the economy such as tourism, recreation, and ranching; and effects on landowners, mineral owners, and royalty interests.
- **Population**—effects on resident and temporary populations in nearby communities.
- **Housing**—demand for temporary and long-term housing.
- **Infrastructure and services**—demands on a variety of government and quasi-public and private facilities and services.
- **Fiscal conditions**—changes in local and state tax and federal mineral royalty revenues and government expenditures.
- **Social conditions**—effects on community stability and cohesion, quality of life, attitudes, opinions, lifestyles, and changes in crime and other social indicators.
- **Environmental Justice**—beneficial or disproportionately high and adverse effects on minority and low-income populations.

Each alternative considered in this EIS, including the No Action Alternative, has the potential to affect the social and economic conditions previously described in **Section 3.15**. All action alternatives would result in increased employment and income in certain sectors of the local economy and population growth with resultant increased demand for housing and community infrastructure and services. After all authorized wells are drilled, each alternative would result in decreased employment and income for certain sectors of the economy, and result in further outmigration of employees and households should the cessation of drilling coincide with a period of economic stability or decline in other regional economic activity. Each of the alternatives has the potential to affect other sectors of the economy, such as ranching and outdoor recreation, that are also closely linked to land use and access in the project area. Beneficial and adverse effects on community infrastructure, local government services, and community social conditions would also likely occur under all alternatives.

Economic Effects

Each action alternative would generate additional direct employment and income in the natural gas industry, indirect employment and income in businesses that support the natural gas industry, and induced effects on other sectors of the economy affected by changes in industry and employee spending. Each alternative would also affect other economic activities including outdoor recreation and ranching and could potentially affect regional economic diversity.

Under the No Action Alternative, it is assumed that drilling and field-development employment would cease, resulting in a substantial decline in direct, indirect, and induced employment in the study area. Production-related employment would continue but diminish as production from existing wells declines and the wells eventually become uneconomical and production ceases.

Under all action alternatives, employment and income associated with drilling and field development is assumed to occur over 15 years and then cease; production-related employment would continue at substantially higher levels than under the No Action Alternative after Year 6, but again diminish as production decreases and previously drilled wells cease production.

Induced and indirect employment associated with drilling, field-development, and production activities would parallel the advances and declines in direct employment for each alternative.

Cyclical Economic Expansion and Contractions

The economic expansion associated with each action alternative would likely be followed by a period of economic contraction.[22] For the No Action Alternative, the contraction phase is assumed to begin upon the issuance of a ROD for the EIS and economic activity and employment would diminish as production decreases and eventually ceases. For all action alternatives, the current level of natural gas development would expand and extend drilling within the project area for approximately 15 years. The contraction phase would then begin as drilling and field-development employment ceases and production employment begins to decrease.

The expansion phase would be characterized by substantial increases in direct employment and income in the natural gas industry and increases in indirect and induced employment and income. For the action alternatives, the 15-year drilling and field-development phase would be accompanied by increases in both temporary and long-term population as well as temporary and long-term housing demand, and demand for community infrastructure and local government services. For the No Action Alternative, these expansionary effects would not occur. To the contrary, No Action would precipitate further economic contraction.

Federal, state, and local governments would receive additional tax and royalty revenues from all alternatives. Such revenues, particularly federal mineral royalties, would be substantially higher under the action alternatives when contrasted to the revenues associated with the No Action Alternative.

The economic contraction phase would likely result in substantial reductions in employment, out-migration of workers and families, and reductions in demand for housing, community infrastructure, and local government services. The contraction phase would also be characterized by reductions in annual federal, state, and local government tax and royalty revenues. The severity of these effects would depend on other economic activities occurring at the time and the success of interim economic development initiatives. Under the No Action alternative, the contractions would follow the issuance of the ROD for this EIS.

The foregoing discussion assumes the pace of development outlined for the Proposed Action and alternatives. Historically, natural gas development and expansion cycles have been more frequent and shorter in duration than the 15-year cycle assumed for all action alternatives in this EIS.

Effects on Other Uses in the Project Area (Recreation and Ranching/Grazing)

All alternatives have the potential to displace some other uses and users of the project area, temporarily in some instances and for longer periods in others. The current level of existing development and ongoing drilling and field-development activity has already altered the recreational setting in portions of the project area, displacing some recreation use (primarily hunting). The intensification of development would result in a more dense level of development in already-developed parts of the project area and perhaps introduce development in currently undeveloped areas. The effect of doubling the average annual level of drilling and field-development activity under the action alternatives would increase the potential for conflict with recreation activities and for displacement of recreation use of the area. Over time, as development and production activities cease and reclamation occurs, recreation users may return to the

[22] This characterization of effects is a function of the assumption of the steady pace of new well development. In fact some variability would be expected over time. Such variability would likely temper both the expansions and contractions described here.

project area. Shifts in the geographic distribution of hunting and other recreation activity could have corresponding economic implications as well.

Grazing patterns and practices in the project area have already been affected by natural gas development activity. The boundaries of some grazing allotments extend beyond the project area, but the portions of these allotments in some areas adjacent to the project area are also affected by natural gas development. The high level of development activity, disturbance, infestation of invasive plant species and resultant reductions in available forage have resulted in reductions in use of certain allotments and require grazing permittees to more actively monitor and more frequently move livestock, resulting in higher labor and fuel costs and reductions in livestock weight gain. These effects—together with damage to fences, cattle guards, and other grazing improvements; increased livestock mortality from vehicle/livestock collisions; an extended period of drought; volatile livestock sales prices; difficulty obtaining capital; high fuel costs; and labor shortages—have resulted in higher cost, lower production, and reduced profitability for grazing permittees and temporarily displaced some permittees from allotments within the project area. Some grazing permittees interviewed for this assessment tied these effects to actual or anticipated reductions in herd size, complete sell-off of herds, and serious consideration of relinquishing their BLM grazing leases. Permanent displacement of grazing permittees along with a substantial reduction in overall levels of grazing use could trigger the significance threshold established for this assessment.

Under the No Action Alternative, the adverse effects on grazing permittees associated with high levels of drilling and field-development activity and traffic would diminish as drilling and field-development and associated traffic ceases, and temporary disturbances are reclaimed. Under all of the action alternatives, the levels of drilling and field-development and associated traffic could potentially double over recent levels and the amount of temporary and long-term disturbance would increase substantially, likely resulting in displacement of grazing operators from portions of allotments that are undergoing intensive development. Adverse effects on portions of grazing allotments, coupled with the aforementioned other factors (drought, high labor costs, volatile livestock sales prices, and scarcity of operating capital) could have detrimental effects on the economic viability of some affected ranches.

Effects on Environmental Amenity Values

As noted in **Section 3.15.7.1**, environmental amenities including air and water quality, wildlife and wildlife habitat, scenic vistas, cultural and historical features, and areas that provide opportunities for solitude are highly valued by many local residents and non-residents alike. These amenities add to the quality of life for residents, provide value by promoting local tourism and recreation, and are some of the factors that can attract new residents and businesses to an area. Many people value these amenities for their very existence and desire their continued availability for future generations.

Much of the project area has already been affected by development, adversely affecting some outdoor amenities including wildlife and wildlife habitat, scenic vistas, and areas that provide opportunities for solitude. All alternatives would continue to affect these amenities, although the No Action Alternative would result in no incremental effect. The action alternatives would intensify development in many currently developed areas of the project area and perhaps result in development in currently undeveloped areas.

In addition to the effects of development, disturbance, and activity on environmental amenities, the proliferation of litter along roads and increases in poaching that have accompanied development activity adversely affect scenic and wildlife amenities. These effects would continue under all alternatives but would likely intensify under the action alternatives given the increase in activity and extended duration of the drilling and field-development phase.

Economic Diversity

Energy development has the potential to enhance economic diversity in rural communities by expanding commercial and community infrastructure and by providing funding which can be used for economic development, community revitalization, and tourism promotion efforts. Energy development also has the potential to limit economic diversity in rural communities by raising housing costs and limiting housing availability, contributing to workforce shortages, and adversely affecting environmental amenities. Potential dampening effects of natural gas development in the project area on the growth and maintenance of economic diversity in certain communities within the study area would diminish sooner under the No Action Alternative as labor competition and high housing costs decline, the perceived effects on amenity values diminish as drilling and field-development cease, and long-term reclamation proceeds. Potential dampening effects on economic diversity would intensify under all action alternatives as the pace and duration of drilling would increase substantially and housing demand and cost and labor shortages would likely increase. The potential dampening effects on economic diversity should be viewed in the context of the cumulative development within the study area as high levels of drilling in the project area would likely be accompanied by high levels of drilling elsewhere in the study area. Potential economic diversity-enhancing effects could ultimately be associated with all action alternatives as well as with cumulative development. Energy development in the region has expanded the inventory of housing, tourism and recreation infrastructure (motels and restaurants), other commercial infrastructure, and increased the resident workforce in communities in the study area, all of which would be resources for economic development as natural gas development subsides.

4.15.2.2 Proposed Action

Oil and natural gas exploration and production have been important but volatile elements of the Carbon and Sweetwater County economies for well over 30 years. According to the Wyoming Oil and Gas Conservation Commission (WOGCC), there were 1,791 producing wells in Carbon County in 2010, with another 3,234 producing wells in Sweetwater County, although natural gas production in the two counties declined by 4 percent in 2010.

Up to 8,950 additional wells would be drilled in the project area over the course of 15 years under the Proposed Action; an average of almost 600 new wells drilled annually. Information provided by the Operators indicates that a range of 213 to 738 new wells per year (**Figure 4.15-1**) would be drilled. The pace and timing of natural gas development are two key variables affecting socioeconomic conditions in communities near development. The actual pace and timing of development in the project area would be dependent on a variety of factors including natural gas demand, pricing, regulatory approvals, rig and manpower availability, weather, and corporate strategies. Given the cyclical nature of natural gas development and the regional nature of the natural gas development industry discussed in **Section 4.15.2.1**, the assessment also considers the socioeconomic effects of surges and declines in development that might result in higher or lower levels of drilling than those contemplated by this assessment.

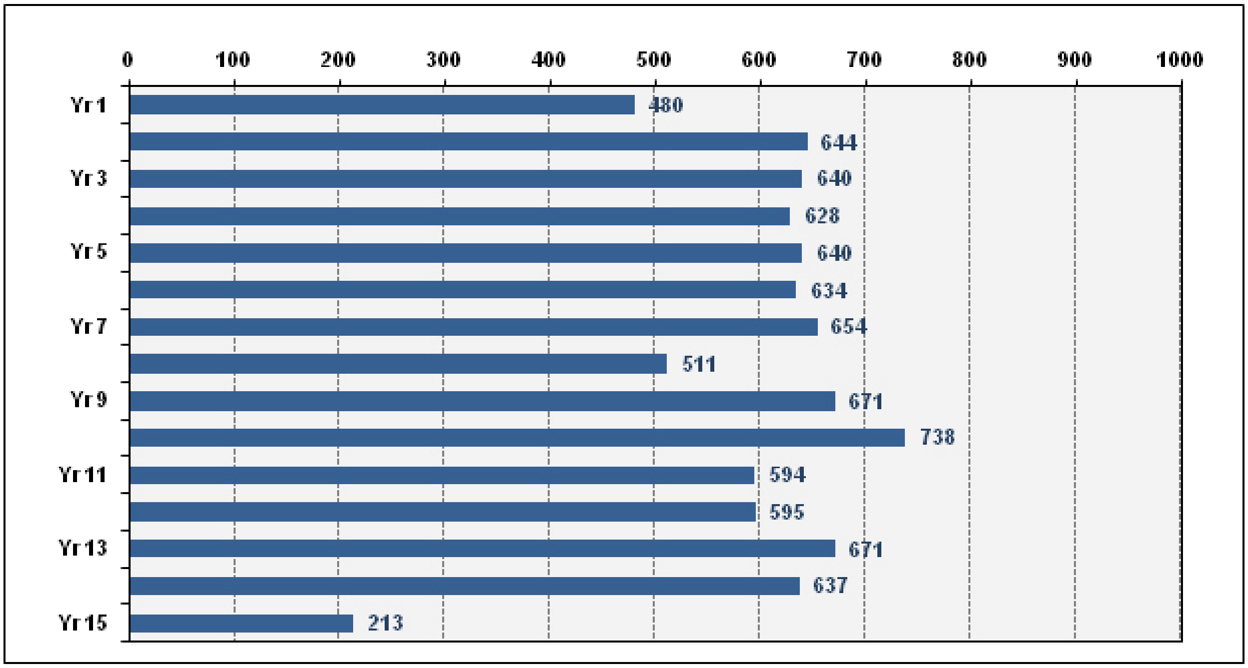


Figure 4.15-1. Number of new wells drilled in the project area, Proposed Action

Source: CD-C Operators.

Implementation of the proposed drilling program would result in consistently increasing production over the first 13 years of drilling, with projected annual production peaking at more than 670 MMcf and 9.4 million bbls of liquid condensates. Production would then begin an extended period of decline (see **Figure 4.15-2**).

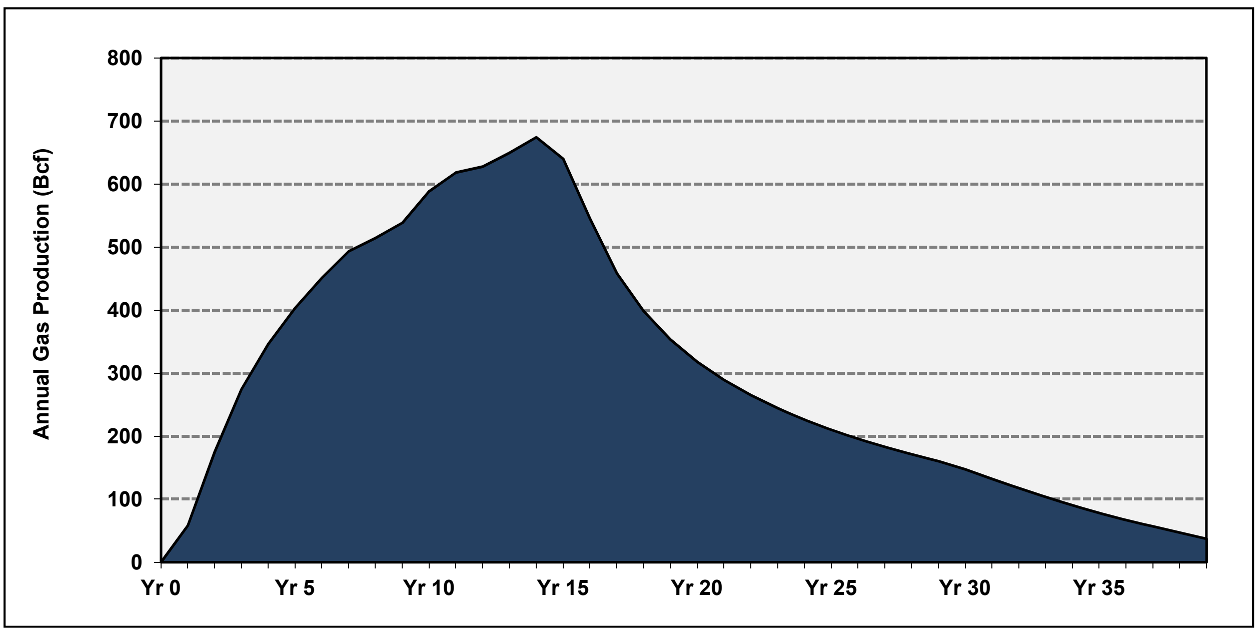


Figure 4.15-2. Estimated incremental annual gas production, Proposed Action

Source: BLM RMG estimates, BCLLC/SDLLC calculations.

Estimated total production for the Proposed Action over the life of the field is 12.02 trillion cubic feet (Tcf) of gas and 167.3 million bbls of liquid condensates.

Employment

A key driver of the socioeconomic impacts of the Proposed Action and alternatives is the estimated direct employment associated with the proposed natural gas development, extending from pre-development approval and permitting through drilling, completion, production, and reclamation. The direct development and operations jobs would in turn support additional indirect and induced jobs in the local economies, all of which would create demands on the local labor force, promote economic migration and population growth, increase demands on housing and public facilities and services, and affect local social conditions.

The labor-intensive drilling and completion phase for new wells is of initial concern for assessing short-term effects on migration, population, housing demand, and public facilities and services. Over time, the level of Proposed Action-related field operations and production employment would rise due to the need to service additional wells and haul increased volumes of produced water and condensate.

Project-related direct employment estimates were developed based on information obtained from the Operators, the U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, Wyoming Department of Employment, and other sources. Projected direct employment estimates were then used as the primary input into the REMI[23] economic-demographic model, calibrated for a six-county region of southwest Wyoming, which in turn yields projections of the total employment, income, population, and other economic and demographic changes over time.

It is important to note that the employment projections described in this section are based on current natural gas development and production employment experience in the CD-C project area. In recent years, the Operators have been successful in refining development and production technologies and processes, which has reduced labor force requirements on a per well basis. It is reasonable to assume that further technology and process refinements will further reduce workforce requirements, particularly in the later years of this period used for this assessment.

Estimated Direct Jobs

Information supplied by the Operators indicates that development of a typical well in the project area, from access road and pad construction through drilling, completion, installation of surface production facilities and gathering lines and interim reclamation, requires approximately 30 days. Direct onsite employment at an individual well site varies over time, ranging from a single field biologist doing pre-development site clearance to 25 or more drilling and well-service employees during actual drilling and completion operations. Some development activities and events are of relatively short duration (a matter of hours); others continue for days on a round-the-clock basis. Interim reclamation would also occur at each site, employing a small number of workers for several days. Additionally, project engineers and managers, state and federal regulatory and resource management staff, and others occasionally visit an

[23] The Economic Profile System – Human Dimensions Tool (EPS-HDT), created by Headwaters Economics, Inc. and supported by the U.S. Bureau of Land Management, is a valuable tool for characterizing and describing historic economic and demographic trends in a region. It was also used to inform this assessment. EPS–HDT does not offer a forecasting or projection capability to assess changes in employment and income stemming from new economic stimulus. Many assessments rely on economic input-output (I-O) models to estimate the indirect and induced effects of natural resource development initiatives. The use of such I-O models has received criticism. Such criticism is one factor that led to the use of the REMI model in this assessment.

REMI is a dynamic, econometric economic and demographic model developed by Regional Economic Models, Inc. that has gained broad professional recognition and acceptance. Versions of the core model are calibrated for specific geographic regions. The specific application of the REMI to this project was completed by Sammons/Dutton LLC (SDLLC) and Blankenship Consulting, LLC (BCLLC). The REMI model is used because its capabilities address many of the more common criticisms associated with the use of economic input-output (I-O) models, including the static nature of the economic relationships and lack of a demographic component.

individual well site, but are not included in the Operator's summary of onsite employees. Allowances for these workers were captured in adjustments for off-site direct employees and estimated induced employment.

The Operators provided information regarding the timing/phasing of development activities, duration of activities, and approximate numbers of employees, including both company and contractor employees, for a typical well in the project area. Separate development profiles were provided for single-bore vertical wells and for multiple-bore directional wells from a single location. These profiles are the basis for estimating direct onsite employment during field development, based on the concept of work teams or crews, with a work team or crew responsible for each of the major development activities. Individual members of a crew may work together or independently, may be company employees or contractors, and may complete some of their work off-site. Given the varying durations of the key activities, it is estimated that completion of an average of almost 600 new wells per year under the Proposed Action could involve as many as 100 separate work crews within the field on any given day, of which approximately 25 would be drilling crews directly associated with operating rigs. **Table 4.15-1** summarizes the estimated numbers of crews and average crew size associated with the Proposed Action.

Table 4.15-1. Overview of direct onsite labor effort to implement the Proposed Action, CD-C project area[1]

Activity	Approximate Number of Crews	Workers / Crew	Typical Activity Duration
Pre-approval / permitting	6	6	3 days
Location construction	10	5	6 / 14 days (single well / multi-well) [2]
Rig mobilization / de-mobilization	10	11	3 / 5 days (single well / multi-well)[2]
Drilling	25[24]	18	10 / 42 days (single well / multi-well) [2]
Completion	17	11	5 / 8 days (single well / multi-well)[2]
Well service	7	22	3 days
Tank battery setup	9	6	4 days
Gas-gathering system	2	15	1 day
Electrical system	3	8	1 / 2 days

[1] Assumes 60 percent are single-bore vertical wells and 40 percent are directional bores with an average of four completed bores per multi-well location.
[2] Average per well bore.

Sources: CD-C Operators, BCLLC, and SDLLC.

Factors including the numerous tasks involved in drilling, completing, and bringing a well into production; the specialized nature of crews involved in completing those tasks; the different number of individuals associated with the various crews and varying durations for distinct tasks; and the fact that the work schedules of different crews vary (some 5-day/40-hour weeks, some round-the-clock for extended periods of time) results in fluctuating levels of onsite employment within the project area over time. Over a typical eight-week period, onsite employment within the project area would range from just over 500 jobs to more than 970 jobs, with an average of approximately 765 jobs.

The round-the-clock drilling and sequential nature of some activities results in a considerable level of activity on weekends and requires additional employees to sustain work crews during scheduled times off,

[24] The Operators have estimated that between 20 and 40 rigs could be on location within the project area at any one time. Some rigs contracted to major Operators would be working on a continuous year-round basis, while others contracted to small independent Operators would drill one or two wells in any one year. An average of 25 rigs was used for this assessment.

illness, injury, or labor market inefficiencies. A 15-percent allowance above the average onsite employment is used for this analysis, raising the total direct onsite jobs supported by the Proposed Action to 881 employees. The breakdown of those jobs by major activity is presented in **Table 4.15-2** below.

Table 4.15-2. Average onsite and total direct employment during the development phase, Proposed Action

Industry/Activity	Onsite Direct	Total Direct
Drilling / rig services	443	532
Completion / field services	311	373
Construction	92	110
Engineering / environmental services	35	42
Total	**881**	**1,057**

Source: BCLLC and SDLLC

The direct workforce estimates for the development phase include one further adjustment; that being an allowance for administrative, management, maintenance, clerical, and other support employees working locally for the company and contractors to support the workers actually working onsite. An example of such direct-support jobs would be the mechanics based in Rock Springs who maintain and service the drilling rigs and gas-field service trucks. This analysis includes a 20-percent allowance for such jobs, based on data from the U.S. Bureau of Labor Statistics and economic censuses of industry. The adjustments for administrative and support personnel raise the total direct employment associated with the Proposed Action to 1,057 (**Table 4.15-2**).

Direct onsite employment was also estimated in conjunction with ongoing production and field operations. The primary activities associated with operations would be the ongoing monitoring, maintenance, and servicing of the wells, occasional well workovers, and the hauling of produced water and condensate.[25] The numbers of jobs in all three categories would climb over time as the cumulative number of producing wells increases. The annual numbers of well service employees are estimated from information provided by the Operators and the numbers of transportation workers are a function of the estimated water and oil condensate production. Estimates of the number of production and transportation workers account for the diminishing levels of production from the existing wells over time. As with the development employment, the estimates of operations employment include allowances to account for 7-day-per-week staffing and for management and support employees. Estimated direct employment for operations derived using these assumptions climbs steadily over time, eventually peaking at 2,494 employees in Year 13 of the project (see **Figure 4.15-3**). The peak coincides with a year of high new development (671 new wells) combined with high levels of water and condensate production.

[25] Some producers may develop piping systems to handle produced water. Such systems would reduce the number of employees required. However, the extent of such systems is currently unknown. Consequently, the current analysis assumes an all truck haul cenario in order to portray a “worst case” scenario with respect to both transportation and socioeconomics.

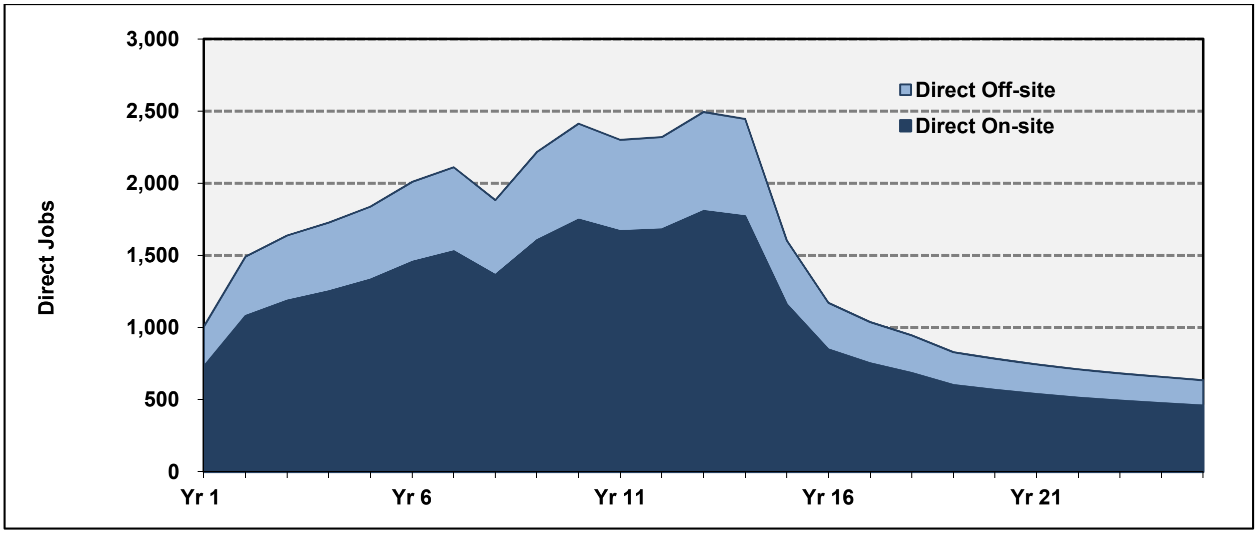


Figure 4.15-3. Direct employment, onsite and off-site, Proposed Action

The current assessment addresses the incremental increase in employment due to the Proposed Action. Such increases would be above and beyond the employment already working in the project area due to the ongoing drilling and production activity by the CD-C Operators, which is estimated at about 522 at present. The resulting incremental direct employment estimates, shown in **Table 4.15-3** and **Figure 4.15-4**, would increase to a peak of 1,600 total direct jobs in Year 13. Direct employment would decline sharply following the completion of new well development, shedding nearly 1,200 total direct jobs by Year 20.

Table 4.15-3 Incremental direct employment during field operations and production, Proposed Action[1]

Year	Total Direct	Incremental Direct Due to the PA
Year 5	1,838	1,128
Year 10	2,413	1,585
Year 15	1,602	666
Year 20	784	475
Year 25	634	431

[1] *Incremental is relative to the estimated direct* CD-C*-related employment in 2007.*
Source: SDLLC and BCLLC.

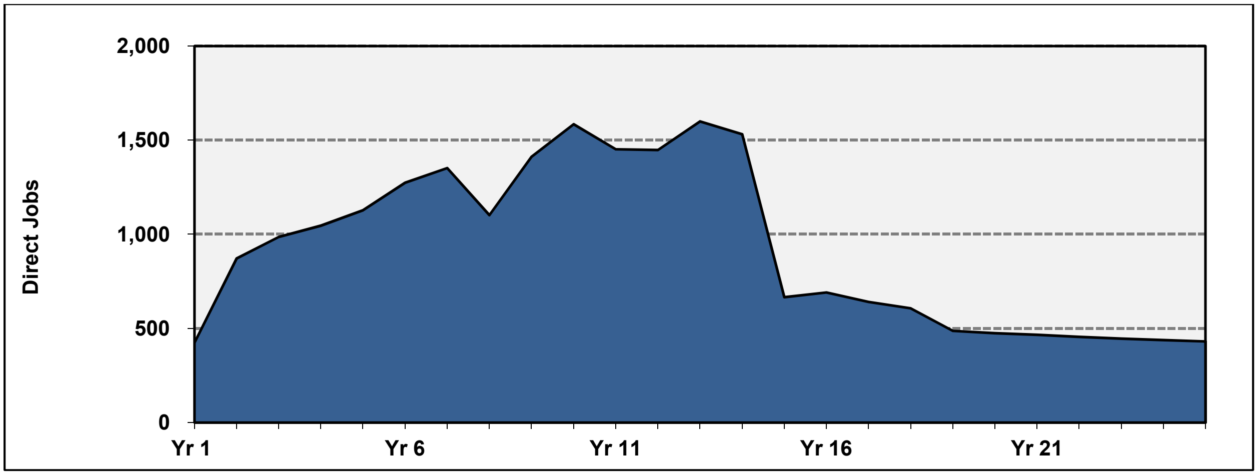


Figure 4.15-4. Incremental direct employment, Proposed Action

Estimated total direct employment over time, by major industrial sector, is the primary input driving the economic and demographic forecasts associated with the Proposed Action. Features in the REMI model were used to increase the likelihood that much of the growth in labor demand from the Proposed Action would be satisfied by non-residents who would work in the region on a temporary basis while maintaining their permanent residence elsewhere, and also that migrating workers would be more predominantly male than the general population. Both of these characteristics have been observed in the local labor force in conjunction with recent and ongoing energy resource development in southwest Wyoming.

In addition to the employment associated with drilling, field development, and production, Proposed Action-related employment would occur in conjunction with the construction of ancillary facilities including up to ten field compression facilities, a central pipeline compression facility, one or two central processing/stabilization plants, and up to 45 miles of high-pressure pipeline. The timing, location, and ultimate configuration of these facilities are not currently known, but their development would result in additional short-term construction and secondary employment during the period in which they were constructed. Most of these facilities would be constructed over a matter of months using a mix of local and non-local construction workers. The central processing/ stabilization plants could require a year or more to construct, with a workforce ranging to several hundred workers at peak.

Effects on Total Employment

Economic activity associated with the Proposed Action would result in additional economic growth in the two-county region. The incremental employment growth would increase over time as production increases the demands for operations and water and condensate transportation.

Projected employment gains of 890 jobs in the region would result from the Proposed Action in the first full year of expanded drilling. The total includes an estimated 428 direct jobs and 432 additional indirect and induced jobs supported by the increased economic stimulus associated with new well development, purchases by the Operators, suppliers and vendors, the consumer purchases of employees, and increased expenditures by local public entities. The net employment increment associated with the increased development activity in Sweetwater and Carbon counties would climb to 3,951 jobs in Year 13 (**Figure 4.15-5**). That total includes the 1,865 direct jobs and 2,086 indirect and induced jobs supported by the Proposed Action. Over the 15-year period of project development, each direct job is estimated to support approximately 1.14 additional induced and indirect jobs.

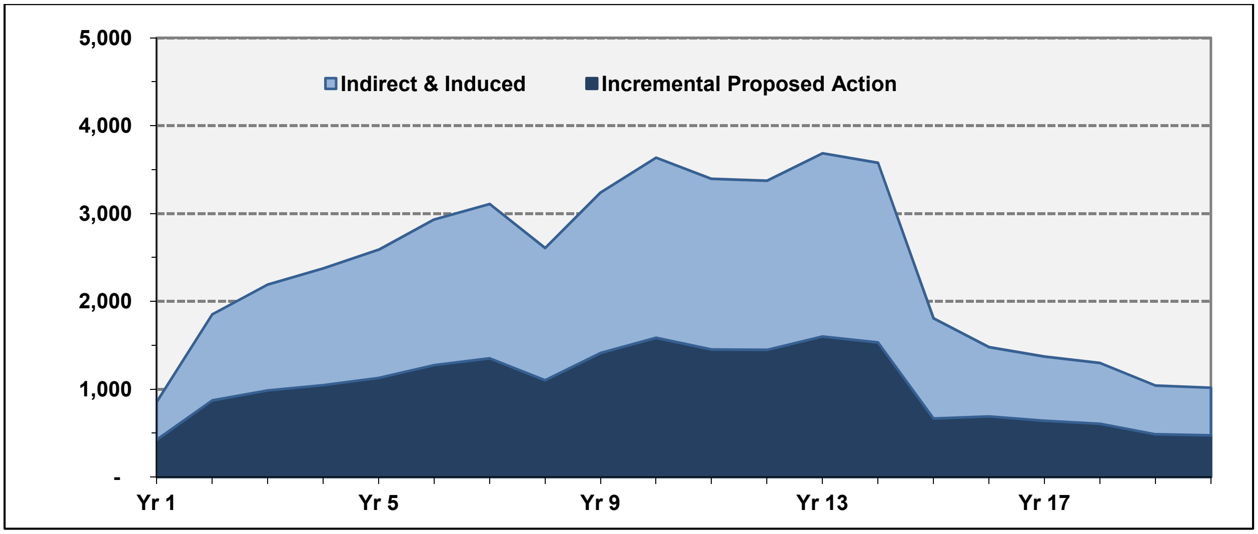


Figure 4.15-5. Direct, indirect, and induced employment effects from the Proposed Action in Sweetwater and Carbon Counties

All sectors of the local economies would be expected to see job gains as a result of the Proposed Action. Beyond the direct impacts in mining (including the oil and gas industry) and transportation, the largest gains in private sector jobs would occur in retail and wholesale trade, construction, and accommodations and food service. Local government employment, including public education, would also increase given implementation of the Proposed Action. The distribution of the net job gains in the peak year, by selected major industrial sector, is presented in **Table 4.15-4.**

Table 4.15-4. Incremental numbers of jobs by industrial sector, Year 13

Industrial Sector	Jobs	Share
Mining *(including oil and gas drilling, production and services)*	1,699	43%
Construction	619	16%
Retail & Wholesale Trade	348	9%
Accommodations and Food Services	238	6%
Local Government	198	5%
Real Estate, Rental, Leasing	173	4%
Transportation and Warehousing	164	4%
Health Care and Social Assistance	168	4%
Administrative and Waste Services	98	3%
Professional Technical Services	77	2%
State Government	29	<1%
All other combined	140	4%
Total	**3,951***	**100.0%**

* *Other includes: manufacturing, information services, other services, management of other companies, educational services, forestry, and fisheries.*

** *The total includes projected indirect and induced jobs in Uinta, Lincoln, Fremont, and Sublette counties.*

The majority of the new jobs, including not only direct jobs but also indirect and induced jobs, would be based in Sweetwater County, although substantial job gains are projected to occur in Carbon County. Net gains in Sweetwater County are projected to be nearly 600 jobs in the first year of development, increasing to more than 2,800 jobs at the peak. The corresponding range of job gains in Carbon County is from 197 jobs in Year 1 to 966 jobs at the peak (**Figure 4.15-6)**. New well development under the Proposed Action is also projected to result in up to 170 incremental indirect and induced jobs elsewhere in southwestern Wyoming due to increases in local income and spending associated with commuters who live in one county and work in either Sweetwater or Carbon counties.

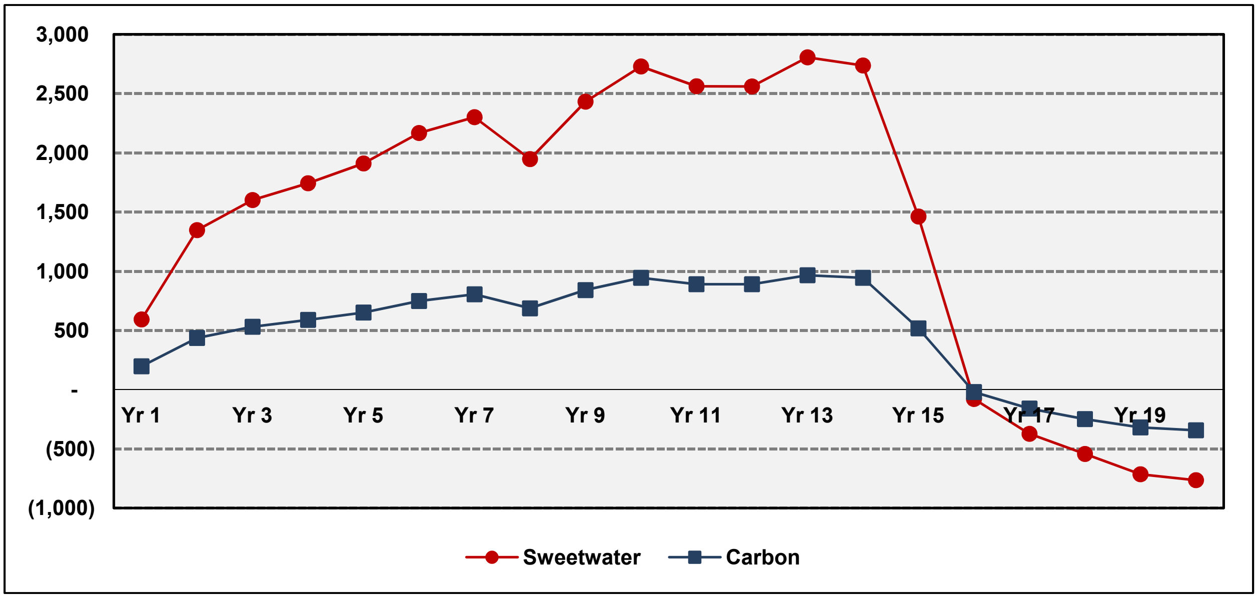


Figure 4.15-6. Total employment effects in Sweetwater and Carbon Counties from the Proposed Action

Completion of field-development operations would trigger substantial reductions in employment. Net reductions of more than 4,300 jobs (approximately 3,100 in Sweetwater County) are projected in the two counties within two years of field development completion. Further declines would be expected over the following three years such that the net change in total employment, as compared to the outset of the project, would become negative even though more than 475 direct employees would be involved in continuing production and transportation. This seeming paradoxical result would occur because of the loss of drilling and development jobs previously associated with ongoing development activity in the CD-C project area that would be sustained by the approval of the Proposed Action.

At the peak, the Proposed Action would increase the combined total local employment in Sweetwater and Carbon counties by about 9 percent as compared to total current (2009) employment. The net increase in local employment attributable to the Proposed Action would also be comparable to the increase in combined employment anticipated from all other economic activity in Sweetwater and Carbon counties.

Year-to-year variability in the pace of drilling would likely result in some corresponding fluctuations in the number of drilling and field-development jobs; higher rates translating into more employees and lower rates of drilling requiring fewer employees. Levels of off-site direct employment would likely be slightly less sensitive to fluctuations in drilling employment, but sustained differences in the annual number of wells drilled would eventually be accompanied by commensurate changes in off-site employment. Differences in the annual rate of drilling and development would translate into slight differences in the number of incremental operations and production employees hired, but such employment tends to be more responsive to the long-term levels of production than to current drilling rates.

Other Economic Effects

At the time of the original assessment (2007), labor-market conditions in the project area were tight due to past and ongoing energy and mineral resource development. Unemployment rates were low, labor-force participation among residents was high, and temporary, non-resident workers filled many jobs. Estimates generated by the REMI model suggested that as many as one in five jobs added prior to the recession had been filled by temporary or commuting non-resident workers. As the economic recession persisted, triggering layoffs, labor-market conditions eased, increasing worker availability and out-migration of some non-resident workers. The higher rate of development associated with the Proposed Action would likely result in a return to pre-recession conditions, including lower unemployment as available local labor is absorbed and an influx of workers, many of whom would be single-status. Labor-market conditions would again change once project development is completed and labor demand weakened relative to available supply. Local unemployment would increase, labor-force participation would decline, and labor-force out-migration would likely occur.

Per-Capita Personal Income

Total and average per-capita personal income would increase under the Proposed Action. Total personal income would rise due to increases in the number of jobs, particularly in the relatively higher-paying energy-sector jobs. More energy-sector related jobs would contribute to rising per-capita incomes, which would also receive a boost from the upward pressure on all wages and salaries from the tight labor markets. Some of the gains in personal income would likely be offset by higher consumer prices. The positive project-related effects on income would moderate and eventually diminish, particularly following the completion of the well-development phase.

Population Growth

Implementation of the Proposed Action would provide a long-term economic stimulus to the local economies of Sweetwater and Carbon counties. Local labor availability to fill the jobs supported by the economic expansion is limited due to recent and ongoing economic expansions in the region. Past expansion also triggered substantial labor immigration to the area. Future expansion with the Proposed Action would trigger additional migration and population growth for the region.

Under the Proposed Action, substantial net labor migration would occur during the first several years of implementation, peaking at over 600 in Year 2. Projected annual net migration attributable to the Proposed Action would fluctuate in response to the variation in the pace of drilling, averaging about 275 people per year through the completion of development. Substantial net out-migration of more than 800 residents per year would occur for several years after the cessation of drilling (**Figure 4.15-7**). The rate of net out-migration would be less pronounced than the initial immigration due to the continuing operations and transportation employment associated with the Proposed Action.

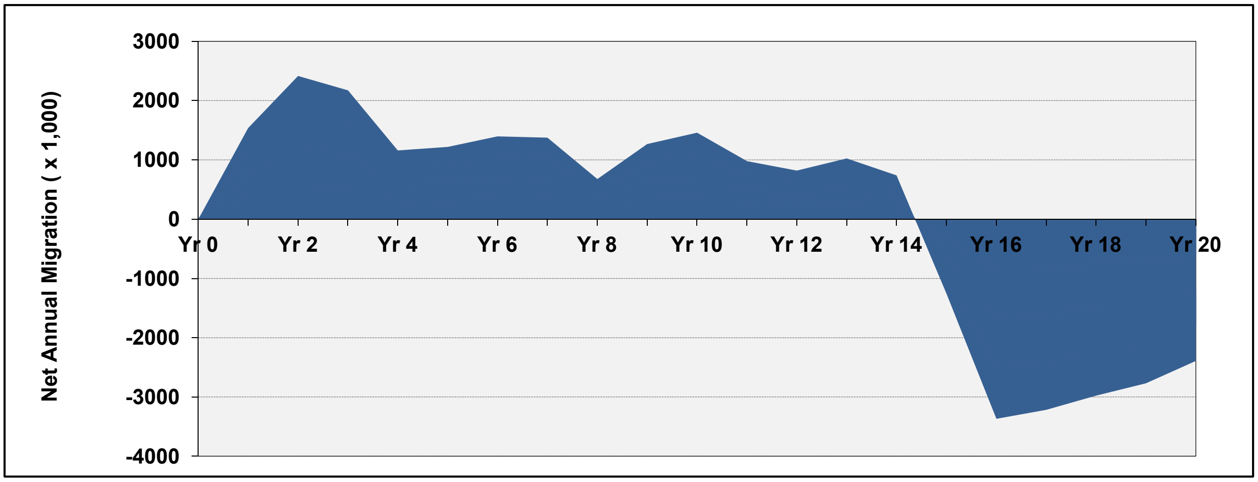


Figure 4.15-7. Projected net migration into the study area

Driven by migration, population growth due to the Proposed Action is projected to increase over time to almost 4,936 residents in Year 14. Approximately 3,100 additional residents are projected to reside in Sweetwater County, with 1,050 additional residents in Carbon County (**Table 4.15-5** and **Figure 4.15-8**). The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/LSRV. The net increase in population is comparable to the net increase in employment, reflecting a combination of a high level of single-status workers, two-worker households, and workers holding multiple jobs among the immigrating households, and an increasing number of temporary non-resident and commuting workers.

Table 4.15-5. Summary of incremental population impacts from the Proposed Action

	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County	236	1,349	2,399	2,990	1,033
Carbon County	69	410	793	1,028	311
Combined Increment	305	1,759	3,192	4,018	1,344

Source: SDLLC and BCLLC, using the REMI model.

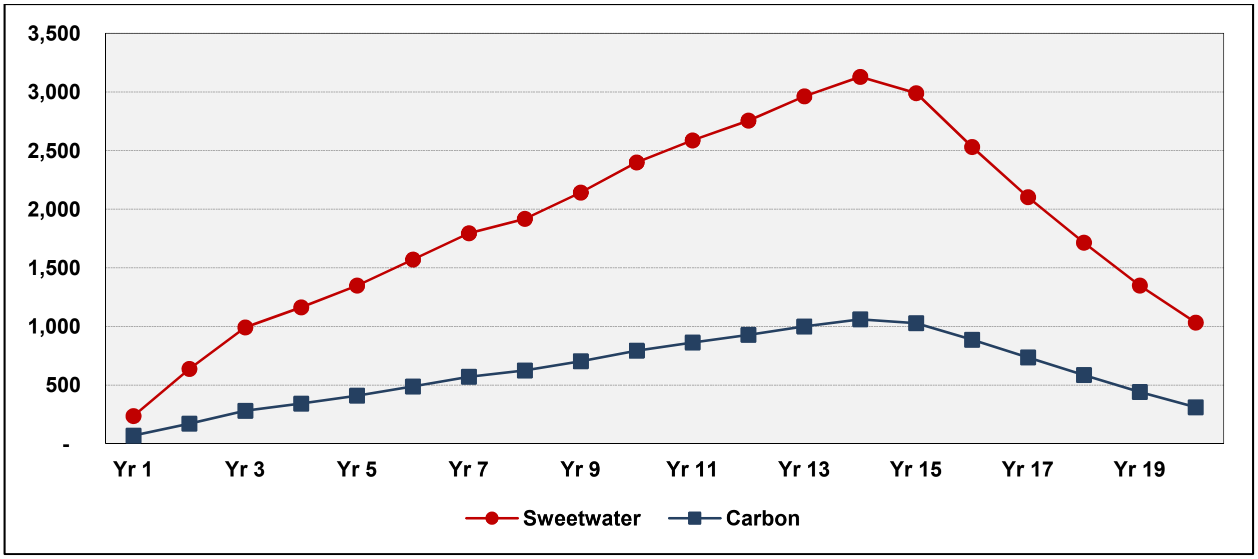


Figure 4.15-8. Forecast population increments due to the Proposed Action

The effects of the Proposed Action would contribute to growth during the development period, with population peaking in about Year 14 or 15 and then declining in the wake of the economic contractions associated with the completion of drilling. At the peak, the incremental population impacts associated with the Proposed Action would represent about 8 percent of the combined 2010 resident populations of Sweetwater and Carbon counties.

The estimated population impacts presented above may overstate the actual change in resident population by the extent to which jobs are filled by unaccompanied temporary non-resident and commuting workers. While these workers would place demands on local facilities and services, increase market demand for private-sector businesses, and generate public-sector revenues, they have fewer indirect demands on facilities, services, and conventional housing than do migrating households.

Results of the model indicate that the number of non-resident workers would increase over time to meet the labor demands associated with production and transportation operations. Following the completion of new well development, the number of non-resident workers would decline substantially.

Short-term surges in temporary population would accompany the construction of the ancillary facilities described in the preceding employment section. The operations workforce associated with these facilities would be relatively small and result in small long-term changes in population within the study area.

Population Distribution in Sweetwater and Carbon Counties

The incremental population growth and additional non-local workers residing in the region would create demands on housing, private-sector businesses, and public facilities and services, with the incidence of demands on various providers being determined largely on the residency patterns of the new residents and workers. In turn, three important factors affect residency patterns: housing availability, the base of operations/location of the jobs, and proximity to community facilities and services. Among those factors, job location and housing availability, including temporary living facilities, tend to be more influential for the temporary workers. Housing availability and proximity to community facilities and services are typically more influential for those production and transportation workers who establish long-term residence in the area, and even moreso for those filling the indirect and induced jobs supported by the Proposed Action.

Residency assumptions for the temporary and permanent populations were established considering the size of communities, their distances from the project area, informed judgment regarding housing availability (including the potential development of construction-worker housing in the area) and historic residency patterns of natural gas workers. Applying the assumed residency patterns to the incremental project-related population shows an increasing population over time, peaking at more than 2,100 residents and 128 temporary workers in Rock Springs in Year 15, with a corresponding peak in excess of 758 residents and 52 temporary workers in Rawlins in that year (**Table 4.15-6**). The peak influx of temporary workers actually happens several years earlier. It is important to note that these estimates are in addition to the population associated with ongoing development and production operations in the project area.

Table 4.15-6. Incremental resident population and non-resident workers by community

		Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County						
Rock Springs	Long-term	25	646	1,310	2,136	644
	Temporary	81	217	304	128	-
	Total	106	863	1,614	2,264	644
Wamsutter	Long-term	3	81	164	267	81
	Temporary	122	325	457	192	-
	Total	125	406	621	459	81
Green River	Long-term	2	65	131	214	64
	Temporary	-	-	-	-	-
	Total	2	65	131	214	64
Other & Unincorporated	Long-term	1	15	33	53	16
	Temporary	-	-	-	-	-
	Total	1	15	33	53	16
County Total	Long-term	31	807	1,638	2,670	805
	Temporary	203	542	761	320	-
	Total	**234**	**1,349**	**2,399**	**2,990**	**805**
Carbon County						
Rawlins	Long-term	14	220	482	758	203
	Temporary	33	88	124	52	-
	Total	47	308	606	810	203
Baggs/LSRV	Long-term	3	50	109	171	46
	Temporary	8	20	29	12	-
	Total	11	70	138	183	46
Unincorporated, including man camps and Other	Long-term	1	5	12	19	5
	Temporary	10	27	37	16	-
	Total	11	32	49	35	5
County total	Long-term	18	275	603	948	254
	Temporary	51	135	190	80	0
	Total	**69**	**410**	**793**	**1,028**	**254**
Total assigned "population"	Long-term	49	1,082	2,241	3,618	1,059
	Temporary	254	677	951	400	-
	Total	**303**	**1,759**	**3,192**	**4,018**	**1,059**

Source: SDLLC and BCLLC, using the REMI model.

The most notable effect on local population would be expected to occur in Wamsutter. The town is located at the I-80 interchange that serves as the major access point into the project area. BP has established a field operations center in Wamsutter and a number of oil and gas service firms have established offices and yards in the town. Furthermore, some new permanent housing has been developed in Wamsutter, and temporary living facilities have been located in Wamsutter during past periods of high drilling activity. An initial impact of 125 residents and non-local workers is projected in Year 1, increasing to over 400 within the next two years. Provided adequate housing is available, the net population growth increment is projected to increase to over 600 residents and temporary workers in Year 10.

In summary, implementation of the Proposed Action would result in substantial incremental employment and population growth in Sweetwater and Carbon counties, with the net increments increasing over time until peaking in Year 14 of the project. Thereafter the impacts would diminish although ongoing production would sustain ongoing operations and transportation employment for more than 40 years. The peak employment impacts are estimated at 3,951 jobs, including 1,863 direct jobs and 2,088 indirect and induced jobs. A peak population impact of nearly 3,700 permanent residents is projected. At the peak, the incremental population attributable to the Proposed Action would represent about 8 percent of the total population of the respective counties. Following the completion of new well development, the incremental employment and population impacts would decline to levels sustained by the ongoing production and transportation. At that time, substantial out-migration of Proposed Action-related population would be anticipated to occur, in the absence of other major economic activities.

Fluctuations in annual drilling rates would result in substantial increases or decreases in temporary workers. Corresponding effects on indirect and induced workers would be less pronounced, but would have relatively larger effects on community population, as most of these workers are assumed to be community residents.

Housing

Direct, indirect, and induced workers associated with the Proposed Action would require both temporary and longer-term housing resources. A portion of the drilling and field-development workforce, including ancillary facility construction workers whose work assignments would be temporary, would be likely to seek temporary housing resources while working in the project area. Such resources include dormitory units in mobile home and RV parks in Wamsutter, as well as motels, mobile home parks and RV Parks in Rawlins, Rock Springs, Wamsutter, and Baggs. Other resources have included a 250-bed complex in Wamsutter, now closed and relocated, and two smaller temporary-living facilities located on WY 789 near Dad.

Most production workers and a portion of drilling, completion, and gas-field service workers and indirect and induced employees would likely seek long-term housing resources in communities near the project area. For this assessment, long-term housing includes conventional single-family and multi-family housing and mobile homes, both on lots and in mobile home parks.

Table 4.15-7 displays estimated Proposed Action-related demand for temporary and longer-term housing in communities near the study area for five periods: the first year of development and Years 5, 10, 15 (following completion of drilling), and 20. Demand estimates for long-term housing are expressed in terms of units; demand for temporary housing is expressed in terms of beds. Temporary demand could be accommodated by motels and RV pads, which typically accommodate more than one bed per unit or by worker camps/temporary living facilities, which can house one or multiple beds per unit.

In all communities, demand for both long-term and temporary housing increases sharply over the first 10 years of activity of the Proposed Action. Demand for temporary housing eases while demand for long-term housing continues to increase for several more years, after which demand for housing is projected to decline dramatically.[26]

[26] Note that vendors and certain types of contractors will require short-term temporary housing, primarily motels throughout the production phase of the project. These short-term requirements have not been estimated.

Table 4.15-7. Proposed Action-related temporary and long-term housing demand

Housing Demand	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County					
Rock Springs					
Long-term (units)	104	501	819	958	150
Temporary (beds)	81	217	304	128	91
Wamsutter					
Long-term (units)	13	63	102	120	19
Temporary (beds)	122	325	456	192	137
Green River					
Long-term (units)	10	50	82	96	15
Temporary (beds)	0	0	0	0	0
Sweetwater County Other					
Long-term (units)	3	13	20	24	4
Temporary (beds)	0	0	0	0	0
Sweetwater County total					
Long-term (units)	**130**	**627**	**1,024**	**1,197**	**187**
Temporary (beds)	**203**	**542**	**761**	**320**	**228**
Carbon County					
Rawlins					
Long-term (units)	31	219	371	422	66
Temporary (beds)	33	88	124	52	37
Baggs/LSRV					
Long-term (units)	7	49	83	95	15
Temporary (beds)	8	20	29	12	9
Carbon County Other					
Long-term (units)	1	5	9	11	64
Temporary (beds)	10	27	38	16	11
Carbon County total					
Long-term (units)	**39**	**274**	**463**	**528**	**83**
Temporary (beds)	**51**	**135**	**190**	**80**	**57**

Source: SDLLC and BCLLC, using the REMI model.

Several communities, including Rawlins, Rock Springs, and Wamsutter, have developed housing and/or infrastructure improvement plans that, if realized, would accommodate the long-term housing demand associated with the Proposed Action and other energy development. At present no communities have the existing available housing to accommodate the anticipated long-term demand.

During late 2008 and early 2009 there was an increase in available long-term housing units throughout the study area as a result of the national economic slowdown and in Carbon County, due to substantial completion of Sinclair Refinery expansion construction. Still, most of the long-term housing required to fill the Proposed Action-related housing demand would need to be added through new construction, given that the Proposed Action would likely occur in the context of substantial regional natural gas development.

Although there are adequate regional temporary housing resources to accommodate temporary housing demand associated with the Proposed Action, there would be localized shortages of temporary housing, particularly in Wamsutter. The closure of the BP Wamsutter base camp, which had 250 beds and was permitted for an additional 250 beds, has substantially reduced the availability of temporary housing resources within that community. If the pace of development within the project area accelerates, as contemplated by the Proposed Action, additional worker housing would be required in Wamsutter. There could also be substantial competition for temporary housing from demand associated with the regional natural gas development projects and other planned and proposed energy development described in **Table 5.0-1**. Development and expansion of temporary living facilities and potential expansions of motels, mobile homes and RV parks throughout the study area would be required to accommodate Proposed Action-related temporary housing demand if the Proposed Action occurred concurrently with other development.

Project-related demand for housing would also be subject to variability in response to the anticipated year-to-year variances in the pace of development. Variations in drilling levels would primarily affect the number of temporary workers, which would correspondingly result in higher or lower demand for and occupancy of temporary housing resources.

The substantial decrease in demand for long-term housing resources in communities following the 15-year drilling and field-development phase of the Proposed Action could result in substantial shocks to community housing markets, including vacancies and a decrease in housing value, depending on other economic activities occurring in the area at that time.

Community Infrastructure and Services

The Proposed Action would affect community infrastructure and services in several ways. The increases in industrial activity within the project area and increases in traffic to and within the project area would result in demand for additional law enforcement, emergency management and response, and road maintenance services for Carbon and Sweetwater Counties and the volunteer emergency response agencies that serve these areas. The Proposed Action-related population increase in affected communities including Rawlins, Baggs/LSRV, Wamsutter, Rock Springs and Green River would experience increased demand for a wide range of community infrastructure and local government services. The increase in temporary and transient population would likely generate higher levels of demand for certain services including law enforcement and emergency medical treatment. County and municipal governments would receive revenues from the Proposed Action (assessed in the following section), which could help offset the costs of the additional services required to meet the demand, although municipal revenues generated directly by the project would be limited to sales and use tax revenues. Incremental revenues from development would typically lag development-related demand by months or in some cases, years.

Community Infrastructure

Expanding and improving community infrastructure to accommodate growth requires substantial lead-time and capital. With the possible exception of Wamsutter, demand for public facilities during the assessment period will result from a number of other projects and factors in addition to the project area. Consequently, while project area-related demand for public facilities may not by itself trigger a need for community infrastructure expansion, cumulative demand from the project area in combination with other natural gas and energy projects and other sources could trigger additional infrastructure needs.

Because energy-related population growth occurred within the study area for several years prior to the current slow-down and additional growth was anticipated, most local governments expanded and improved some community facilities including water and wastewater systems, solid-waste disposal facilities, detention facilities, and a range of other facilities. For some local governments, further improvements in specific systems are planned.

Solid Waste Disposal Facilities. Most communities and solid-waste management districts within the study area have implemented solid waste management plans and in some cases, expanded landfill capacities. The Carbon County communities within the study area (Rawlins and Baggs) are transporting their municipal solid waste to the Casper Regional Landfill. The City of Casper is permitted to operate the CRL on a 1,750 acre site; Phase I includes 88 acres and has an estimated capacity of 11,920,000 cubic yards and a lifespan of 50 years. Five future cells also have estimated life spans of 50 years (Inberg-Miller Engineers 2009).

The Sweetwater County communities in the study area (Wamsutter, Green River and Rock Springs) plan to transport their municipal solid waste to the Rock Springs Regional landfill. Much of the gas-field solid waste within the project area is also transported to the Rock Springs landfill. The Rock Springs Landfill, which will become the I-80 Solid Waste Management Planning Area landfill, has capacity for about 30 years at current fill rates. The District has an additional 300 acres that may be used after the current facility reaches capacity.

Through their participation in the solid-waste management districts, all communities within the study area should have capacity to accommodate the increase in solid-waste-disposal demand generated by the Proposed Action and alternatives, although some operating improvements will likely be required to accommodate the increased volumes associated with the Proposed Action, with associated increases in operating costs. Increased levels of drilling and development in the project area would likely be accompanied by increases in drilling and development in other natural gas fields in the study area. Implementation of the Proposed Action would increase fill rates at both regional and municipal landfills, hastening the date when expansion of existing landfills or development of new landfills would be required.

Water. Water systems within the study area are operated by municipalities. All communities have adequate water rights and treatment and storage capacity or are in the process of improving their systems to provide adequate capacity to accommodate additional population.

Although the main components of municipal water systems, with planned improvements, would be adequate to accommodate the growth associated with the Proposed Action, each municipality could encounter the need to expand or improve its water-distribution system to accommodate areas within the community that would develop housing to accommodate growth. Additionally, elevated levels of drilling and development in all gas fields in and near the project area could result in the need to expand water systems to serve new housing developments in each municipality, resulting in additional water system expenditures.

Wastewater. Rawlins, Rock Springs, and Green River all have adequate wastewater treatment capacity to accommodate the population increment associated with the Proposed Action and other foreseen growth. Baggs and Wamsutter are currently in the planning stages of developing additional wastewater treatment capacity to accommodate foreseen growth. All municipalities have the potential to encounter costs to develop wastewater collection mains to serve areas of their communities that would accommodate new housing development and to expand or improve wastewater treatment systems to meet evolving regulatory standards.

Criminal Detention Facilities. Carbon and Sweetwater counties each have relatively new criminal-detention facilities. The 78-bed Carbon County detention facility has been in operation since 2004. During the summer of 2009 the facility’s design capacity was exceeded several times; suggesting a shorter than expected 10- to 15-year design life for the facility. The Proposed Action would contribute to the potential need to expand the Carbon County Detention Facility during the 15-year development phase of the project.

The Sweetwater County Detention Facility has a design capacity of 208 inmates. Recent occupancy has averaged about 110 inmates, or 53 percent of capacity. The facility was designed to allow for expansion on the same site while maximizing use of existing administrative facilities. The Sweetwater County Detention Facility should be adequate to accommodate the population increment associated with the Proposed Action.

Hospitals. Major health-care institutions within the study area include the Memorial Hospital of Carbon County, which is undergoing major renovations, and Memorial Hospital of Sweetwater County, which recently completed a major improvement and expansion project. In general, the expanded physical hospital facilities should be adequate to accommodate the population increment associated with the Proposed Action. Both hospitals would experience increased use of emergency rooms and staff to treat patients, including gas-field development workers who do not have local primary-care physicians. Consequently the Proposed Action, in concert with other energy-development activities, could result in strains on emergency-room facilities and staff. On the other hand, recent development and expansion of urgent care facilities in Rawlins and Rock Springs could reduce this impact.

Both hospitals experienced substantial increases in uncollected debt attributed to increasing numbers of patients without health-care insurance and indigent patients during periods of expanded energy development. Uncollected debt would likely increase under the Proposed Action and increases in other energy development.

Physician and health-care professional recruitment and retention has also been a problem in the past. The Proposed Action and other energy development would increase demand for physicians and likely contribute to increases in housing costs, which could contribute to difficulties in physician and health-care professional recruitment.

Other Municipal Infrastructure. As discussed below, each of the counties and communities within the study area will require additional employees and equipment to accommodate demand from the incremental population growth associated with the Proposed Action and other energy development. New employees will require office space and new equipment will require storage space in buildings or storage yards. Recreational facilities such as parks, libraries, and recreation centers will receive additional demand and may require expansion, improvement, or increases in staffing. It is likely that counties and municipalities would be required to develop new facilities and expand and improve existing facilities to accommodate the additional demand associated with the Proposed Action and other energy development.

Community Services

Demand associated with the incremental population associated with the Proposed Action would result in additional demand for community services, which, in turn, would require additional staff, equipment, and operating expenditures.

County sheriff's departments and local emergency-management and response agencies would be required to increase resources to maintain the current level of services (LOS) they provide to the project area and on highways and roads that provide access to the area. County road and bridge departments would experience demands for additional road maintenance for county roads within the project area. County governments would experience pressure to expand all essential services to accommodate the additional population, housing, commercial, and community infrastructure associated with the Proposed Action and other energy development. As discussed in the following section on fiscal effects, counties would receive ad valorem property taxes on certain natural gas facilities and production and sales and use tax revenues to help offset the cost of increased service demand.

Affected communities and certain special districts within the study area would also experience increased demand for services associated with the Proposed Action. For municipalities, this demand would generally be driven by the incremental population associated with the Proposed Action, although the specific demographics of the temporary and transient, single-status, working-age male population would likely result in higher demand for law enforcement and emergency medical services.

Communities are much more limited than counties in their ability to fund the needed increases in municipal services. As is discussed in the fiscal section, direct revenues generated by the Proposed Action to communities would accrue primarily in the form of sales and use tax revenues, although the Proposed Action could indirectly result in additional ad valorem tax revenues on commercial and residential development and from relatively larger distributions from various shared revenues for which the allocation formulas are population based. To assist local communities affected by energy development, the Wyoming Office of State Lands and Investments administers a number of grants and loans funded out of mineral revenues that local governments can use to fund infrastructure improvements, and a number of energy companies have provided funds to local governments to develop facilities to accommodate energy-related growth, particularly in Wamsutter.

Public Education

Three school districts would be affected by the Proposed Action, Sweetwater County School Districts 1 and 2 and Carbon County School District 1. **Table 4.15-8** below summarizes the projected increases in student enrollments in these school districts for the first 20 years of the Proposed Action.

Table 4.15-8. Projected Proposed Action-related school enrollment: Years 1 through 20

District/(Location)/Grades	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater #1 (Rock Springs)					
Elementary: K–4 (ages 5–9)	16	16	125	211	170
Elementary: 5 & 6 (ages 10 & 11)	6	6	11	69	69
Junior High: 7 & 8 (ages 12 & 13)	5	5	10	45	66
High School: 9–12 (ages 14–17)	11	11	22	29	129
Rock Springs Subtotal	***38***	***38***	***168***	***354***	***434***
Sweetwater # 1 (Wamsutter)					
Wamsutter Elem/Middle (K–8)	6	6	37	81	76
Sweetwater #1 Total	***44***	***44***	***205***	***435***	***510***
Sweetwater #2 (Green River)					
Elementary: K–4 (ages 5–9)	2	2	14	23	19
Elementary: 5 & 6 (ages 10 & 11)	1	1	1	7	8
Junior High: 7 & 8 (ages 12 & 13)	1	1	1	5	7
High School: 9–12 (ages 14–17)	1	1	2	3	11
Sweetwater #2 Total	***5***	***5***	***18***	***38***	***45***
Carbon District #1 (Rawlins)					
Elementary: K–5 (ages 5–10)	6	6	46	90	77
Middle: 6–8 (ages 11–13)	2	2	6	26	35
High School: 9–12	3	3	7	10	34
Rawlins Total	***11***	***11***	***59***	***126***	***146***
Carbon District #1 (Baggs/LSRV)					
LSRV K–12	4	4	15	32	36
Carbon #1 Total	***15***	***15***	***74***	***158***	***182***

Source: SDLLC and BCLLC, using the REMI model.

Proposed Action-related increases in school enrollment would follow the trends in resident population increase, climbing over time as long-term employment increases, but then declining as drilling activity is completed and the production levels begin to fall (see **Figure 4.15-9)**.

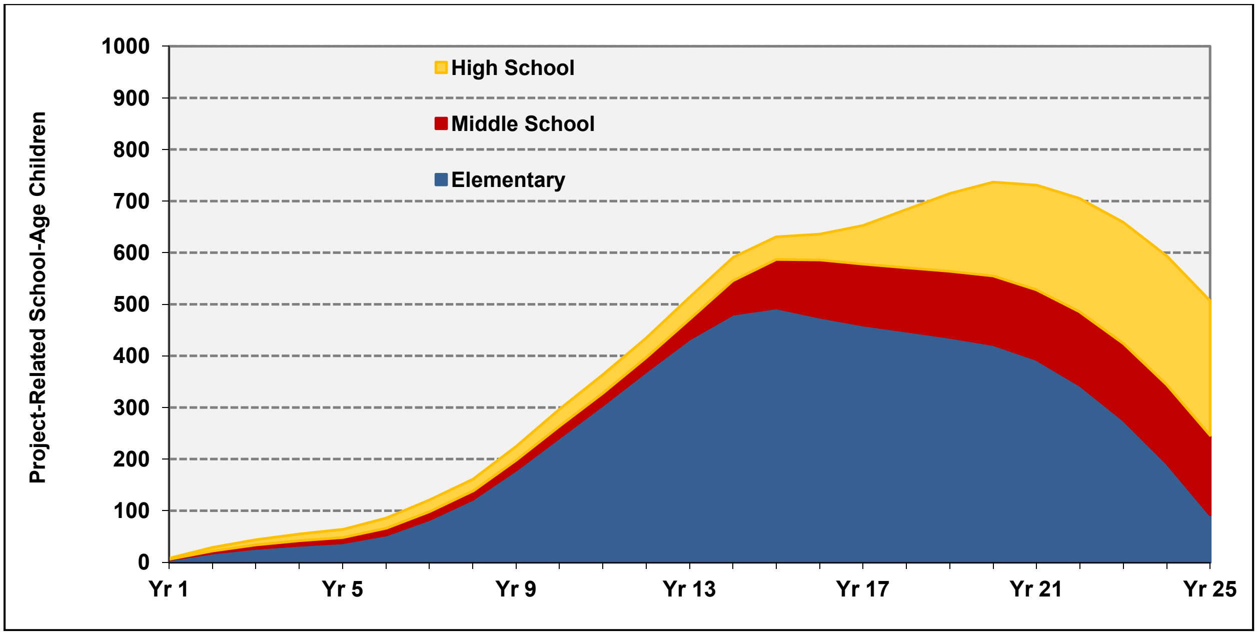


Figure 4.15-9. Increases in school-age children due to the Proposed Action

Source: SDLLC and BCLLC, using the REMI model.

Proposed Action-related enrollment in SCSD #1 schools in Rock Springs would increase from an estimated 38 students in Year 1 to 434 in Year 20. Based on recent enrollment trends, the incremental increases in student enrollment would initially be more heavily concentrated in kindergarten and the lower grades, but shifting into the middle and high school grades over time. Considering cumulative increases in enrollment for other energy development, the Proposed Action-related enrollment would exceed the capacity of the current schools during the 15-year field-development period, depending on other concurrent levels of energy development in the region. If SCSD #1 is able to anticipate the increase in demand in a timely fashion and seek and obtain approval from the Wyoming School Facilities Commission for new school facilities, the demand could likely be accommodated without long periods of overcrowding. Depending on the date of approval, the length of time required to construct such facilities and the concurrent level of energy development, modular classrooms could be required to accommodate some Proposed Action-related students in the interim.

Proposed Action-related enrollment in the SCSD #1 K–8 school in Wamsutter would increase from an estimated six students in Year 1 to 81 in Year 15, decreasing thereafter. The current school facility in Wamsutter would require expansion to accommodate this increase in enrollment.

SCSD #2, based in Green River, would experience much lower impacts on student enrollments than would SCSD #1. Proposed Action-related enrollment in the SCSD #2 in Green River would increase from an estimated five students in Year 1 to 45 in Year 20. SCSD #2 could accommodate the anticipated increase in enrollment with current school facilities, depending on the level of other energy development concurrent with the Proposed Action.

Proposed Action-related enrollment in CCSD #1 in Rawlins would increase from an estimated 15 students in Year 1 to 182 in Year 20. The school-age enrollments would begin declining thereafter. CCSD #1 schools in Rawlins could nominally accommodate the Proposed Action-related increases in enrollment, but given that increases in drilling and field development in the project area are likely to be accompanied by increases in drilling and development in other fields in the study area, the capacities of Rawlins schools are likely to be exceeded during the 15-year drilling period. The available capacities of the newly completed Rawlins Elementary School and the 500-student-capacity high school authorized by the Wyoming School Facilities Commission would be nearly exceeded by the projected Proposed Action-related increase in enrollment alone, not considering increases in enrollment related to other energy development.

The LSRV K–12 schools in Baggs could accommodate the projected Proposed Action-related increase in enrollment, but would absorb most available capacity such that enrollment associated with other nearby energy development could result in enrollment increases beyond available capacities, particularly toward the end of the 15-year drilling phase and the subsequent five years of project operations.

As discussed in Section 1.7.4 of the Socioeconomic Technical Report, the Wyoming School Foundation Program provides a guaranteed level of funding to every school district in the state, with funding based on numbers of students, classrooms, and other factors such as adjustments for small schools, transportation, special programs, and the cost of living. Consequently, the school districts affected by Proposed Action-related increases in enrollment should have the financial resources to fund the required increases in teachers and operating costs, although the districts would experience increased costs to provide for special needs of incoming students, including programs for transient students and additional teachers to serve English-language learners. Wyoming teacher salaries are relatively high, but districts may have to provide housing to recruit the required number of teachers. Districts may also have trouble recruiting and retaining custodians and school-bus drivers if the area experiences another surge in energy development, given the wage competition during energy booms.

Fiscal Effects

Projections of future natural gas and condensate production provide the foundation for projecting the Proposed Action-related mineral development revenue.[27] Projected production was derived using typical well-production data provided by the BLM Wyoming's Reservoir Management Group (RMG) and the projected numbers of new wells associated with the Proposed Action.

Estimated total production for the Proposed Action (and Alternative A) over the life of the field is 12.02 Tcf of gas and 167.3 million bbls of liquid condensate. The estimated market value of that production, based on assumed future commodity prices of $4.00 per thousand cubic feet (Mcf) of gas[28] and $40.00 per bbl of liquid condensates is $52.0 billion ($2010); $45.6 billion for gas and $6.4 billion for condensate.[29]

The value of gas and condensate sales under the Proposed Action would reflect the trends in annual production, increasing over time as long as the anticipated level of new development occurs, but declining steadily once new development ceases. At the level of development associated with the Proposed Action, the incremental annual sales would exceed $1 billion within three to four years and remain above that mark for approximately 20 years. Projected annual sales value would peak at approximately $2.92 billion for the Proposed Action (**Figure 4.15-10)**. Sales of natural gas would account for nearly 90 percent of the total, $2.6 billion. In 2007, a total value of $1.37 billion in natural gas and $441 million in crude oil and condensate was produced in Carbon and Sweetwater counties. Despite substantial increases in natural gas production, the corresponding production values in 2009 were $949 million and $330 million, respectively.

[27] The gas and condensate volumes associated with the Proposed Action would be in addition to gas and condensate produced from wells already developed and allowed under previous NEPA actions.

[28] The $4.00/mcf commodity price for natural gas is net of an assumed $0.50/mcf gas processing allowance.

[29] Projected market value of sales assumes 95 percent of projected production is sold.

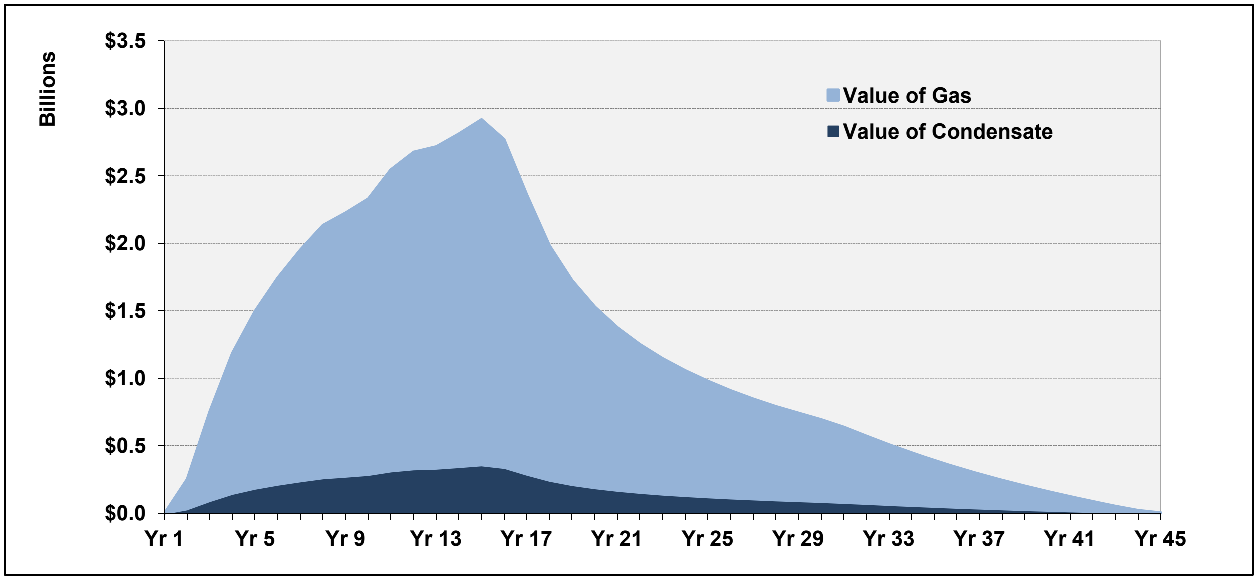


Figure 4.15-10. Projected value, annual natural gas and liquid condensate production, Proposed Action

Source: SDLLC and BCLLC

Production and the value of sales would decline rapidly after full-field development occurs (Year 15), decreasing by approximately 65 percent in the subsequent decade.

Severance Taxes

The State of Wyoming levies a severance tax on all minerals produced in the state. Current severance tax rates are 6.0 percent on condensate and natural gas. Severance tax rates are applied to the taxable value at the point where the production process is complete, before processing and transportation. Because processing adds value to the raw gas, the effective tax rate relative to market value is less than the nominal rate. In 2007, the Wyoming Legislative Services Office estimated the effective rates at 5.46 percent for condensate and 4.86 percent for natural gas. Applying these rates to the project values for the Proposed Action yields severance taxes of $818 million in the first decade as development continues and production climbs; $1.13 billion in the second decade during which peak production occurs; and a total of nearly $2.6 billion over the life of the field (**Figure 4.15-10** and **Table 4.15-9**).

Table 4.15-9. Projected state severance tax revenues and initial allocations, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Permanent Wyoming Mineral Trust Fund, 41.7%	$ 341,020,000	$ 468,900,000	$ 185,770,000	$ 1,066,450,000
General Fund, 19.4%	159,700,000	219,580,000	86,990,000	499,410,000
Budget Reserve, 38.6%	317,730,000	436,880,000	173,080,000	993,620,000
Total state severance taxes	**$ 818,450,000**	**$ 1,125,360,000**	**$ 445,840,000**	**$ 2,559,480,000**

Source: SDLLC and BCLLC

Severance tax receipts collected by the state are allocated to the Permanent Wyoming Mineral Trust Fund (PWMTF) and to the Severance Tax Distribution Account; further distributions to numerous other funds are made from the latter. Those subsequent distributions are subject to a legislatively established aggregate cap of $155 million on annual revenue deposits. Revenue in excess of the annual cap is distributed one-third to the state's general fund and two-thirds to the budget reserve account.[30] The high levels of mineral production and prices over the past decade have consistently generated sufficient severance taxes for such distributions to the general fund and budget reserve account. Under the assumed allocations, the Proposed Action would generate nearly $1.1 billion to the PWMTF, nearly $500 million to the state's General Fund, and more than $993 million to the Budget Reserve Account.

Federal Mineral Royalties

Federal mineral royalties (FMR), based on a rate of 12.5 percent, would be derived on the value of production from the federal mineral estate. The federal mineral estate encompasses about 59 percent of the total oil and gas mineral estate in the project area. Total projected FMR of $3.8 billion would be generated from the Proposed Action over the life of the field.[31] Of that total, nearly $1.96 billion would accrue to the Federal Treasury, with $1.88 billion in disbursements to the State of Wyoming (**Table 4.15-10**).

Table 4.15-10. Projected federal mineral royalties and distribution ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Federal Treasury (51%)	$ 625,690,000	$ 860,330,000	$ 340,830,000	$ 1,956,680,000
State of Wyoming (49%)	601,150,000	826,590,000	327,470,000	1,879,950,000
Total FMR	**$1,226,840,000**	**$1,686,920,000**	**$ 668,300,000**	**$ 3,836,630,000**

Source: SDLLC and BCLLC

As with the state's severance taxes, the state's share of FMR is allocated according to a tiered allocation formula. The state first deducts 1 percent for administration. Thereafter, the next $200 million in annual receipts is distributed among seven different funds, e.g., a county highways fund and school capital construction account. FMR in excess of $200 million are distributed as follows: one-third to the School Foundation Program and two-thirds to the state Budget Reserve Account. The $200 million annual cap has been exceeded consistently for more than a decade, such that incremental revenues flow to the education and budget reserve accounts. In recent years, a portion of the School Foundation Program distributions has been diverted to two special education accounts: the Hathaway and Higher Education endowments. The Hathaway endowment provides scholarships for high-school graduates entering college and the Higher Education endowment allows the University of Wyoming (UW) to fund a number of endowed faculty positions and acquire materials and resources to support those chairs. Projected allocations of the $1.88 billion in FMR accruing to the state are $626 million for education and $1.25 billion to the state's Budget Reserve Account (**Table 4.15-11**).

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[30] The high levels of mineral production and commodity prices have consistently generated sufficient severance tax revenue to exceed the cap, such that additional revenues flow to the general fund and budget reserve account. The resulting distribution, which is used in this analysis, is 41.7 percent to the PWMTF, 19.4 percent to the General Fund and 38.9 percent to the Budget Reserve Account.

[31] A "temporary" change in the distribution of FMR was recently enacted by Congress and the President. Under the new formula, 51 percent of the revenue accrues to the federal government and 49 percent to the state, rather than the prior 50/50 split net of a 1 percent administrative processing fee. The forecasts reflect the current allocation formula.

Table 4.15-11. Projected allocation of Wyoming's share of federal mineral royalties, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Wyoming School Foundation	$ 200,180,000	$ 275,250,000	$ 109,050,000	$ 626,020,000
State budget reserve	400,970,000	551,340,000	218,420,000	1,253,930,000
Total state share of FMR	**$ 601,150,000**	**$ 826,590,000**	**$ 327,470,000**	**$1,879,950,000**

Source: SDLLC and BCLLC

State Royalties

Like the federal government, the State of Wyoming collects mineral royalties on production from the state's mineral estate. The state's interest in the project area oil and gas estate is estimated at 2 percent, yielding an estimated $169 million ($2010) in royalties over the life of the field, assuming a 12.5-percent royalty rate. State mineral royalties accrue to the Wyoming Office of State Lands and Investments. Those revenues are in turn used to benefit public education and other designated state institutions, such as the Wyoming State Hospital.

Gross Products and Local Ad Valorem Taxes

The gross products tax is based on the value of the minerals produced in the previous year. The taxable value is determined by the state, but the tax is levied and collected by local taxing jurisdictions based on the applicable tax levy. Consequently, the tax is akin to local ad valorem property taxes. Based on the location of the wells and mineral resources, the taxing districts most directly affected by the Proposed Action include Sweetwater County, Carbon County, SCSD #1 and CCSD #1. A mandatory statewide mill levy to support public education via the Wyoming School Foundation program would be collected by the two counties, with the proceeds being transferred to the state. Projected gross products tax revenue from the Proposed Action, assuming current mill levies over the life of the project, would total $3.11 billion (**Table 4.15-12**). Of that total, 13.8 percent would accrue to Sweetwater County, 7.4 percent to Carbon County, 43.2 percent to SCSD #1, 25.0 percent to CCSD #1, and 10.6 percent to the Wyoming School Foundation Program.[32]

[32] The allocation to school districts assumes that the two local districts retain all of the additional tax revenue to meet increases in operating costs associated with changes in enrollment, rather than being subject to the "recapture" provisions under the Wyoming School Finance Act. Under those provisions, locally generated tax revenues in excess of the amount a district is authorized to expend under the financing equalization program are transferred to the state to help support statewide education. As a result, school districts realize little significant fiscal benefits from high levels of mineral development within their boundaries. Both SCSD #1 and CCSD #2 have been subject to the recapture provisions, CCSD # 1 as recently as 2010. In 2010, CCSD #1 contributed $15.8 million of its ad valorem tax collections to the School Foundation Program.

Table 4.15-12. Projected gross products and ad valorem taxes to local counties and school districts, Proposed Action ($2008)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project (40+ years)
Sweetwater County	$ 94,360,000	$ 162,330,000	$ 68,150,000	$ 354,130,000
Carbon County	50,810,000	87,410,000	36,700,000	190,680,000
Sweetwater County School District #1[1]	296,470,000	510,000,000	214,120,000	1,112,560,000
Carbon County School District #1 [1]	171,490,000	295,010,000	123,860,000	643,560,000
Wyoming School Foundation Program **	72,580,000	124,860,000	52,420,000	272,380,000
Combined totals	**$685,710,000**	**$1,179,610,000**	**$495,250,000**	**$2,573,310,000**

[1] These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the “recapture” provisions of the Wyoming School Finance Act. Both SCSD #1 and CCSD #2 have been subject to the recapture provisions, CCSD # 1 as recently as 2010. In 2010, CCSD #1 contributed $15.8 million of its ad valorem tax collections to the School Foundation Program.

Source: SDLLC and BCLLC

In addition to the gross products tax on production, the counties, school districts, and some local taxing districts (special service districts and communities) would levy ad valorem taxes on the production equipment, pipelines, and other real improvements associated with the project, as well as residential, commercial, and industrial development generated by the project. Local communities would realize additional ad valorem tax revenues from new real-estate development supported by the project and the effects of demand on values of existing real estate. The affected local taxing districts include: Sweetwater County Conservation District; Sweetwater County Solid Waste District #2; Sweetwater County Weed and Pest District; Western Wyoming Community College; the Baggs Cemetery and Solid Waste Disposal districts; the Little Snake River Conservation, Museum, and Rural Mental Health districts; Carbon County Weed and Pest District; the cities of Rock Springs, Green River, and Rawlins, and the towns of Wamsutter and Baggs. Project-related ad valorem tax revenues accruing to these districts are not estimated in this analysis.

Sales and Use Taxes

Future expenditures for materials, supplies, and equipment associated with new well development and subject to sales and use tax are projected to exceed $2.8 billion under the Proposed Action. That total excludes taxable capital expenditures associated with any new centralized gas-processing facilities or transmission pipelines. Based on the locations of the wells and the concentration of well drilling and oil and gas service firms in Rock Springs, approximately two-thirds of that total, $1.9 billion, would occur in Sweetwater County. Taxable expenditures of $340 million by the Operators are assumed to occur in Carbon County, and $626 million are assumed to occur elsewhere in Wyoming or out of state.[33] The latter would be subject to use tax when brought into the state.[34]

The state imposes a 4.0-percent general sales and use tax on such purchases. Sweetwater County’s tax rate is 2.0 percent (1.0 percent general purpose and 1.0 percent specific-purpose option). Carbon County historically levied only the 1.0-percent general purpose tax, but added a 1.0-percent specific purpose tax effective April 2009. Those tax rates, assumed to remain constant, would yield nearly $161 million in

[33] These estimates are based on information provided by the Operators to SDLLC and BCLLC and the development of 8,950 new wells.

[34] Additional taxable purchases would be made in conjunction with ongoing production and field operations. However, data to estimate such purchases was not available at the time of the analysis.

sales and use taxes; $115.8 million from the state's 4.0-percent rate, $38.2 million in locally imposed taxes in Sweetwater County and $6.7 million on sales in Carbon County.[35]

Projected distributions of the state's sales and use tax receipts, based on the current statutorily established allocations, would include $80.3 million to the general fund and $35.5 million to local governments. The distributions to local governments, which are primarily a function of population distribution in the 2000 Census, would include: $4.2 million to Sweetwater County, $1.3 million to Carbon County, and $30.0 million to other local governments.[36] Each county retains a portion of its distribution from the state; the remainder is distributed to cities and towns in the respective counties. Combining the locally generated sales and use tax and distributions from the state yields totals of $42.4 million in Sweetwater County and $8.1 million in Carbon County; more than $2.8 million in Sweetwater County and $534,000 in Carbon County on an annual basis.

The Proposed Action would stimulate higher consumer expenditures in the regional economy and Sweetwater and Carbon counties and local municipalities would benefit from sales and use tax receipts derived from the consumer expenditures. All sectors of the economy would benefit from the boost in consumer sales, with the most pronounced effects on the retail trade, food and beverage, and lodging and entertainment sectors. Incremental consumer expenditures would increase over time, as production and transportation employment increases, augmenting the incremental expenditures associated with the development phase. The incremental expenditures would drop sharply after the development phase is completed.

Revenue Summary

The combined total public-sector revenues from the identified sources are projected to exceed $9.3 billion over the life of the field. FMR totaling $3.8 billion would account for the single largest share of the total, 41.0 percent (**Table 4.15-13** and **Figure 4.15-11)** though nearly one-half of that total would be distributed to the State of Wyoming. The state would garner another $2.7 billion in severance taxes and state mineral royalties. Sweetwater and Carbon Counties would realize a combined total of $544 million in gross products and ad valorem taxes and the two school districts and Wyoming State Foundation program would collectively receive nearly $2.0 billion in tax revenues.

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[35] The total assumes all non-local purchases are made out of state. If purchases are made elsewhere in Wyoming, additional sales taxes could be generated for that county, but the revenues accruing to Sweetwater and Carbon counties would be unaffected.

[36] The resident populations of Sweetwater and Carbon county, expressed as a percentage of Wyoming's total population, increased slightly between 2000 and 2010. Consequently, assuming no changes in the allocation formula by the Wyoming Legislature, the shares of local distributions from the state's receipts may increase slightly in the future.

Table 4.15-13. Projected public-sector taxes and royalties on gas and condensate production, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$ 818,450,000	$ 1,125,360,000	$ 445,840,000	$ 2,559,480,000
Federal Mineral Royalties	1,226,840,000	1,686,920,000	668,300,000	3,836,630,000
State Mineral Royalties	54,030,000	74,300,000	29,430,000	168,960,000
Gross products / ad valorem, Counties [1]	145,170,000	249,740,000	104,850,000	544,810,000
Gross products / ad valorem, Schools [1]	540,540,000	929,870,000	390,400,000	2,028,500,000
Sales and use taxes, development-related	156,610,000	66,660,000	n/a	223,270,000
Total combined	**$2,941,640,000**	**$4,132,850,000**	**$1,638,820,000**	**$9,361,650,000**

[1] *These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.*

Source: SDLLC and BCLLC

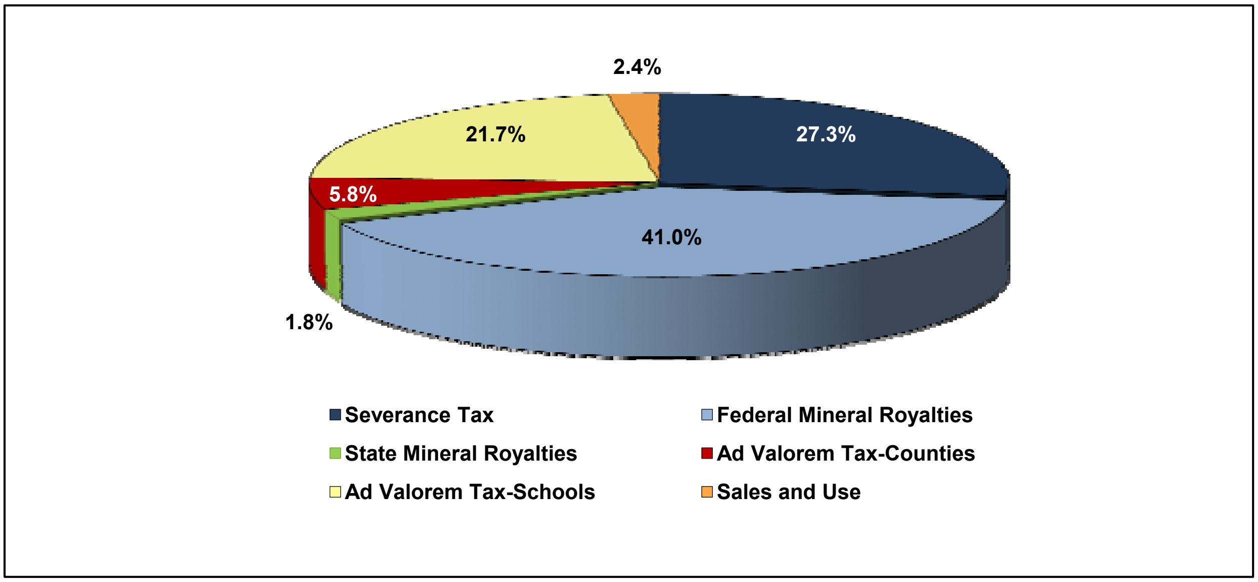

Figure 4.15-11. Distribution of public-sector taxes and royalties, Proposed Action

Source: SDLLC and BCLLC

Local Public Sector Expenditures

Although the revenues generated to the public sector by the Proposed Action would be substantial over time, local and state governments would correspondingly be required to make substantial expenditures to respond to demand from development activities and from the population associated with the Proposed Action. Many of the required infrastructure and service expenditures were identified and discussed conceptually in the preceding Community Infrastructure and Services section. The amount and timing of expenditures that local governments might make in response to development are not known and would depend in part on the concurrent level of development throughout the study area.

In the past, local governments have often had to respond to service demand from energy development prior to receiving substantial revenues from that development. In the case of major infrastructure investments, local governments assume substantial risk that the development will continue and generate adequate revenue to pay for the investment. This phenomenon has been called the "tax lead-time problem" (Governors Committee on Oil Shale Environmental Problems 1974), but might be more appropriately called the "tax lag-time problem," in that the receipt of adequate tax revenues lag the point in time at which local governments incur cost to serve development and growth.

Another issue alluded to elsewhere in this assessment is the "jurisdictional mismatch problem," in which development-related tax revenues do not accrue in sufficient amounts to the local governments affected by development-related impacts. In Wyoming, ad valorem taxes on natural gas production and facilities typically do not accrue to municipalities, where most of the population-related impacts occur. Municipalities must rely on development-related sales and use taxes, which are often inadequate to fund expenditures to serve development and can diminish relatively rapidly when development slows.

These are historical problems that have accompanied energy and other forms of natural-resource development in Wyoming and much of the west. The magnitude of these problems in relation to the Proposed Action will depend in part on the magnitude of concurrent energy development in the study area. As previously noted, most local governments in the study area have expanded infrastructure during past periods of energy development, so there is some capacity for growth in infrastructure in the affected communities. Additionally, production-related revenues from existing wells within the project area will provide revenue streams for counties, school districts, the Wyoming School Foundation Fund and some special districts as future development occurs.

Social Effects

Many of the social effects of the last natural gas boom discussed in **Section 3.15.7** could occur under the Proposed Action, particularly if substantial concurrent development were to occur in other parts of the study area. The availability of a relatively large number of high-paying jobs and corresponding low regional unemployment would again be seen as positive aspects of development. Many of the current residents of Carbon and Sweetwater counties are associated with energy industries and residents of all affected communities are familiar with energy development. But as the population in affected communities would grow as a result of the Proposed Action and other energy development, the proportion of newcomers and the numbers of temporary and transient persons in affected communities would increase. This trend has been associated with decreased community cohesion and increases in certain types of crime including those involving drugs, alcohol, and minor disturbances and assaults (see **Section 3.15.4.1**).

Conversely, as more families relocate to communities, more commercial and community infrastructure would be available for newcomers and long-time residents alike. Community infrastructure and services would likely be strained and commercial establishments would experience some crowding in some communities during the early part of the development period, particularly if increases in development in the project area coincided with development elsewhere in the study area.

Each of the communities within the CD-C study area would be affected differently by population growth associated with the Proposed Action. Rawlins and Rock Springs have embarked on housing and infrastructure development and community revitalization efforts. Both of these communities have initiated programs to preserve and redevelop portions of their historic downtown areas and have instituted and expanded cultural and recreational events that offer venues for newcomers and long-time residents to socialize. Wamsutter has an extensive program to develop and expand both physical and commercial infrastructure and housing resources and has enlisted participation by natural gas companies and the State of Wyoming in their efforts. Baggs is expanding and improving infrastructure to accommodate growth and the social effects of growth on this relatively close-knit ranching and outdoor recreation community will present unique challenges. However, the relatively modest level of growth associated with the Proposed Action and the community's experience with prior and ongoing energy development will likely soften these effects. Green River would receive proportionately the smallest amount of growth from the

Proposed Action and is likely to host few temporary workers, so adverse social effects of the Proposed Action would likely be minimal in that community.

Although the value of environmental amenities and outdoor recreation for residents of the study area is relatively well-documented, social effects of the change in environmental amenities associated with the Proposed Action are likely to be minimal. The fact that much of the project area is already developed and industrialized would diminish concern for further changes in most environmental amenities. The exceptions would be areas that are considered sensitive such as the sage-grouse lek complex southeast of Creston, the small portion of the Red Lake Dunes Citizens' Proposed Wilderness that extends into the northwestern part of the project area, and the Chain Lakes Wildlife Habitat Management Area.

The displacement of grazing permittees from the most intensively developed areas of the CD-C project area would be a substantial social impact, particularly if the ranching families who hold the allotments exit the ranching business. Ranching is an important element of the culture in the study area and further reductions in the ranching community would be of concern for many residents.

Environmental Justice

No environmental justice populations have been identified within or in areas immediately adjacent to the project area. Although some communities in this area have concentrations of racial and ethnic minority populations slightly higher than the statewide averages, the percentages are not meaningfully higher with the exception of Rawlins and that minority population is in large part attributable to the racial composition of the inmate population at the Wyoming State Penitentiary. Rawlins is 25 miles from the eastern boundary of the project area; consequently, the inmate population is unlikely to be affected by human health or environmental effects of the Proposed Action.

The percentage of persons in poverty within and immediately adjacent to the project area is lower than the statewide average. The percentage of persons in poverty in Carbon County is slightly higher than the statewide average as a result of the population associated with the Wyoming State Penitentiary, but again, that population is unlikely to be affected by the activities associated with the Proposed Action.

Based on the foregoing, no disproportionately high and adverse human health or environmental effects on minority or low-income populations are anticipated under the Proposed Action.

4.15.2.3 Alternative A: 100-Percent Vertical Drilling

Employment

Like the Proposed Action, Alternative A assumes a total of 8,950 new wells would be drilled over a 15-year period. Alternative A assumes that all wells would be drilled vertically from single-well pads. The shift to all single-well pads would require more rigs to drill the same number of wells each year compared to the Proposed Action. Projected long-term gas, condensate, and water production would be the same as under the Proposed Action. Applying the work-crew concept developed for the Proposed Action to Alternative A yields an increase of 15 to 20 percent in the number of direct onsite jobs (about 150) and 200 to 210 total direct jobs as compared to the Proposed Action. Estimated long-term production and transportation employment would be slightly higher than for the Proposed Action due to the reduced efficiencies of servicing the higher number of single-well pads.

The additional direct employment would support more indirect and induced employment, as well as triggering additional population growth. Total peak incremental employment under Alternative A would average about 400 more jobs than under the Proposed Action during the 15-year development phase (**Figure 4.15-12**). The majority of the added jobs would be based in Sweetwater County.

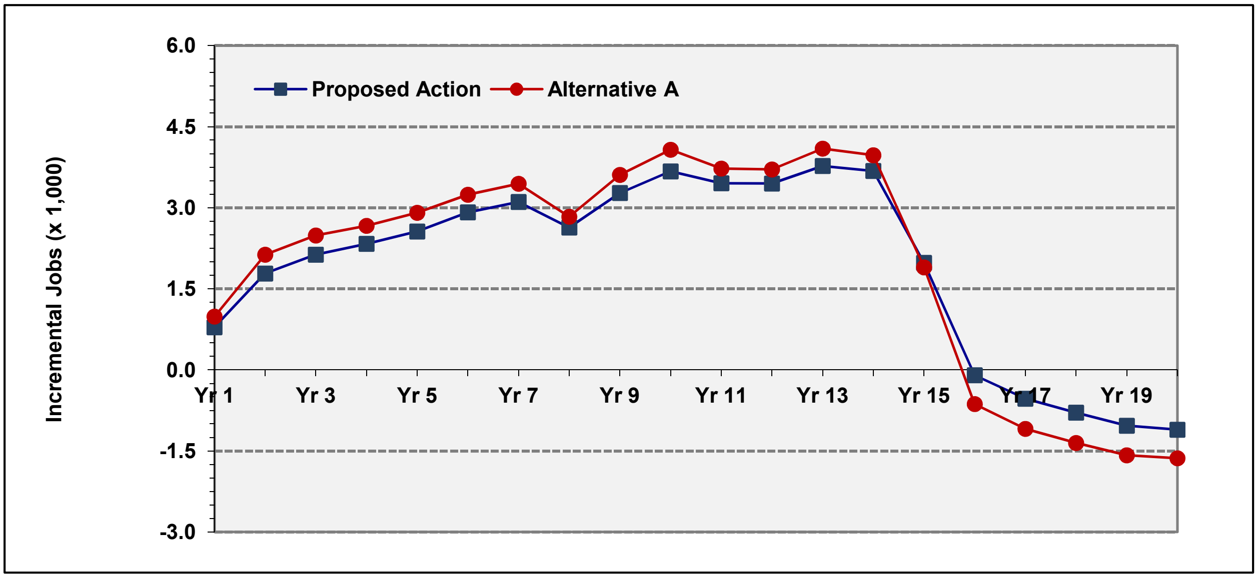

Figure 4.15-12. Total incremental employment, Alternative A compared with the Proposed Action

Sources: SDLLC & BCLLC based on CD-C Operators employment estimates and REMI model output

Following the completion of new well development, incremental employment under Alternative A would be comparable to that under the Proposed Action, because Alternative A would have similar long-term direct production and transportation employment requirements.

Population

Projected population growth under Alternative A would mirror employment impacts, with the peak incremental population eventually reaching 4,464 residents, approximately 450 higher than under the Proposed Action (**Table 4.15-14**). The majority of the higher population would likely reside in Sweetwater County, particularly in Rock Springs. Alternative A would also result in higher net in-migration and an influx of temporary non-resident workers during the initial years of implementation, but also higher out-migration following the completion of new well development.

Table 4.15-14. Incremental resident population impacts from Alternative A

	Year 1	Year 5	Year 10	Year 15	Year 20
Alternative A	353	2,054	3,664	4,464	1,028
Proposed Action	303	1,759	3,192	4,018	1,059
Difference	50	295	472	446	-31

Source: SDLLC and BCLLC, using the REMI model

Most of the difference in population change would occur in Rock Springs and Rawlins, although the magnitudes of those differences would be limited in comparison to either the current population or the incremental growth associated with the Proposed Action.

Other Socioeconomic Effects

The relatively minor differences in community population between Alternative A and the Proposed Action would result in minor differences in housing demand, demand for community infrastructure and local government services, and increases in public-school enrollment. Rock Springs and Rawlins would likely experience a small increase in temporary workers resulting in a corresponding increase for services associated with the predominantly working-age-male demographics of that workforce.

Fiscal Effects

Alternative A includes the same number of wells as the Proposed Action, both in total and on an annual basis. However, all of the wells would be drilled from single-bore pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (**Table 4.15-15)**.

Table 4.15-15. Summary of projected public-sector taxes and royalties on gas and condensate production, Alternative A ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$ 818,450,000	$1,125,360,000	$ 445,840,000	$ 2,559,480,000
Federal mineral royalties	1,226,840,000	1,686,920,000	668,300,000	3,836,630,000
State mineral royalties	54,030,000	74,300,000	29,430,000	168,960,000
Gross production / ad valorem tax, counties **	145,170,000	249,740,000	104,850,000	544,810,000
Gross production / ad valorem tax, schools **	540,540,000	929,870,000	390,400,000	2,028,500,000
Sales and use taxes -	156,610,000	66,660,000	n/a	223,270,000
Total combined	**$2,941,640,000**	**$4,132,850,000**	**$1,638,820,000**	**$9,361,650,000**

** *These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.*

Source: SDLLC and BCLLC

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative A would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be slightly higher under Alternative A than under the Proposed Action, due to the higher level of employment during the development phase; however, estimates of the differences were not prepared for this analysis.

Social Effects

Social effects of Alternative A would be comparable to those associated with the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative A.

4.15.2.4 Alternative B: Enhanced Resource Protection

Employment

Like the Proposed Action, Alternative B assumes a total of 8,950 wells drilled over a 15-year period, but assumes a 20 percent increase in the number of directionally drilled wells located on federal lands. For purposes of this assessment the shifts in projected long-term gas, condensate and water production would be the same as under the Proposed Action. Total direct employment under Alternative B, including long-term production and transportation employment, would be slightly lower than for the Proposed Action. However, the differences would not be of such a magnitude as to materially alter the direct, indirect, and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative B.

Population

Projected population growth under Alternative B, like the foreseeable effects on employment and income, would be similar but slightly lower than those under the Proposed Action. The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/LSRV. Any difference in population in communities would likely be negligible and not reflective of any specific feature of Alternative B.

Other Socioeconomic Effects

Project-related demands on temporary and long-term housing resources, community infrastructure and local government services, and public-school enrollment under Alternative B would be comparable to those under the Proposed Action.

Fiscal Effects

Alternative B includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above).

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative B would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be slightly lower under Alternative B than under the Proposed Action, due to the lower level of employment during the development phase; however, these differences would be minimal and estimates of the differences were not prepared for this analysis.

Social Effects

Generally, social effects of Alternative B would be comparable to those associated with the Proposed Action. However, the additional protections afforded by Alternative B for areas that are considered sensitive such as the sage-grouse lek complex southeast of Creston, the small portion of the Red Lake Dunes Citizens' Proposed Wilderness that extends into the northwestern part of the project area, and the Chain Lakes WHMA would reduce concern for the environmental effects on those areas.

Similarly, the additional resource protections provided by Alternative B (**Section 2.2.3**) would result in a reduction of impacts to forage and grazing activities and correspondingly reduce impacts to ranchers and grazing permittees as compared to the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative B.

4.15.2.5 Alternative C: Surface Disturbance Cap

Employment

Like the Proposed Action, Alternative C assumes a total of 8,950 wells drilled over a 15-year period, but assumes a 50-percent increase in directional drilling of wells located on federal lands. Projected long-term gas, condensate, and water production would be the same as under the Proposed Action. Total direct employment under Alternative C, including long-term production and transportation employment, would be lower than for the Proposed Action. However, the differences would not materially alter the direct, indirect, and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative C.

Population

Projected population growth under Alternative C, like the foreseeable effects on employment and income, would be similar to but somewhat lower than those anticipated under the Proposed Action.

Other Socioeconomic Effects

Project-related demands on temporary and long-term housing resources, community infrastructure and local government services, and public-school enrollment under Alternative C would be comparable to but somewhat lower than those under the Proposed Action.

Fiscal Effects

Alternative C includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production would also be equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above**)**.

Sales and use tax revenues derived from direct expenditures by the Operators under Alternative C would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be somewhat lower under Alternative C than under the Proposed Action, due to the lower level of employment during the development phase; however, the difference is anticipated to be small and estimates of the differences were not prepared for this analysis.

Social Effects

Social effects of Alternative C would be comparable to those associated with the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative C.

4.15.2.6 Alternative D: Directional Drilling

Employment

Like the Proposed Action, Alternative D assumes a total of 8,950 new wells drilled but with all future natural gas wells on federal mineral estate to be drilled directionally from multi-well pads. Projected annual and long-term gas, condensate, and water production would be the same as under the Proposed Action (see **Figure 4.15-3**). Based on differences in the lower average overall labor requirements between vertical wells on single wells pads and those for directionally drilled wells on multi-well pads, on a per well basis, total direct employment under Alternative D, including long-term production and transportation employment, would be 5 to 10 percent lower than for the Proposed Action. However, the differences would not materially alter the direct, indirect and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative D.

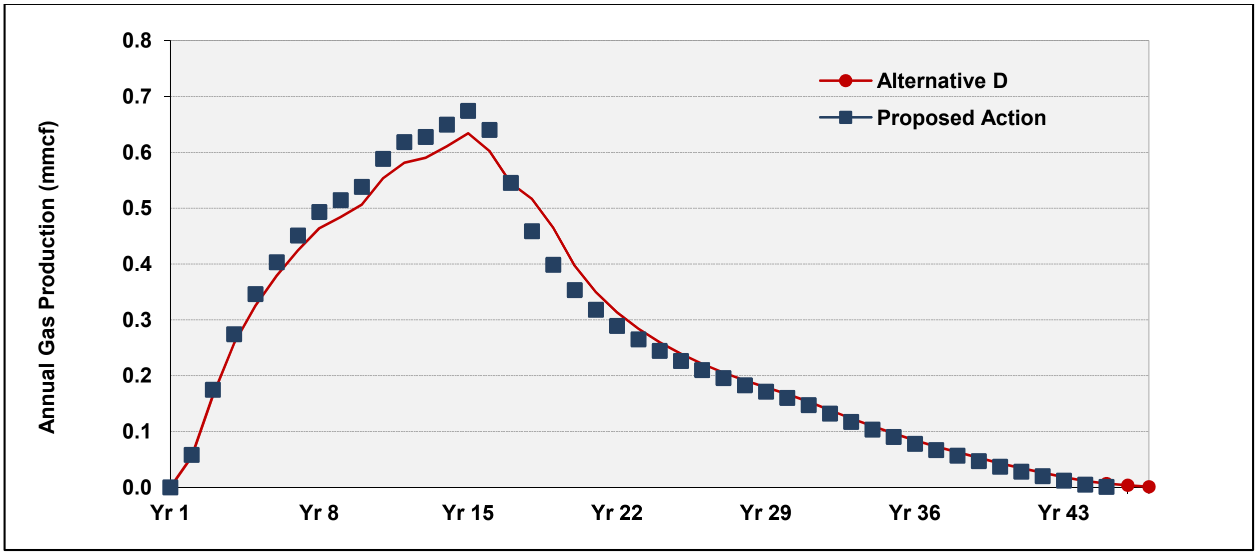

Figure 4.15-13. Projected annual natural gas production (MMcf), Alternative D and Proposed Action

Population

Projected population growth under Alternative D, like the foreseeable effects on employment and income, would mirror those under the Proposed Action—but with about 300 fewer residents at the peak. The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/the Little Snake River Valley. Any difference in population in communities would likely be negligible and not reflective of any specific feature of Alternative D. Alternative D would also result in lower initial influx of temporary non-resident workers during the initial years of implementation but also lower out-migration following the completion of new well development.

Other Socioeconomic Effects

The relatively minor differences in community population between Alternative D and the Proposed Action would result in minor differences in housing demand, demand for community infrastructure and local government services, and increases in public-school enrollment. Rock Springs and Rawlins would likely experience a somewhat smaller influx of temporary workers than under the Proposed Action, the difference resulting in a corresponding lesser decrease for services associated with the predominantly working-age-male demographics of that workforce.

Fiscal Effects

Alternative D includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes under Alternative D would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above**)**.

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative D would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be slightly lower under Alternative D than under the Proposed Action, due to the lower level of temporary employment during the development phase; however, estimates of the differences were not prepared for this analysis.

4.15.2.7 Alternative E: No Action

At year-end 2010 there were an estimated 3,486 producing wells in the project area. For this analysis, the No Action Alternative assumes that no additional wells would be drilled in the project area beyond those drilled before the issuance of the ROD for the EIS. Assuming the cessation of drilling in 2012, production would peak at approximately 270 Bcf per year, less than 40 percent of the peak under the Proposed Action, and then begin an extended period of decline (see **Figure 4.15-14**). Total remaining production from producing wells under No Action is estimated at about 3.2 Tcf of gas and 43 million barrels of oil condensates.

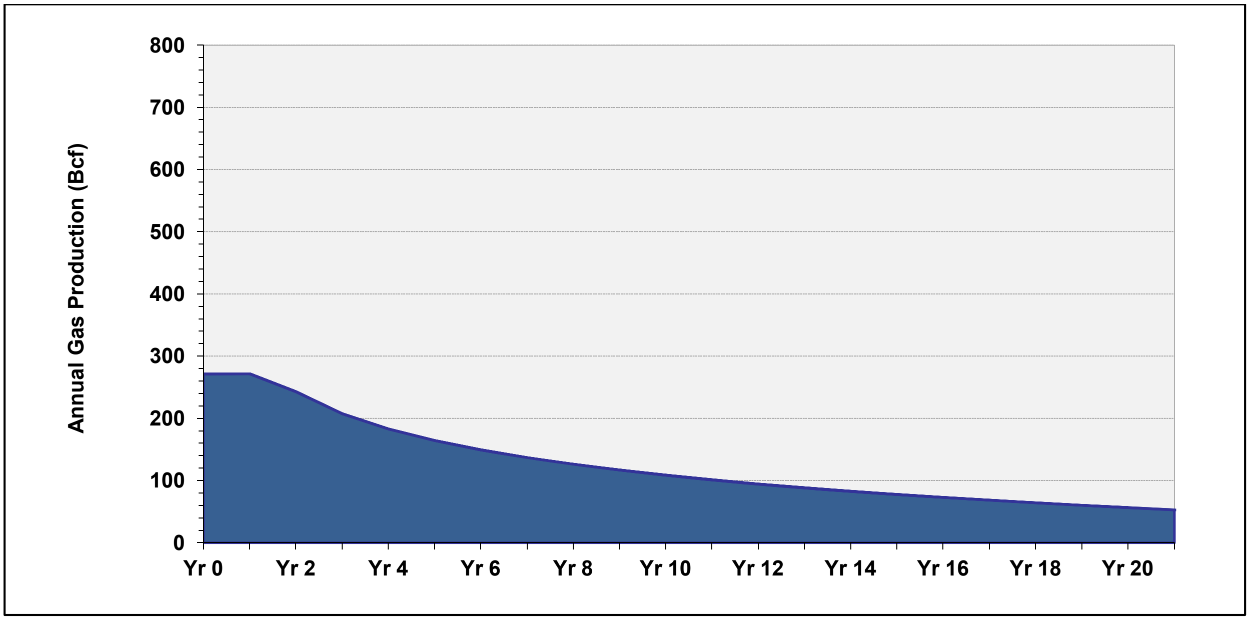

Figure 4.15-14. Projected annual natural gas production under the No Action Alternative

Sources: SDLLC & BCLLC based on USBLM Wyoming RMG production estimates

Employment

Implementation of the No Action alternative would reduce an important source of economic stimulus in the regional economy as drilling and field development in the CD-C area would come to a halt in 2012. Thereafter, drilling-and-completion-related employment would rapidly decline (**Figure 4.15-15**). Long-term production and transportation employment would also be lower under the No Action as compared to the Proposed Action, due to the lower volumes of gas, condensate, and water production.[37] The loss of direct onsite and off-site drilling and field-development employment, along with the lower production and transportation jobs relative to the Proposed Action, would ripple through the economy, reducing the number of indirect and induced jobs supported by activity in the project area. The magnitude of the eventual job losses would grow over time.

[37] Current levels of direct onsite and off-site development employment associated with development are assumed to cease at the same time as the completion of drilling under the No Action.

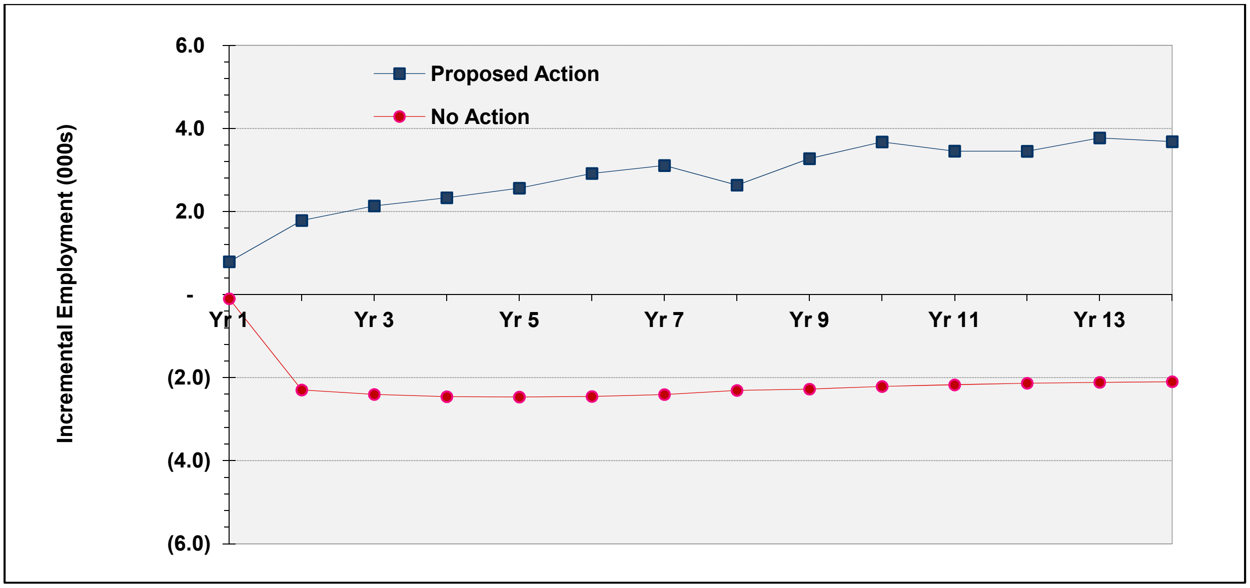

Figure 4.15-15. Incremental employment in Sweetwater and Carbon Counties, No Action and Proposed Action

SDLLC & BCLLC based on CD-C Operators' employment estimates and REMI model output.

Projected population change under No Action would initially show a modest decline as temporary residents would account for most of the outflow. Over time, population declines would mount as the losses in temporary and long-term induced and production-related jobs and slower growth in population-related consumer demand affected resident households. Net population declines in the region would exceed an estimated 2,000 residents within 5 years and eventually total approximately 4,000 fewer residents (see **Figure 4.15-16**), assuming the absence of other economic activity that would provide employment for the displaced workers. The largest declines in resident and temporary populations would occur in Rock Springs, with the largest relative difference occurring in Wamsutter.

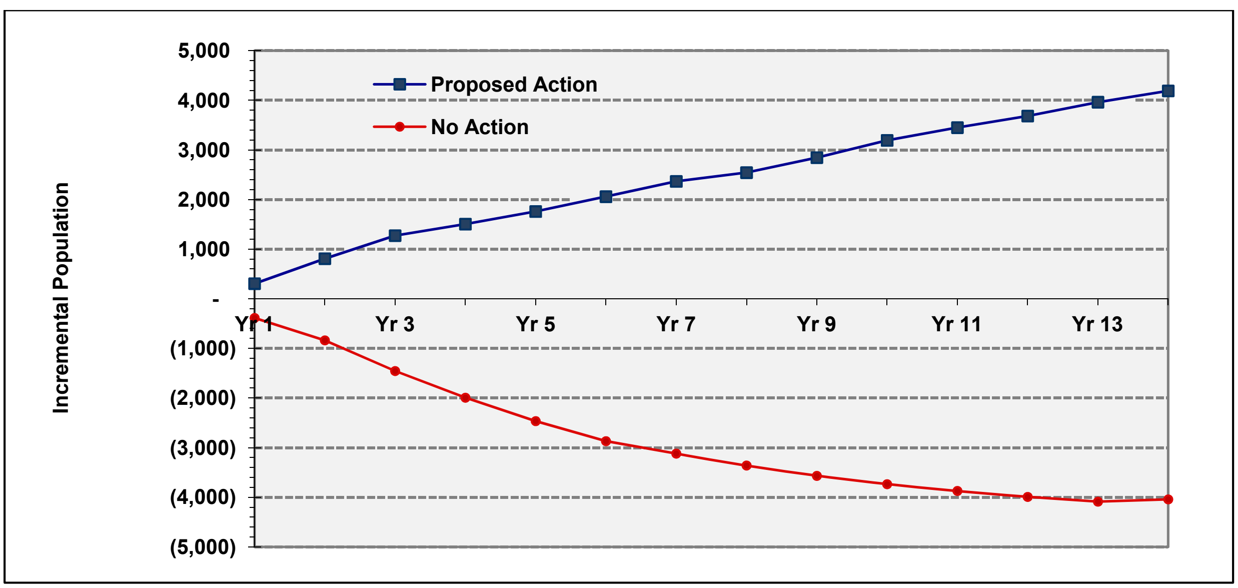

Figure 4.15-16. Incremental population change, No Action and Proposed Action

SDLLC & BCLLC based on CD-C Operators' employment estimates and REMI model output.

Housing, Community Infrastructure and Services

Implementation of the No Action Alternative would result in substantially lower demand for long-term and temporary housing resources in communities near the project area. Following the completion of development, and depending on other energy-development activities occurring at the time, communities near the CD-C project area could see substantial increases in vacancies and lower real estate values and rental costs in both long-term and temporary housing under the No Action Alternative.

Communities near the project area would experience moderating demand for most community facilities and services following implementation of the No Action Alternative. Some workforce and social service organizations may see temporary increases in the need to assist individuals and families affected by loss of employment. Over time, the trends in population change could result in excess capacity in some communities depending on the level of other energy-development activity. Future reductions in service demand would be relatively greatest in Wamsutter and Baggs/LSRV but would also extend to Rawlins and Rock Springs.

Fiscal Effects

The No Action Alternative assumes a halt to new oil and gas development in the project area following a ROD for the EIS. Cessation of activity would be followed by a steady decline in production volumes, with corresponding effects on sales of product and the associated public sector tax revenues. Total estimated incremental sales value of production from existing wells under the No Action is projected at $15.0 billion, approximately 29 percent of the $52.0 billion in aggregate sales value under the Proposed Action. Under No Action, peak annual market value of sales is projected at $1.38 billion in 2012. The rapidity of both the growth and decline of annual sales volume under the No Action Alternative contrasts markedly to that for the Proposed Action (**Figures 4.15-2** above and **4.15-17** below).

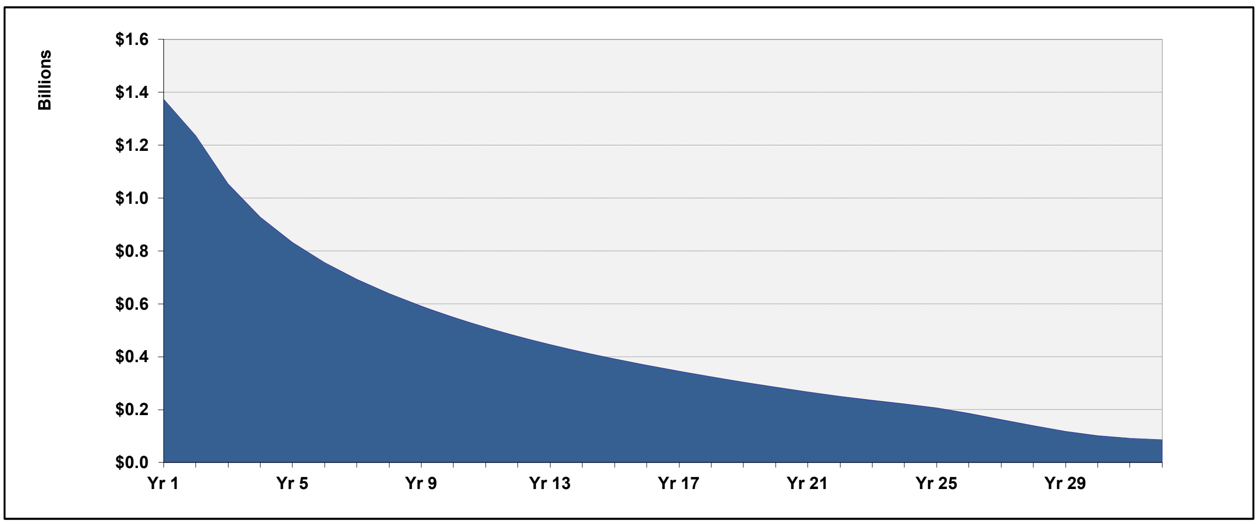

Figure 4.15-17. Projected annual value of gas and condensate production, No Action

Source: SDLLC and BCLLC

The lower total production under No Action, relative to the Proposed Action, would result in correspondingly lower royalty and tax generation. Total projected revenues from the defined sources are $2.5 billion (**Table 4.15-16**), nearly 73 percent lower than under the Proposed Action. Similar relative reductions characterize the differences in the other major public sector revenues as well. The differences reflect not just the lower projected production, but also the absence of FMR resulting from the lack of additional new wells on federal lands under the No Action Alternative. State mineral royalties from new wells and production on state lands would, however, be the same as under the Proposed Action.

Table 4.15-16. Summary of projected taxes and public-sector royalties on gas and condensate production, No Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$624,280,000	$274,610,000	$131,910,000	$1,049,850,000
Federal mineral royalties	0	0	0	0
State mineral royalties	92,800,000	48,870,000	22,780,000	168,960,000
Ad valorem tax, counties [1]	120,840,000	64,940,000	31,330,000	223,670,000
Ad valorem tax, schools [1]	448,550,000	241,040,000	116,280,000	830,190,000
Sales and use taxes	156,610,000	66,660,000	n/a	223,270,000
Total combined sources	**$1,443,080,000**	**$696,120,000**	**$302,300,000**	**$2,495,940,000**

[1] These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.
Source: SDLLC and BCLLC.

The lower total production under No Action, relative to the Proposed Action, would result in correspondingly lower royalty and tax generation, including FMR and state mineral royalties due to the lack of new wells completed on public lands. Not only would less revenue accrue to the Wyoming State Foundation program from distributions of the FMR, but the program would also receive less revenue from the statewide mandatory levy on gross products and the taxable real property associated with oil and gas development.

Sales and use taxes would also be substantially lower under No Action than under the Proposed Action due to the lower value of taxable purchases by the Operators and lower consumer expenditures by workers and businesses supported indirectly by new development.

Social Effects

Social effects of the No Action Alternative would include increases in unemployment and reductions in income that would result 15 years sooner under the No Action than the Proposed Action. Widespread unemployment would trigger out-migration and some disruption of the social fabric in communities.

Local residents who have benefited economically from continued development of the project area would likely be dissatisfied with the forgone opportunities.

As development within the project area ceases and interim reclamation occurs, many of the adverse impacts to grazing permittees would begin to diminish. Over time, the use of grazing allotments in the most intensely developed portions of the project area could increase, benefiting ranchers in the region. Similarly, as development activities cease and interim reclamation occurs, some recreation users of public lands within the project area might return to the area.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under the No Action Alternative.

4.15.3 Impact Summary

Each of the alternatives assessed in this EIS would result in substantial social and economic effects within the study area. Under the parameters and assumptions used for this assessment, the five action alternatives would generate similar effects with minor differences. Alternative A – 100 Percent Vertical Drilling would have slightly higher levels of employment, population, sales and use tax generation, and housing and public infrastructure and services demand than the Proposed Action; Alternative B – Enhanced Resource Protection, Alternative C – Surface Disturbance Cap, and Alternative D – Directional Drilling would each have increasingly fewer effects on socioeconomic conditions. However, for broad assessment purposes the effects of the five action alternatives would be similar and are summarized together.

The beneficial economic, social, and fiscal effects of the action alternatives would be foregone under the No Action Alternative. Instead, the added economic stimulus associated with drilling, development, and production would be replaced by increased unemployment, workforce outmigration, and a decline in public-sector revenues. Moreover, these effects would begin occurring soon after the issuance of the ROD, 15 years sooner than under the action alternatives.

Each of the five action alternatives would generate over 1,000 incremental total onsite and off-site direct jobs during the fifth year of field development and about 1,400 and 1,600 total direct jobs in Years 10 and 15, respectively. Direct employment would decline sharply following the completion of new well development, shedding nearly 1,200 total direct jobs by Year 20. At that time, five years after drilling and field development is scheduled to cease, total direct jobs would decrease to below 500.

For the five action alternatives, total employment including direct, indirect, and induced jobs, would climb to a peak of around 4,000 jobs in Year 14 of development. It is important to note that these would be in addition to the existing level of project-area employment associated with average annual drilling of almost 300 wells and production of over 3,700 wells. Once drilling/field development is completed, regional employment would decrease by over 4,300 jobs, which would include not only the incremental jobs associated with drilling/field development under the Proposed Action but the currently existing drilling/field development-related jobs as well, hence the total job loss would be larger than the total incremental job gain associated with the action alternatives, even though a substantial number of production-related jobs would remain after drilling/field development ceases.

Population increases and losses for all alternatives would closely follow employment gains and losses. Incremental population associated with the five action alternatives would increase over time to a peak of about 3,700 new residents and almost 1,000 temporary workers during Year 15 of development. Project-related population would fall to about 700 residents by Year 20, five years after drilling/field development ceases.

Project-related population under No Action would decline rapidly upon issuance of the ROD resulting in population outmigration in both Sweetwater and Carbon counties and the affected communities.

The population associated with the five action alternatives would generate demand for additional long-term and temporary housing resources, increasing to an estimated total demand of over 1,500 long-term units and almost 1,000 temporary beds in Year 15 of development, and decreasing to about 250 long-term units and no temporary units during Year 20. Again, this substantial reduction in housing demand would be associated not only with the decrease in incremental demand associated with the action alternatives, but the decrease in demand from the population associated with current development and production employment in the project area as well.

Implementation of the No Action Alternative would result in a substantial decrease in area housing demand compared to existing conditions. Depending on other energy-development activities occurring at the time of the issuance of the ROD, communities near the CD-C project area could see substantial vacancies in both long-term and temporary housing under the No Action Alternative.

The substantial increase in population associated with the five action alternatives would generate corresponding demand for community infrastructure and services. Most communities within the study area have anticipated energy-related growth and have improved or are planning to improve major community infrastructure such as water, wastewater, solid-waste disposal systems, criminal detention facilities, and schools. Current or planned facilities should be adequate to accommodate the population associated with the action alternatives in the near term but may require expansion during the latter part of the 15-year drilling and field-development cycle, depending on the cumulative level of energy development occurring at the time. Demand for community facilities would substantially diminish after the 15-year drilling/field-development cycle is completed.

Many community-service providers would be required to add staff, equipment, and perhaps facilities to accommodate the population associated with the five action alternatives, particularly in the context of cumulative regional energy development.

Under the No Action Alternative, current infrastructure and service demand associated with development in the CD-C project area would diminish substantially, perhaps resulting in excess capacity in some infrastructure and services, depending on the level of other energy development activity occurring at the time of the issuance of a ROD. Future reductions in service demand would be relatively greatest in Wamsutter and Baggs/LSRV but would also extend to Rawlins and Rock Springs.

Substantial federal, state, and local government revenues would be generated by the natural gas and liquids production associated with each of the five action alternatives and by the capital investment associated with drilling/field development. Under the production and pricing assumptions used for this assessment, the action alternatives would generate about $3.8 billion ($2008) in FMR over the 40-year life of the project, and about $1.8 billion of that amount would accrue to the state. An estimated $530 million in state mineral royalties would be generated by the action alternatives, and $3.1 billion in ad valorem and gross products taxes to various counties, special districts, school districts, and the Wyoming School Foundation Fund. Sales and use taxes associated with project-related investments would yield nearly $161 million in sales and use taxes at current rates: $115.8 million from the state's 4.0 percent rate, $38.2 million in locally imposed taxes in Sweetwater County, and $6.7 million on sales in Carbon County. Projected distributions of the state's sales and use tax receipts, based on the current statutorily established allocations would include $80.3 million to the general fund and $35.5 million to local governments. As noted above, sales and use tax revenues would be somewhat higher under Alternative A and somewhat lower under Alternatives B, C, and D.

Oil and gas-related tax revenues would be much lower under the No Action Alternative than under any of the action alternatives, both in terms of annual receipts and total receipts over the life of the field.

The lower total production under No Action relative to the action alternatives would result in correspondingly lower royalty and tax generation. Total projected revenues from the defined sources would be nearly 77 percent lower than under the Proposed Action. Similar relative reductions characterize the differences in the other major public-sector revenues as well.

Not only would less revenue accrue to the Wyoming State Foundation program from distributions of the FMR, but the program would also receive less revenue from the statewide mandatory levy on gross products and the taxable real property associated with oil and gas development.

Sales and use taxes would also be substantially lower under No Action than under the action alternatives due to the lower value of taxable purchases by the Operators and lower consumer expenditures by workers and businesses supported indirectly by new development.

Social effects of the action alternatives would generally be similar to current effects in communities within the study area, which are both beneficial and adverse. Increases in certain types of crime and social problems and decreases in community cohesion could be associated with rapid population growth and large numbers of temporary workers in communities, depending on the concurrent level of energy development in the area. Conversely, increased employment opportunities, a generally robust economy, and increases in commercial and community infrastructure would be seen as beneficial to many residents.

The fact that much of the project area is already developed and industrialized would diminish concern for further changes in most environmental amenities under the action alternatives. Given that substantial change in the recreation setting has already occurred, the relative change in recreation use associated with any further development would be small. The concern for development-related effects on areas that are considered sensitive would also occur under all action alternatives, but would not occur under the No Action Alternative.

The displacement of grazing permittees from the most intensively developed areas of the project area could occur under all alternatives; the risk of additional displacement would not occur under the No Action Alternative.

No disproportionately high and adverse human-health or environmental effects on minority or low-income populations would be anticipated under any of the action alternatives or the No Action Alternative.

4.15.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Most unavoidable adverse socioeconomic impacts of the Proposed Action and alternatives are associated with: the rapid and/or temporary influx of new workers, the need to provide housing and community services and facilities for the additional workforce and their families, and the decline in public revenues that would occur at the end of the project or with the implementation of the No Action alternative. The following mitigation measures should be implemented to reduce adverse socioeconomic effects and enhance the beneficial effects:

- To the extent practicable, the Operators should attempt to hire and train local workers from Carbon and Sweetwater counties.
- The Operators should acquire and require their contractors to acquire Carbon and Sweetwater County sales and use tax licenses and purchase all materials, equipment, and supplies to be used within the project area under these licenses so that proper attribution of sales and use tax payments can occur.
- The Operators and their major contractors should ensure that adequate temporary housing resources are available to accommodate their temporary drilling, field-development, and ancillary facility construction workforces.

In order to allow local governments to effectively plan for the needed infrastructure and services to accommodate the workforce and population associated with this major development initiative, the Operators should meet annually with the BLM and representatives of local and state governments to discuss near-term and mid-term development plans. If events that would substantially accelerate or retard development in the project area become evident, the Operators should meet with the BLM and representatives of local and state governments to discuss the potential effects of such events.

4.16 TRANSPORTATION

This section assesses effects of the Proposed Action and other alternatives on the transportation system providing access to and within the CD-C project area, including federal and state highways, Carbon and Sweetwater county roads, BLM roads, and private roads. Environmental effects of new and improved roads within the project area are described in sections **3.3 Soils; 3.7 Invasive, Non-native Species; 3.8 Wildlife; 3.11 Visual; 3.12 Recreation;** and **4.18 Range Resources**.

4.16.1 Planning Documents and Criteria

4.16.1.1 Rawlins RMP

The Rawlins RMP (BLM 2008a) prescribes the following goal and objectives for transportation and access management:

Management Goal

1. Develop and maintain a transportation management system to accommodate public demand for legal access through and across public land and to meet resource management needs and objectives (e.g., wildlife objectives).

Management Objectives

1. Maintain or expand, as determined necessary, existing access, including the right of access by a non-federal-land in-holder.
2. Abandon or close redundant or unnecessary access roads; reclaim after consultation with local government and interested parties.
3. Conduct transportation planning to manage existing and new access in a manner that ensures compatibility with resource values and management objectives.
4. Incorporate existing state and county road systems into BLM transportation system to accurately show existing access. Coordinate access issues with state and local governments.

4.16.1.2 Transportation Plan

As noted in **Section 3.16 Transportation and Access**, an MOU between the BLM, WYDOT, Carbon and Sweetwater Counties and a number of the CD-C Operators established a transportation plan (TP) and transportation planning committee (TPC) for the Continental Divide portion of the project area. Upon the issuance of a ROD, the Creston portion of the project area will be brought into the TP and the Creston Operators will join the TPC as part of the federal permitting process.

4.16.1.3 Impact Significance Criteria

The following criteria are used to determine whether transportation impacts would be significant and represent a balance between public access and transportation safety:

1. Substantial limitation on public access to travel within the project area.
2. Substantial reduction in opportunity for acquisition of access easements and road development.
3. Increases in traffic levels on the local public transportation system that would cause the level of service on the system to fall below acceptable levels, as defined by the responsible government agency.

4.16.2 Direct and Indirect Impacts

Section 3.16 Transortation and Access describes the highway network providing access to the project area and the county, the BLM, and the private road network providing access within the project area. The CD-C project is an infill project; consequently, under all alternatives new roads would primarily be resource roads connecting the existing road network with new well pads, and ancillary facilities (e.g. gathering systems, compressor stations, and other associated infrastructure).

The principal measure of transportation effects related to the alternatives would be changes in the number of vehicle trips required. Vehicle trips would be generated by drilling, completion, and ancillary facility construction; by production activities, including routine monitoring and maintenance; by hauling of produced water and liquids; and by periodic well workovers. Interim and final reclamation activities would also generate vehicle trips.

For all alternatives, vehicle trips would originate from a variety of locations including Rock Springs, Rawlins, Wamsutter, Baggs, and locations outside the study area. Drilling rigs and some gas-field service and construction equipment would be transported to the project area and remain there for the duration of a particular contract or task. For the major Operators, drilling rigs would work on a year-round basis; in these cases, trips involving major pieces of equipment, such as rig moves, would occur primarily within the project area. Similarly, most produced-water and liquids-collection trips are likely to occur entirely within the project area as produced-water disposal and liquids-transportation sites will be located within the project area.

Many gas-field service firms serving the project area are presently located in Rock Springs, although some are located in Rawlins and a few are located in Baggs and the Little Snake River Valley (LSRV) area. BP has a major field-operations center just north of Wamsutter and several companies have established field offices and equipment lay-down and support yards in Wamsutter, which also houses many gas-field workers on both a temporary and longer-term basis. Devon Energy has a field office in Baggs to serve the Creston/Blue Gap field. There are two temporary living facilities located adjacent to WY 789 in the Dad area, and many gas-field workers reside in Rock Springs, Rawlins, and Baggs.

Tables 4.16-1 and **4.16-2** display estimated per-well round-trips associated with typical drilling and production activities in the project area. Trip estimates were developed from information provided by the Operators, estimates from similar projects, and from information concerning anticipated per-well volumes of produced liquids and water provided by the BLM Wyoming's Reservoir Management Group. The trip estimates are based on drilling and completion activities for typical wells, construction of gathering systems and well-site production facilities, performance of routine field operations and maintenance activities, and consideration of vendor and miscellaneous visits.

Table 4.16-1. Per-well round-trip estimates: drilling and completion

Activity	Vertical Wells		Multi-Well Pad (4 wells)	
	Total	Trucks[1]	Total	Trucks
Pad/access road construction	35	21	45	28
Mobilization / demobilization	107	73	161	97
Drilling	251	174	980	704
Completion	256	175	602	403
Construction of production facilities, electrical and gathering lines	29	17	33	21
Interim reclamation	10	6	15	9
Total Drilling	**688**	**466**	**1,836**	**1,262**

[1] *For this assessment, a "truck" is defined as any vehicle other than a passenger vehicle such as a pick-up, car, or van.*

Sources: CD-C Operators; BCLLC

Table 4.16-1 displays trip estimates for single wells drilled vertically from an individual well pad and for directional wells drilled from multi-well pads, which are assumed to average four bores/pad. Directional wells drilled from multi-well pads generate reduced drilling, completion, and field-development traffic, on a per well basis, as compared to vertical wells on single-well pads. The reductions are principally in trips associated with well pad and access road construction, rig moves, completion, gathering and electrical system construction, and interim reclamation activities.

Table 4.16-2. Estimated production traffic (round-trips)

Activity	All Wells
Pumpers (pick-ups)	Each well visited daily; each pumper can visit 15 wells/day
Produced water & liquids haul trucks	Trips are based on a BLM Reservoir Management Group decline curve for produced water and liquids assuming an average of 6,900 gallon haul trucks
Workovers	Each well every 15 years; 6 light truck and 8 heavy truck trips/well

Sources: CD-C Operators; BCLLC

Tables 4.16-1 and **4.16-2** display traffic estimates in terms of round trips. The principal measure of traffic used elsewhere in the assessment is average annual daily traffic (AADT). In contrast to round trips, AADT represents one-way trips, i.e. AADT would count a round trip as two trips.

Not all drilling and production trips would originate outside the project area. For each drilling and production activity, a certain number of trips would originate within the project area, including trips associated with some rig moves and other heavy equipment that would move from well pad to well pad without leaving the project area, commuting trips for some drilling and completion crews who reside in Wamsutter in motels and mobile-home/RV parks, and some trips associated with gas-field service companies whose offices and yards are located in Wamsutter.

Under all action alternatives, construction and operations of additional compressor sites, a central pipeline compression facility, central gas-processing/stabilization facilities and high-pressure gas line would be required. Because the same number of wells would be developed under all action alternatives, the overall volume of traffic generated by these facilities is assumed to be the same, although the location of individual facilities and the timing of construction could differ based on the alternative. For Alternative E: No Action, no additional facilities are assumed to be required.

4.16.2.1 Proposed Action

This analysis assumes a total of 8,950 additional wells would be drilled over 15 years under the Proposed Action; an average of about 600 wells per year. The transportation assessment is based on the drilling schedule outlined in **Section 3.5, Air Quality**. Of the total wells, 42 percent are assumed to be directional wells drilled from multi-well pads averaging four bores/pad. The remaining 58 percent are assumed to be drilled vertically from single-well pads.

Drilling and production in the project area during 2009 generated an estimated AADT of 1,525. Of that total, an estimated 1,060 trips traveled on highways providing access to the project area and on county, BLM, and private roads to a worksite within the project area. An estimated 465 trips were internal, both originating and terminating within the project area, traveling entirely on county, BLM, and private roads to reach a worksite.

Figure 4.16-1 displays estimated Proposed Action-related AADT, including both internal and external trips by year through the 15-year drilling period and the first 15 years of full-field operations, based on the drilling schedule provided by the Operators. Transportation effects of drilling and production activities associated with the Proposed Action would build from an estimated 1,682 AADT in Year 1 to a peak of over 3,900 AADT in Years 13 and 14 of drilling. This would be in addition to the trips associated with ongoing production activities from existing wells, which are described under the No Action alternative (**Section 4.16.2.6**). This volume would diminish during the last year of drilling and for the remainder of the productive life of the project, as produced-water and liquids volumes decrease as the wells age. By Year 30 of the Proposed Action, an estimated 1,360 AADT would be generated daily within the project area. **Table 4.16-1** provides estimates of per-well round trips for drilling and completion activities. Drilling-related trips could be higher or lower during any given year, depending on the actual number of wells drilled. Actual future drilling levels would vary in response to natural-gas demand and prices, drill rig and workforce availability, gas transmission pipeline capacity, weather, regulatory approvals, individual company development strategies, and other factors. Actual production-related trips would depend on the cumulative number of wells in production.

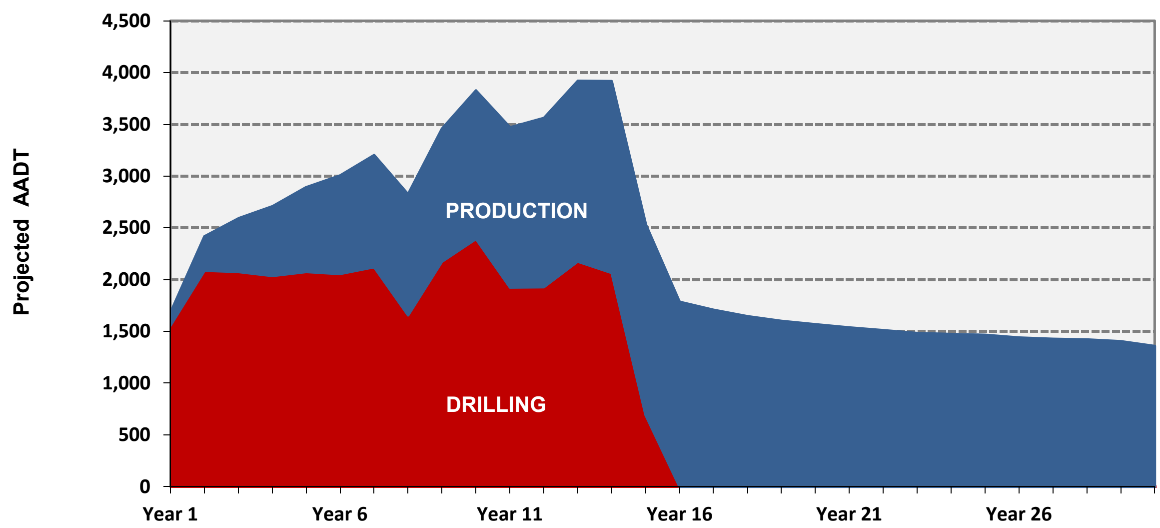

Figure 4.16-1. Drilling/field development AADT, Proposed Action

Source: CD-C Operators, BCLLC

Tables 4.16-3, 4.16-4, and 4.16-5 display estimated incremental highway AADT associated with Year 1, Year 10, and Year 20 of the Proposed Action. Year 1 AADT is contrasted with WYDOT 2009 AADT estimates for segments of highways providing access to the project area. It is important to note that WYDOT 2009 AADT estimates include traffic associated with the drilling of 244 new wells and production services for 3,783 wells within the project area during that year.

Estimates of drilling-related traffic for Year 1 and Year 10 of the Proposed Action represent the increment over the 2009 drilling level, which are included in the WYDOT 2009 AADT and the forecast 2020 AADT. Note that in Year 20 of the Proposed Action, project area-related traffic would be entirely operations related, as all drilling would have been completed under the assumptions used for this assessment.

Project area drilling and production-related AADT were assigned to highway segments based on a combination of development-area access and likely locations of Operator offices and yards, natural gas field-service companies and vendor offices and yards, and temporary and long-term employee housing. Based on these origin and destination factors and a review of each drilling and production-related activity, it is assumed that about 40 percent of all project area-related trips would originate internally, from Wamsutter or elsewhere within the project area during the initial years of drilling. That percentage would decrease over time as production-related traffic increases. Beginning in Year 16, following the completion of drilling, an estimated 24 percent of all trips would be strictly internal, traveling exclusively on county, BLM and private roads. Internal trips would diminish to about seven percent by Year 30, due to reductions in produced water and liquids over time.

Of trips that originate or terminate externally, 55 percent are assumed to be to or from Rock Springs; 25 percent to/from Rawlins, 10 percent from Baggs/LSRV or at points along WY 789 and 10 percent from Wamsutter.[38] Of the total trips traveling from Rawlins, 15 percent are assumed to originate at points to the

[38] Although Wamsutter is within the CD-C project area, external trips originating from Wamsutter are assumed to travel on I-80 to other destinations within the project area.

north and travel US 287 through Rawlins during Year 1, 8 percent during Year 10, and 2 percent during Year 20 following the completion of drilling.

Table 4.16-3. Projected AADT, highways providing access to the CD-C project area: Year 1, Proposed Action

Highway Segment	2009 WYDOT Estimated AADT		Proposed Action Year 1 AADT		% Increase over 2009	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	13,078	6,495	158	75	1%	1%
• Creston Junction	12,225	6,368	203	96	2%	2%
• Continental Divide Int.	11,973	6,443	209	99	2%	2%
• Wamsutter	12,014	6,458	503	238	4%	4%
• Red Desert	11,563	6,332	413	195	4%	3%
• Tipton	11,493	6,287	356	169	3%	3%
• Table Rock	11,693	6,314	354	167	3%	3%
• Rock Springs E. Urban Limits	1 1,678	6,498	348	165	3%	3%
WY 789						
• Creston Junction	1,265	316	28	13	2%	1%
• Jct CCR 700 West	1,801	427	28	13	2%	2%
US 287						
• Rawlins N. Urban Limits (Bypass)	5,241	786	24	11	<1%	2%
• Jct Rte 46 (Lamont/Bairoil)	2,303	620	24	11	1%	2%

Jct = junction
Source: WYDOT 2009 VMB and 2020 and 2030 AADT projections; BCLLC calculations

Under the assumptions used for this assessment, the highest concentration of project area-related traffic on I-80 would be at Wamsutter. As shown in **Table 4.16-3**, during Year 1 of the Proposed Action, when a total of 440 wells are assumed to be drilled, both total AADT and truck AADT on I-80 at Wamsutter would be an estimated 4 percent of 2009 WYDOT estimates for that location. Total AADT and truck AADT on WY 789 would be 1 to 2 percent of 2009 AADT. Total AADT would be less than 1 percent of 2009 AADT at the bypass north of Rawlins; total and truck AADT would be 1 to 2 percent of 2009 AADT elsewhere on US 287 during Year 1 of the Proposed Action.

Table 4.16-4. Projected AADT, highways providing access to the CD-C project area: Year 10, Proposed Action

Highway Segment	2020 WYDOT Projected AADT		Proposed Action Year 10 AADT		% Increase over 2020	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	15,342	8,992	748	339	5%	4%
• Creston Junction	14,915	8,740	960	436	6%	5%
• Continental Divide Int.	14,880	8,750	985	447	7%	5%
• Wamsutter	14,938	8,747	2,375	1,078	16%	12%
• Red Desert	14,806	8,722	1949	885	13%	10%
• Tipton	14,858	8,640	1683	764	11%	9%
• Table Rock	15,054	8,782	1672	759	11%	9%
• Rock Springs E. Urban Limits	16,715	9,374	1642	745	10%	8%
WY 789						
• Creston Junction	1,501	377	132	60	9%	16%
• Jct CCR 700 West	1,874	411	132	60	7%	15%
US 287						
• Rawlins N. Urban Limits (bypass)	4,419	962	60	27	1%	3%
• Jct Rte 46 (Lamont/Bairoil)	2,722	862	60	27	2%	3%

Jct = junction
Source: WYDOT 2009 VMB and 2020 and 2030 AADT projections, BCLLC calculations.

During Year 10 of the Proposed Action (**Table 4.16-4**), a total of 738 wells are assumed to be drilled and 6,240 Proposed Action-related wells would require production activities. Highway traffic estimates during Year 10 of the Proposed Action are contrasted with WYDOT forecasts of 2020 traffic on affected highways. Proposed Action-related AADT for all traffic on I-80 at Wamsutter would be a 16 percent increase over forecast 2020 AADT at that location and Proposed Action-related truck AADT would be 12 percent. Total AADT on WY 789 at Creston Junction would be 9 percent of forecast 2020 AADT and truck AADT would be 16 percent. Proposed Action-related total AADT on US 287 would be 1 to 2 percent of forecast 2020 AADT and truck AADT would be about 3 percent.

Table 4.16-5. Projected AADT, highways providing access to the CD-C project area: Year 20, Proposed Action

Highway Segment	2030 WYDOT Projected AADT		Proposed Action Year 20 AADT		% Increase over 2030	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	17,539	10,627	334	75	2%	1%
• Creston Junction	17,142	10,320	429	98	3%	1%
• Continental Divide Int.	17,130	10,354	440	99	3%	1%
• Wamsutter	17,211	10,354	1,061	239	6%	2%
• Red Desert	17,063	10,325	870	196	5%	2%
• Tipton	17,132	10,224	752	170	4%	2%
• Table Rock	17,365	10,43	747	168	4%	2%
• Rock Springs E. Urban Limits	18,949	11,059	733	165	4%	1%
WY 789						
• Creston Junction	1,731	426	59	13	3%	13%
• Jct CCR 700 West	2,174	472	59	13	3%	3%
US 287						
• Rawlins N. Urban Limits (bypass)	5,046	1,098	7	2	<1%	<1%
• Jct Rte 46 (Lamont/Bairoil)	3,000	978	7	2	<1%	<1%

During Year 20 of the Proposed Action, no new drilling would occur but 8,950 wells would require production-related activities. Highway traffic estimates during Year 20 of the Proposed Action are contrasted with WYDOT forecasts of 2030 traffic Proposed Action-related total AADT on I-80 at Wamsutter would be six percent of WYDOT projected 2030 AADT at that location and truck traffic would be two percent. Total AADT on WY 789 at Creston Junction would be 3 percent of forecast 2030 AADT and Proposed Action-related truck AADT would be 13 percent. Both total and truck AADT on US 287 would be less than 1 percent of forecast WYDOT 2030 AADT on that highway.

Traffic associated with the Proposed Action would be unlikely to result in a deterioration of the LOS on I-80, except to perhaps accelerate the decrease from LOS A to LOS B at the Creston Junction intersection, given the relatively high forecasts for Proposed Action-related traffic at that intersection during drilling and field development. Similarly, the level of Proposed Action-related traffic on WY 789 from Creston Junction south to Baggs would be unlikely to result in a substantial deterioration in LOS but would certainly contribute to the LOS rating of C at the intersection with Carbon County Road 700 West during the drilling and field development period. The Proposed Action-related traffic on US 287/WY 220 north to Casper will contribute to the decrease in LOS from B to the forecast LOS C, but the relatively minor level of project-related traffic will play a small role in that decrease in LOS.

In addition to the drilling and production-related traffic shown in the preceding table, a number of ancillary facilities would be required under the Proposed Action. Such facilities could include up to 10 field compression facilities, a central pipeline compression facility, one central processing/stabilization plant, and up to 45 miles of high-pressure pipeline. Trip estimates for these facilities were not available from the Operators; consequently, estimates of similar facilities in other natural gas development areas were used to provide order-of-magnitude estimates for assessment purposes. **Table 4.16.6** below summarizes the construction trip traffic associated with each of these facilities.

Table 4.16-6. Projected traffic effects on highways associated with ancillary facilities: Proposed Action

Facility Type	Duration of construction	Light-duty vehicle trips	Truck trips	Total trips	Approximate AADT
Field compressors (up to 10 required)	Several weeks per compressor	152 / compressor facility	24 / compressor facility	176 / compressor facility	< 1.0
Pipeline compressors (1)	Several months	760	120	880	5
Central processing facility (1)	Up to two years	27,200	12,700	39,900	110
High-pressure pipeline (45 miles)	--	1,305	1,951	3,256	18

Source: BCLLC.

These facilities would be constructed at different locations and at different times during the drilling and field-development period; therefore, the construction trips would also occur during different periods. In addition to the construction traffic estimates contained in **Table 4.16-6**, these facilities would generate a low level of traffic during operations and most of those trips would involve light-duty vehicles.

Because AADT is calculated on a 365-day/year basis, construction of each of these facilities, except the central gas-processing/stabilization facility, would result in minor increases in AADT. However, traffic on the specific access road to each facility and at intersections of highways and access roads could be substantial during the construction period, particularly during shift changes for construction workers. During these brief periods, the level of service ratings for these intersections could drop below current levels. As noted, once constructed, these facilities would generate relatively low volumes of daily traffic.

The increases in traffic volumes associated with the Proposed Action could result in additional maintenance requirements on affected highway segments, particularly on WY 789 and on I-80 around the Wamsutter interchange during peak drilling years. The volume of over-height/over-width loads using I-80 underpasses (described in **Section 3.16.2**) would continue to increase under the Proposed Action, requiring more frequent Wyoming Highway Patrol traffic-safety services, unless and until modifications in underpasses are completed. Given the substantial percentage increase in AADT associated with the Proposed Action, higher accident rates could be possible on the segments of highways providing access to the project area, especially during peak drilling years.

County roads providing access within the project area would see substantial increases in use, particularly SCR 23S (Wamsutter-to-Crooks Gap Road South), CCR 701 (Wamsutter-to-Dad Road), and SCR 23N (Wamsutter-to-Crooks Gap Road North), which would provide access to the most densely developed portion of the project area. CCR 701 currently has the highest traffic volume of any road or highway in Carbon County, with the exception of I-80, and SCR 23 (north and south) is among the highest traffic-volume roads in Sweetwater County. The vast majority of traffic on these roads is industrial and is associated with project area gas-field activities. The Proposed Action would result in substantially accelerated maintenance requirements on these roads and likely require additional improvements to accommodate the increased volume of industrial traffic.

Certain BLM and private roads providing access within the project area would also experience substantial increases in traffic associated with the development phase of the Proposed Action. Typically the Operators improve and maintain these roads through agreements with the BLM and private surface owners. Operators would also be required to secure right-of-way agreements with private landowners for use of private roads and BLM roads without right-of-way agreements.

Based on the above, the state of Wyoming, Sweetwater and Carbon counties, and the BLM would all experience substantially higher road-improvement and maintenance requirements associated with the Proposed Action. Each of these entities would also receive substantial additional revenues from severance taxes (in the case of the state), federal mineral royalties (in the case of the BLM, the state, and the counties) and from ad valorem property taxes (in the case of the counties[39]), on natural gas production associated with the Proposed Action, which could be used to help fund Proposed Action-related improvements and maintenance requirements.

Continued implementation of the CD-C TP and TPC process would result in a coordinated approach to road use, development, maintenance, and reclamation; to the extent possible considering the high level of development and associated traffic, it would also reduce transportation effects.

4.16.2.2 Alternative A: 100-Percent Vertical Drilling

Alternative A assumes the same overall drilling schedule as the Proposed Action, but assumes all wells would be drilled vertically from single-well pads. The trip-generation factors used for Alternative A are the same factors used for vertical wells in the Proposed Action (see Vertical Wells columns in **Table 4.16-1**).

Figure 4.16-2 compares total AADT for the Proposed Action and Alternative A. Alternative A would result in an estimated total AADT of 1,935 during Year 1, 15 percent higher than the estimated total AADT for the Proposed Action during Year 1. During Year 10, Alternative A would generate an estimated AADT of 4,217, 10 percent greater than the Proposed Action. The smaller percentage is the result of the larger proportion of operations-related traffic to total traffic in that year (the level of operations traffic would be the same under either alternative). After Year 15, when drilling is assumed to be completed under both alternatives, the estimated average number of round trips would be the same.

The higher level of traffic associated with Alternative A would generate correspondingly higher levels of traffic on federal and state highways providing access to the project area. However, incremental AADT associated with Alternative A would generate no more than 1 to 2 percent increases in AADT on any highway segment during the first 15 years as compared to the Proposed Action.

Under Alternative A, the increases in AADT on highways providing access to the project area associated with construction and operations of additional compressor sites, a central pipeline compression facility, two or more central gas processing/stabilization facilities and 45 miles of high-pressure gas line would be the same as under the Proposed Action.

The higher traffic volumes associated with Alternative A would result in correspondingly higher maintenance requirements on affected highway segments as compared to the Proposed Action and generate the potential for higher accident rates on the segments of highways providing access to the project area.

County roads providing access within the project area would experience higher levels of traffic under the drilling and field-development phase of Alternative A compared to the Proposed Action and correspondingly higher maintenance requirements.

BLM and private roads providing access within the project area would also experience higher increases in traffic associated with the Proposed Action. As with the Proposed Action, the Operators would improve and maintain these roads through agreements with the BLM and private surface owners.

Although WYDOT and Sweetwater and Carbon counties would experience higher road maintenance costs under Alternative A compared to the Proposed Action, natural gas production would likely be the same under both alternatives; consequently, the state and counties would receive the same revenues under both alternatives but be required to fund somewhat higher highway and road maintenance costs under Alternative A than under the Proposed Action.

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[39] Sweetwater County has a dedicated mill levy for road and bridge funding; Carbon County does not.

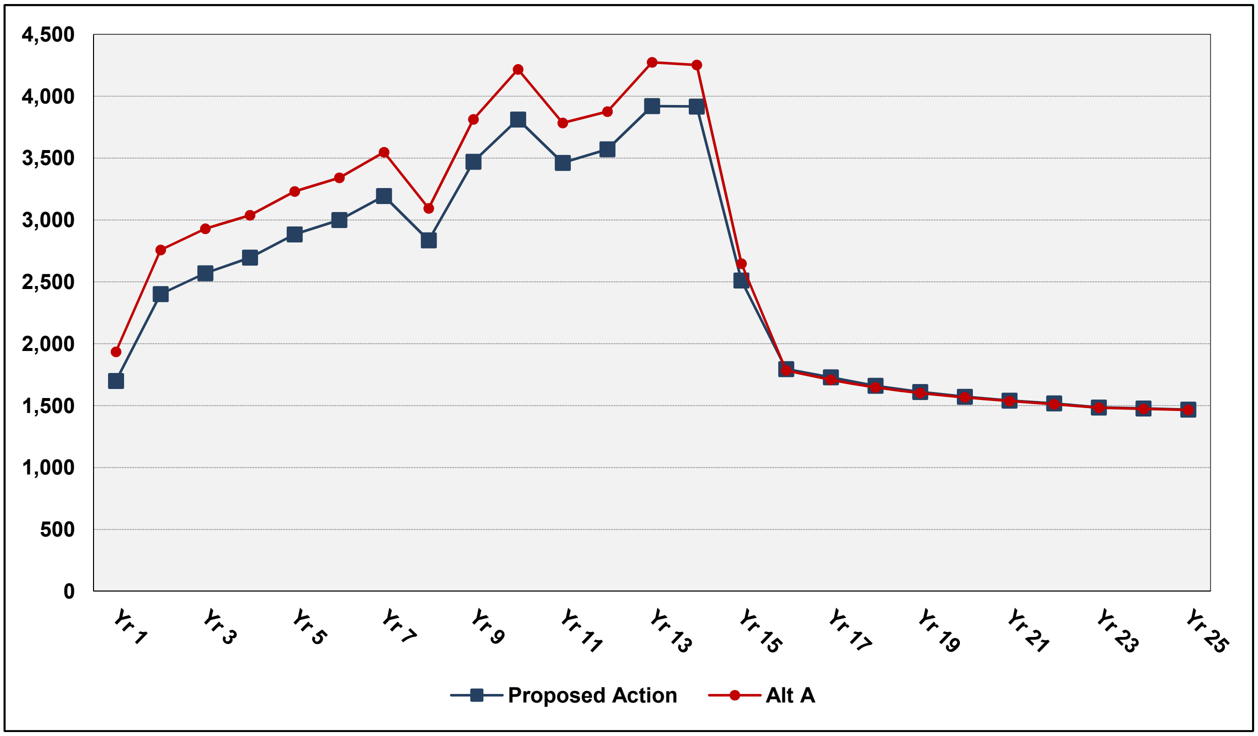


Figure 4.16-2. Total project-related AADT: Alternative A and Proposed Action

As with the Proposed Action, continued implementation of the CD-C TP and TPC process would result in a coordinated approach to road use, development, maintenance and reclamation and, to the extent possible considering the high level of development and associated traffic, reduce potential transportation effects.

4.16.2.3 Alternative B: Enhanced Resource Protection Alternative

Implementation of Alternative B would result in the same drilling schedule and number of wells as the Proposed Action. For the purposes of this assessment, it is assumed that implementation of the enhanced resource protection measures described in **Section 2.2.3** would result in a 20 percent increase in directional drilling from multi-well pads on federal lands compared to the Proposed Action. This would result in 53 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 47 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-3 provides a comparison of total AADT for the Proposed Action and Alternative B. Alternative B would result in an overall reduction of 1 to 2 percent in total AADT during the 15-year drilling period compared to the Proposed Action. However, at a site-specific level, drilling four directional wells on a multi-well pad would require approximately 33 percent fewer trips than drilling four vertical wells on individual pads. Consequently, reductions in traffic at specific well-site locations could be substantial under Alternative B as compared to the Proposed Action.

After drilling is completed, Alternative B and Proposed Action AADT would be the same because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative B would be similar to that associated with the Proposed Action.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

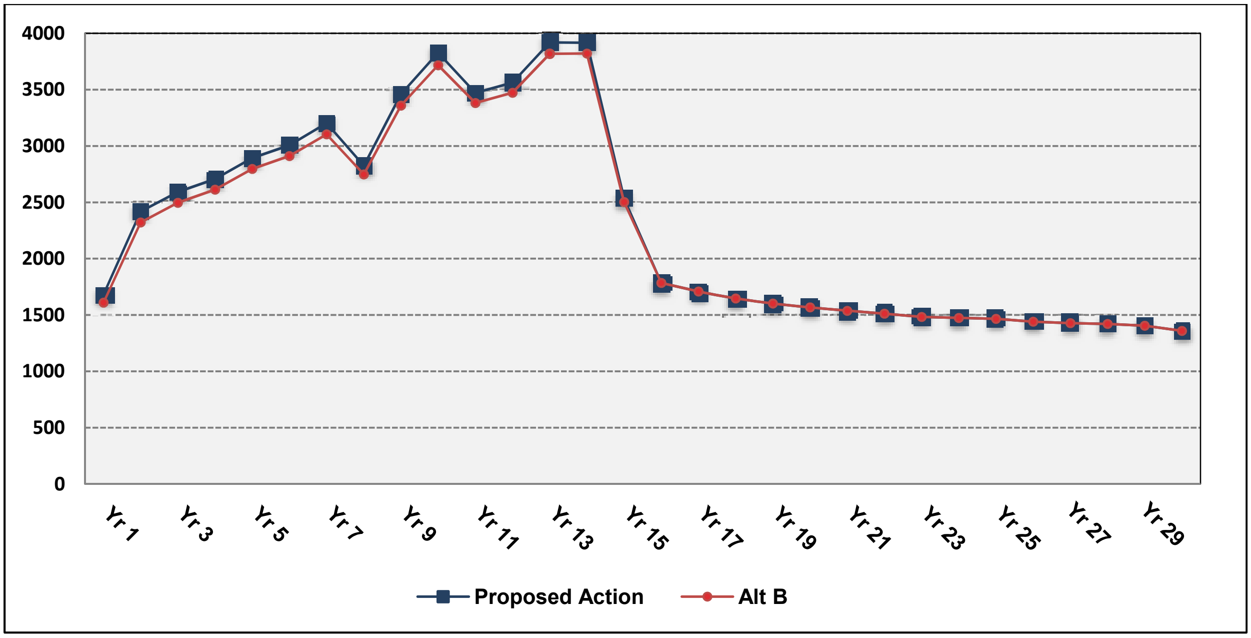


Figure 4.16-3. Total project-related AADT: Alternative B and Proposed Action

4.16.2.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Implementation of Alternative C would result in the same drilling schedule and number of wells as the Proposed Action. For the purposes of this assessment, it is assumed that implementation of the 60-acre surface disturbance cap in high-density natural gas development areas and the 30-acre disturbance cap elsewhere in the project area would result in a 50-percent increase in directional drilling from multi-well pads on federal lands. This would result in 46 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 54 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-4 compares total AADT for the Proposed Action and Alternative C. Implementation of Alternative C would result in a reduction of 3 to 4 percent in total AADT during Years 1 through 13 of the 15-year drilling period compared to the Proposed Action; AADT would be the same for the two alternatives after drilling is completed. As with all alternatives, at a site-specific level, drilling four directional wells on a multi-well pad would require an estimated 33 percent fewer trips than drilling four vertical wells on individual pads.

After drilling is completed, Alternative C and Proposed Action AADT would be the same because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative C would be similar to that associated with the Proposed Action.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

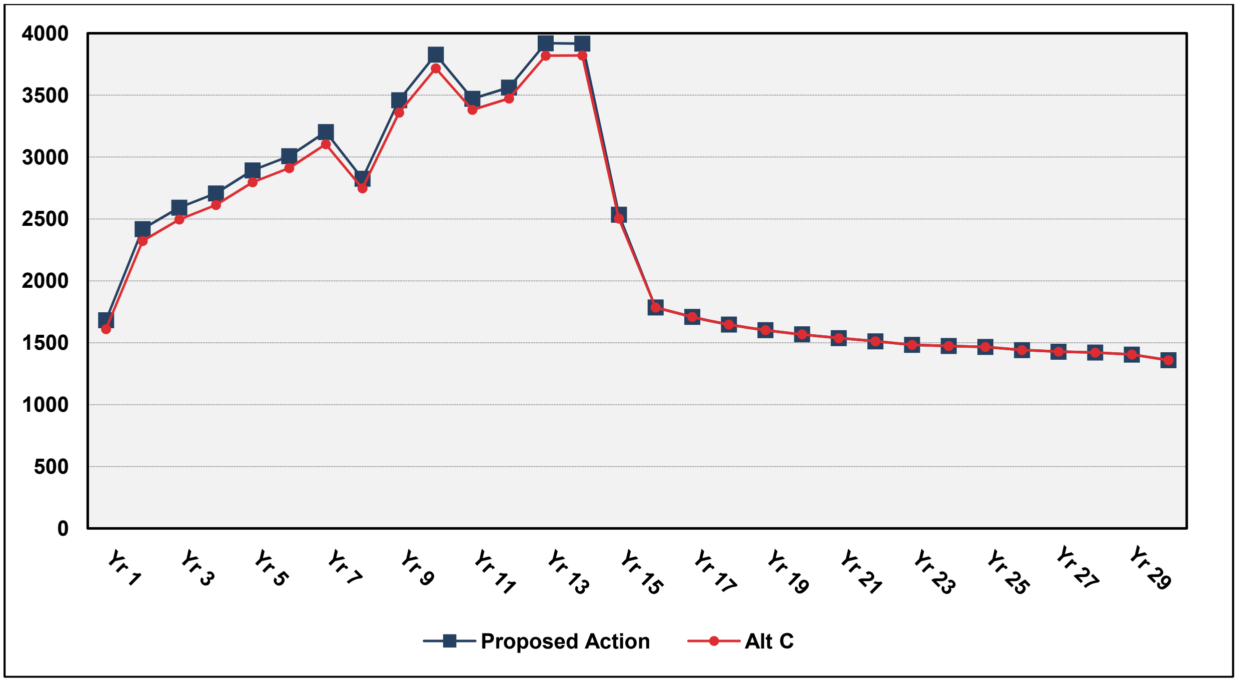


Figure 4.16-4. Total project-related AADT: Alternative C and Proposed Action

4.16.2.5 Alternative D: Directional Drilling

For the purpose of this assessment, it is assumed that requiring all wells on federal lands to be drilled on multi-well pads would result in a 74-percent increase in directional drilling from multi-well pads on federal lands. This would result in a total of 27 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 74 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-5 provides a comparison of total AADT for the Proposed Action and Alternative D. Implementation of Alternative D would result in a reduction of 3 to 11 percent in total AADT during the 15-year drilling period compared to the Proposed Action. These reductions would result from the reduced number of trips required for location construction, rig mobilization and demobilization, and other drilling and completion activities that could be performed for multiple wells on one well pad. During project operations, AADT would be about the same as that associated with the Proposed Action.

After drilling is completed, Alternative D and Proposed Action AADT would be similar because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative D would be similar to that associated with the Proposed Action although the timing and location of facilities construction could differ.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

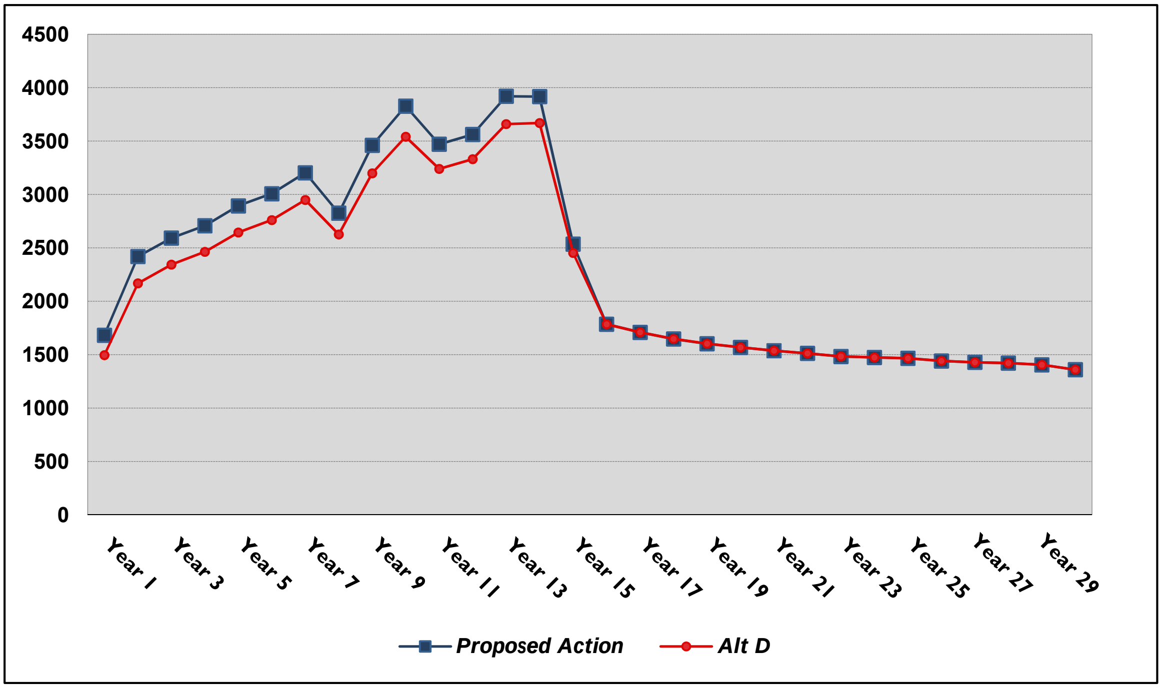


Figure 4.16-5. Total project-related AADT: Alternative D and Proposed Action

4.16.2.6 Alternative E: No Action

Under the No Action alternative it is assumed that drilling activities would cease upon issuance of a ROD for the EIS. The termination of drilling within the CD-C project area would result in a reduction of traffic on area highways and roadways; during 2009 an estimated AADT of 726 was associated with drilling and completion activities within the project area. Production activities for existing wells would continue under the No Action alternative; it is estimated that an AADT of 798 was associated with production activities within the project area during 2009. Production-related AADT would be somewhat higher initially to account for additional wells drilled prior to the issuance of a ROD, but begin to decline thereafter as produced water and liquids volumes decline and wells come off-line as the field matures.

The reduction in traffic associated with the No Action alternative would result in substantially lower wear and tear on area highways and on county, BLM, and private roads as compared to any of the action alternatives. Conversely, state and county governments would receive substantially fewer revenues to perform road maintenance activities. Given the substantially lower volumes of traffic, the potential for project-related accidents would be substantially lower under the No Action alterative.

4.16.3 Impact Summary

Figure 4.16-6 contrasts estimated total AADT for the Proposed Action with each of the four action alternatives.

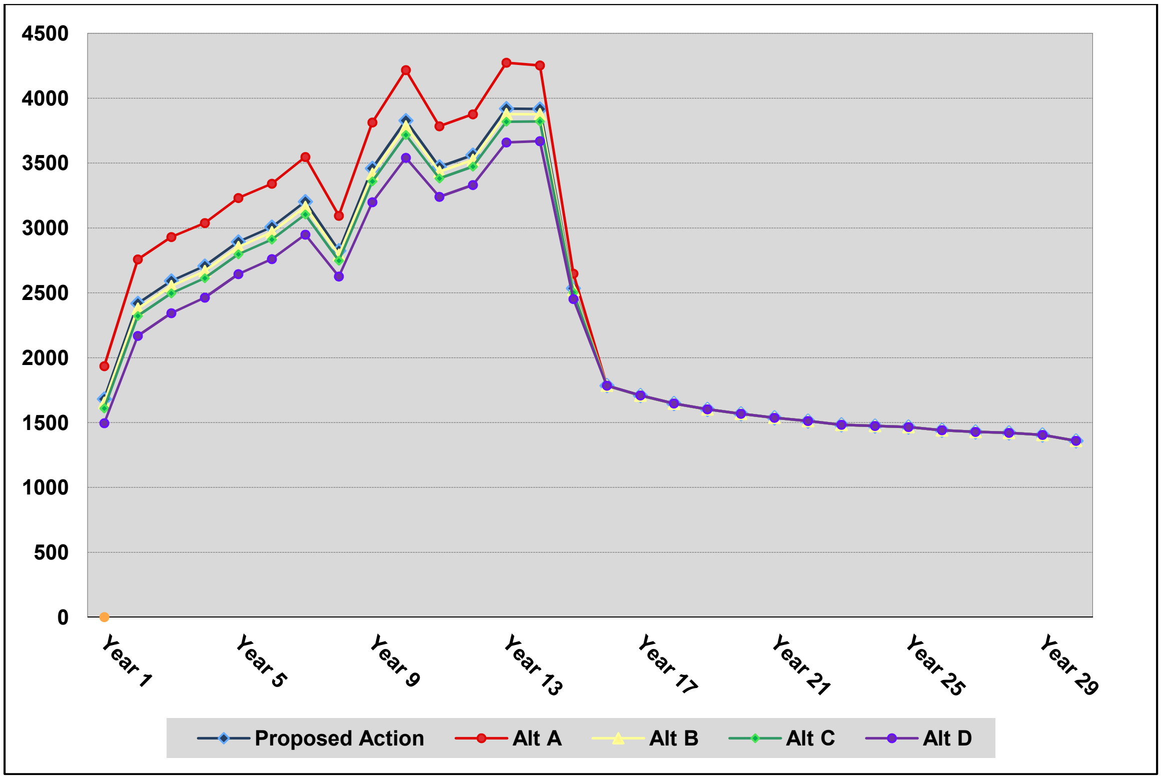


Figure 4.16-6. AADT, all action alternatives

Each action alternative would result in increases in traffic associated with drilling and production activities. Based on the assumptions associated with each alternative, the pattern of traffic increases would be similar for all alternatives. Differences in the magnitude of traffic increases on affected highways and roads would result from differences in the ratio of directional wells drilled on multi-well pads to wells drilled horizontally on single-well pads. Additionally, the pace of drilling would be a factor under Alternative D.

In addition to the traffic associated with drilling and production, each action alternative would result in similar temporary increases in AADT on federal and state highways resulting from construction of ancillary facilities such as compressor sites, a central pipeline compression facility, two or more central gas-processing/stabilization facilities, and a high-pressure gas line.

All action alternatives would accelerate highway maintenance requirements on county, BLM, and private roads. The timing and level of improvements and maintenance requirements would be driven by the magnitude of traffic increases on specific highways and roads.

All action alternatives would generate similar amounts of revenue that could be used to fund highway and road-maintenance needs.

Highway and road-maintenance requirements would be substantially less under the No Action alternative than under any action alternative. The amount of production-related tax and royalty revenues to fund maintenance requirements would correspondingly decrease as production diminishes and wells cease production at a more rapid pace than under the action alternatives.

4.16.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Most unavoidable adverse transportation impacts of the Proposed Action and alternatives are associated with increases in the number of vehicle trips on the network of roads and highways in the project area and the consequent need to manage and maintain that network. An important component for reduction of those impacts for all action alternatives would be continued active participation in the CD-C TP and TPC process. For all alternatives, the substantial increase in industrial traffic would require a sustained and coordinated transportation-planning and road-maintenance effort. For Alternative E, No Action, road-abandonment and reclamation planning would be required sooner than under the action alternatives.

4.17 NOISE

4.17.1 Introduction

Noise anticipated from the Proposed Action and all alternatives would include that which currently occurs within the CD-C project area as a result of gas-compression stations, livestock grazing operations, wind, well-workover operations, and traffic along area access roads, state highways, and I-80. Additional noise would be generated by well site and access road construction, drilling and completion, pipeline construction, and surface-disturbing reclamation operations. Frequent strong winds would add to ambient noise levels. The EPA guideline of 55 decibels (dBA) represents a level at which an activity would have no effect on receptors in the environment; the sounds would not be noticeable to the human ear. Emerging research relative to the impact of noise on wildlife, specifically greater sage-grouse and mountain plover, indicates this level of noise or the 49-dBA level (10 dBA over background) commonly found in BLM documents may not be sufficiently protective (Blickley and Patricelli undated, Blickley and Patricelli 2010). The Rawlins RMP does not contain specific noise limitations or reduction/mitigation requirements; rather, the RMP manages noise impacts through performance-based project design or mitigation. In Appendix 15 to the RMP (Best Management Practices) there is a general statement requesting consideration of “noise reduction techniques and designs” to benefit wildlife in general and the greater sage-grouse in particular.

Blickley and Patricelli (2010) express concern that, “Other acute impacts of noise, such as masking and behavioral disruption, occur over a much larger area. Masking occurs when the perception of a sound is affected by the presence of background noise, with high levels of background noise decreasing the perception of a sound. One possible consequence of masking is a decrease in the efficacy of acoustic communication. Many animals use acoustic signals to attract and retain mates, settle territorial disputes, promote social bonding, and alert other individuals to predators. Disruption of communication can, therefore, have dramatic impacts on survival and reproduction,” and “In addition to the acute effects of noise, animals may suffer chronic effects, including elevated stress levels and associated physiological responses. Over the short term, chronic stress can result in elevated heart rate. Longer-term stress can be associated with the ability to resist disease, survive, and successfully reproduce.”

Appendix 16 of the Rawlins RMP (Mountain Plover Guidelines) provides for operations setbacks from identified nesting habitat, as follows: “To protect the identified mountain plover-occupied habitat, the proposed facility will be moved one-half mile from the identified occupied habitat.” Blickley and Patricelli (2010) found through their research of selected compressor stations in the Powder River Basin that “stipulations limiting the development of compressor stations within ½ mile of nesting sites are likely to prevent masking of the mountain plover vocalizations analyzed.”

Refer to Wildlife (**Section 4.8**) and Special Status Species (**Section 4.9**) for evaluations of the performance standards and their effectiveness relative to the project area.

4.17.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) does not provide management objectives specific to noise. The following criterion was used to assess the significance of noise impacts related to this project:

1. Long-term activities that would exceed the federal 55-dBA maximum guideline for noise at either human- or animal-sensitive locations.

Impact significance criteria for noise relative to wildlife and special status species can be found in **Sections 4.8** and **4.9**, respectively.

4.17.3 Direct and Indirect Impacts

4.17.3.1 Proposed Action

Direct impacts of the Proposed Action would include increased noise levels from the drilling, completion, and production of an additional 8,950 wells, of which 500 may be CBNG. Operators anticipate drilling up to 600 wells per year with up to 25 rigs running at any one time for up to 15 years; 42 percent of the wells could be directionally drilled. Related activities would include construction of associated infrastructure including access roads, power lines, and gas/water/condensate pipelines, as well as the reclamation of disturbed areas.

Construction and drilling operations would take place at each well site resulting in an increase in noise when compared to the natural background condition of 30 to 50 dBA. Construction, drilling, and completion activities related to the drilling of conventional wells may last from 30 to 60 days. Wells drilled directionally may take slightly longer to drill and complete compared to vertical conventional wells. Directional wells may also require a larger rig with larger engines. Directional pad drilling usually involves several wells drilled from the same location, lengthening the period of disturbance per location. If 3,760 wells were drilled directionally, the greater number of days needed for drilling and completion activities would increase well-development noise/activity substantially, compared to vertical drilling. However, directional drilling would result in fewer well pads and access roads being built in the project area and would require a reduced number of rigs to accomplish the development within the estimated 10- to 15-year period. Fewer semi-truck loads of equipment would be brought to each site, resulting in reduced overall traffic noise. The shallower CBNG wells are expected to take up to 20 days for drilling and completion.

Equipment and operational noise would be generated during these activities from a variety of sources including engines, equipment impact, and well-flaring. The large rigs used for drilling conventional wells are significantly louder than the lower-horsepower (hp) rated small drilling rigs used for developing CBNG. It has been determined that drilling and flaring operations produce the loudest project-related noise. In the Jonah field, noise from drilling operations was measured as 77.5 dBA onsite and 50.1 dBA at 0.25 miles (BLM 2006b). Based on this information, drilling operations should not exceed the significance threshold for impacting sage-grouse leks—a sensitive receptor—as long as the lek and nest protection buffers are observed. This is consistent with the findings of the 2009 PAPA Noise Study (KC Harvey 2009) which evaluated noise at various lek sites within the natural gas field. Flaring operations at the Jonah field were measured at 97.9 dBA on site and 66.3 dBA at 0.25 miles. The use of flowback separators decreased flaring noise to 63.7 dBA on site. Holloran (2005) suggests that heavily traveled main haul-roads located within 3 miles of greater sage-grouse leks may negatively impact male lek attendance. While Holloran (2005) does not provide information regarding the vehicle type(s), anecdotal information (Holloran pers. com. 2003) indicated a steady stream of large diesel semi-rigs such as water and fuel tankers, completion equipment haul trucks, and drilling equipment as the traffic generating noise and disturbance impacts to sage-grouse. Directional pad drilling would result in locally more intense noise generation but would result in fewer well pads and access roads being built in the project area. In addition, directional pad drilling would result in fewer total semi-truck loads of equipment going into the field over the life of the project.

During the production phase of field operations, noise sources are generally less intense or of very short duration. These activities include occasional well workovers, routine site visitation by company personnel (“pumpers” and technicians) and road-maintenance equipment. Produced-water and condensate hauling, compressor stations, and well-site compression are generally louder and frequent or continual sources of noise.

Vehicle traffic associated with production is typically limited to pickup trucks and occasional workover rigs. Wells producing water and condensate are regularly visited by haul tanker trucks, which transport these fluids to disposal facilities and sales points unless connected to gathering pipeline systems. In the absence of gathering systems, the greater the volume of fluid produced, the more frequent the tanker visits.

Noise resulting from compressor stations or well-site compression would continue for as long as gas production, gathering, and transmission occur within the field or from a particular well. The number, size, and location of field compressors would change over the life of the field depending on the volume of gas produced, the size of the lines, and the volume and pressure of gas within the major transmission lines. Project Operators anticipate the need for 10 additional compressor stations in the project area including one large central pipeline compression facility. Operators also anticipate the need to enlarge some of the existing compression infrastructure.

The need for well-site compression is dependent on the characteristics of the specific well and gas-line pressures. An unknown number of wells would likely require well-site compression for some period of time during the life of the project. Well-site compression typically uses 125- to 200-hp two-stage compressors.

Two or more central gas-processing/stabilization plants would also be required within the project area. The specifics of these anticipated facilities have not been determined and would be evaluated on a case-by-case basis by the BLM.

Existing operations within the project area generate noise levels as indicated in **Table 4.17-1**. Operations that may result from the Proposed Action are expected to generate noise at the same level at a larger number of sources for the life of the project.

Table 4.17-1. Typical noise measurements from common energy development-related sources in the CD-C project area[1]

Description	HP	dBA	dBC
Two (2) Cat 3516 with noise wall	1,000	45	--
Two (2) Cat 3516 without noise wall	1,000	50	--
Two (2) Waukesha H24 and F18 compressor engines	--	75	--
Two (2) electric-driven compressors	--	65	--
One (1) Ajax Cooper 2802	250	51	--
One (1) Ajax Cooper 2803 compressor engine	400	52	--
Cat or Waukesha compressor engine	1,200	75	--
Cat or Waukesha with high-performance intake and exhaust silencers	1,200	70	--
One (1) Waukesha 5794LG compressor engine; fan end	1,000	91	95
One Cat 3516 compressor engine; fan end, quiet fan	1,000	63	
One (1) Dehyd boiler	15	52	--
One (1) Cummins electric generator skid unit	1,000	69	--
Cat 3608 compressor engine w/ 2 heat exchangers	--	79	--
Disposal well pump building with electric motors inside	--	53	--
Cat 3608 compressor engine	1,000	58	--
Drill rig (Jonah Field)	--	69	
One (1) Ajax/Cooper compressor engine with weather cover	4,000	--	76
One (1) Champlin 242J-12 Ajax wellhead compressor	--	71	86

[1]*Noise emission data – Levels at 100 ft. collected by Engineering Dynamics Incorporated.*

Relative to the production life of a well, the construction, drilling, and completion phases of operations are short-term events lasting up to 60 days. However, when considered over the life of the Proposed Action, the increased noise levels resulting from drilling and completion activities at multiple sites within the project area would continue for up to 15 years, until the resource is fully developed. In addition to the noise related to field-development activities, noise could be expected from the continued production and maintenance of existing wells within the project area. Noise levels in the project area would also continue to be influenced as they are now by weather, occasional vehicle traffic, and aircraft overflights.

At various times and at specific locations within the project area, noise levels associated with drilling, field-development, and operations activities would temporarily exceed the EPA-established baseline noise levels of 39 dBA for a "Farm in Valley" and the EPA-established threshold of 55 dBA, averaged over 24 hours. Noise generated from these activities can be of an intensity and frequency that causes harm to human receptors. Field-development and production-related noise impacts would affect site workers who are subject to state and federal Occupational Health and Safety (OSHA) standards. OSHA mitigation standards for noise limits exposure as follows: an 8-hour time-weighted average of 85 dBA or a dose of 50 percent are referred to as OSHA action levels [29 CFR 1910.95(c)(2)]. Occupational exposure to noise levels in excess of 85 dBA requires monitoring and mitigation, preferably by engineering means, to protect workers. Offsite worker impacts would be limited due to the lack of residential occupation and concentrated recreational activity within the development area. The small towns within the project area are generally located along I-80 and would continue to be impacted by the general noise of human activity, the vehicle and traffic noise generated along the interstate, and train movement along the railroad. Scattered, transitory activities such as livestock operations and recreation including hunting may be exposed to noise as they move past development activities and operating equipment. Temporary worker housing (man camps) located within the project area may be affected by noise generated by field-development activities but these impacts would generally be associated with specific operations and of limited duration. Noise can also modify animal behavior and habitat-use patterns such as the use of critical winter habitats or sage-grouse leks.

Operational noise would be lessened with the implementation of remote telemetry, which can significantly reduce the number of site visits needed by operations personnel. A survey conducted in the Moxa field area (BLM 2007e) found that the use of telemetry (remote monitoring of wells) could reduce field visits by 50 percent. The use of electricity or natural gas as a fuel for onsite power generation, as opposed to the use of diesel fuel, also reduces noise levels. There would be situations when noise-mitigation opportunities are limited by operational and engineering constraints. For example, CBNG production might be operated using diesel generators until water is removed and gas volumes are adequate to power pumping equipment. Natural gas wells may require artificial lift systems to facilitate production resulting in the need to use gas-lift, plunger-lift, down-hole pump, or other technology. This could include rod pumps or other noise-generating mechanisms. Depending on the fluid volumes produced, the installation of produced-water and condensate-gathering systems to transport these fluids to centralized facilities for disposal or sale could substantially reduce production-related noise compared to tanker-truck transportation.

Noise from field-development and production activities can also be dampened or reduced with the use of mechanical muffler systems; the use of vegetative, constructed, or topographic screening; distance; and consideration of the direction of the noise source from the receptor. These methods serve to lessen the impact of noise on workers, residences, and sensitive wildlife species. Noise is also affected by environmental factors such as humidity, wind direction and speed, and air density. Consideration of the prevailing wind direction when siting noise-generating operations also serves to lessen the impact of noise on sensitive receptors.

Indirect impacts of the Proposed Action include the continued production of the existing federal, fee, and state wells in the project area and the continuation of compression required to transport the gas produced in the field. Noise-control devices already in place would continue to provide mitigation. Directional drilling of 3,760 wells would require an increase in the number of rigs needed to complete development within the proposed 10- to 15-year period due to the additional number of days needed for drilling and completion activities per well; alternatively, the time needed for completion of the project would be extended appreciably.

4.17.3.2 Alternative A—100-Percent Vertical Drilling

Overall noise generated as a result of drilling 100 percent of the project wells vertically, as opposed to the Proposed Action, which includes drilling 42 percent or 3,760 of the wells directionally, would not change the analysis of impacts when compared to the Proposed Action. The number of days needed for drilling and completion of individual wells may be slightly less for vertical wells when compared to directional wells and result in an overall reduction in the number of days of drilling and completion noise generated during development of the project.

Construction, drilling, and completion activities related to the drilling of vertical conventional wells may last from 30 to 60 days. If it takes an additional week (7 days) to drill a well directionally, then the total number of days affected by drilling and completion noise would decline substantially under this alternative. However, 100-percent vertical wells would also require 42 percent more rig moves and the associated noise from rig moves within the field, when compared to the Proposed Action. In addition, the number of well completion semi-truck trips may also increase as a result of this alternative.

Directional wells may also require a larger rig with larger engines, which may operate at higher decibel and frequency levels when compared to the rigs needed to drill vertically. The noise level, frequency of noise generation, or distance from which noise from larger engines is perceived may decline under Alternative A.

4.17.3.3 Alternative B: Enhanced Resource Protection

Design features of Alternative B, as detailed in Chapter 2, would serve to reduce noise in sensitive environments. For example, (1) clustered development would concentrate noisy activities rather than having noise sources dispersed across the project area, (2) use of noise-reduction technology would prevent noise exceeding 49 dBA measured at 30 feet from the source at all drilling, production, and compressor sites, (3) pipeline transportation of produced liquids would reduce semi/haul truck traffic and associated noise, and (4) remote well-monitoring would also reduce daily traffic near sage-grouse leks and in crucial big game habitats. Enhanced seasonal restrictions on surface-disturbing or disruptive activities within buffers associated with sage-grouse leks, mountain plover nesting habitat, and ferruginous hawk nests would reduce noise impacts on these sensitive species.

4.17.3.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Implementation of Alternative C could result in areas with concentrated development activity as well as areas of more dispersed operations. It is likely that development noise levels within the high-density areas would be greater than those found in the low-density development areas. The Surface Disturbance Cap approach could slow the pace of development, especially in the high-density development areas, to the point that elevated development noise levels were extended in time compared to the Proposed Action.

4.17.3.5 Alternative D: Directional Drilling

Alternative D would likely result in an extension of the period of time over which a sensitive receptor is impacted by drilling noise. The engine size required for directional drilling would be larger and may result in a higher, or more noticeable, level of noise impacting a sensitive receptor. Noise resulting from completion activities and flaring would also be extended over a longer period of time at any one drilling site. These extended and possibly enhanced noise levels could result in a greater frequency of displacement by sensitive receptors.

4.17.3.6 Alternative E: No Action

Under the No Action alternative the noise generated by currently authorized and approved development and production operations would continue. No new noise sources would be produced.

4.17.4 Impact Summary

The Proposed Action (8,950 wells, of which an estimated 3,760 could be directional) may result in an increase in the number of rigs running annually in order to accomplish the goal of completion of resource development in 15 years when compared to Alternative A, 100-Percent Vertical Drilling. Noise impacts would differ somewhat among the alternatives with noise sources potentially being more dispersed across the landscape under the disturbance cap alternative (Alternative C) or extended over time.

The duration of noise-generating activity and dispersal of noise-generating equipment across the project area would be greatest under the Proposed Action. Directional wells are considered in the Proposed Action and Alternatives B, C, and D. Directional drilling may require a larger rig with larger engines, which may operate at higher decibel and lower frequency levels when compared to the rigs needed to drill vertically. The noise level, frequency of noise generation, or distance from which noise from larger engines is perceived may decline under Alternative A. Alternative D (Directional Drilling), while these rigs are a more intensive noise source, would result in an overall reduction in well pads and roads built and provide only localized areas of noise.

Alternative A, 100-Percent Vertical Drilling, would result in the greatest number of generation sources. The number of days needed for drilling and completion of individual wells may be slightly less for vertical wells when compared to directional wells and result in an overall reduction in the days of drilling and completion noise generated in the development of the project. The time savings realized from vertical drilling could be negated by the amount of time it takes for a rig move; furthermore, the noise reductions realized from Alternative B could be negated by the noise of semi/haul trucks moving drilling rigs. The greatest difference between the Proposed Action and Alternative A could possibly be reduction in the low-frequency noise generated by the bigger engines on directional rigs.

Design features of Alternative B, as detailed in Chapter 2, would serve to reduce noise in sensitive environments.

4.17.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Under the Proposed Action and all alternatives, construction, drilling, and flaring activities would generate onsite noise levels exceeding the EPA-established maximum of 55 dBA. In addition, haul trucks and other construction traffic would generate transitory noise exceeding the federal maximum. In general, these would be short-term events lasting up to 20 days for directional wells and up to 60 days for conventional wells. However, when considered over the life of the Proposed Action, the increased noise levels resulting from drilling and completion activities at multiple sites within the project area would continue for up to 15 years, until the resource is fully developed. Over the life of the project, compressor stations and well-site compression would generally be louder and frequent or continual sources of noise. However, full and successful implementation of the required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**) would ensure that the significance criterion is not exceeded.

In Appendix 15 of the RMP (Best Management Practices) there is a general statement requesting consideration of "noise reduction techniques and designs" to benefit wildlife in general and the greater sage-grouse in particular. Implementation of mitigation measures should be considered on a site-specific basis. The following additional mitigation measures would also be considered:

- Dampen or reduce noise from field-development and production activities with the use of mechanical mufflers, vegetative or constructed screening, and direction from receptor, topography, or distance. Noise is also affected by environmental factors such as humidity, wind direction and speed, and air density.

- Consider the prevailing wind direction when siting noise-generating operations to lessen the impact of noise on sensitive receptors.
- Use flowback separators within 0.25 mile of sensitive receptors.
- Reduce semi/haul truck traffic with the installation of gathering pipelines for produced water and condensate.
- Install remote well-site monitoring to reduce light-truck traffic.
- Modify or enclose compressors to minimize or eliminate loud, continuous noise during greater sage-grouse strutting periods from March 1 through May 20 each year within 0.25 mile of strutting grounds.
- Avoid noise-generating activities from 6 p.m. to 9 a.m. within 2 miles of strutting grounds.

■ MANAGEMENT ENVIRONMENT

4.18 RANGE RESOURCES

4.18.1 Introduction

The CD-C project area includes lands that are located within 47 grazing allotments (described in **Section 3.18**). In many cases, the boundaries of these allotments extend beyond the boundaries of the CD-C project area. Under all alternatives, cattle and sheep grazing would continue throughout the duration of the project. Impacts to rangeland resources would result with implementation of all alternatives. Impacts would be the greatest during the natural gas project development phase but would occur throughout the life of the project, due to vegetation and soil disturbance associated with construction activities, reclamation, weed-control, and road construction and use (e.g., fugitive dust and animal collisions).

4.18.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) includes the following management objectives for livestock grazing:

1. Maintain, restore, and enhance livestock grazing to meet Wyoming Standards for Healthy Rangelands (RMP Appendix 8) and achieve allotment objectives.
2. Encourage grazing permittees and the interested public to participate with BLM to monitor and evaluate rangeland health to determine appropriate management actions.
3. Utilize livestock grazing management techniques (RMP Appendix 19) to maintain vegetation communities and ecosystem functions, in consultation and coordination with the grazing permittees and with participation by the interested public. Utilize data collected from scientifically based inventory and monitoring techniques to support decisions that authorize livestock grazing levels and management.
4. When feasible and providing Wyoming Standards for Healthy Rangelands are met, maintain and/or increase animal unit month (AUM) levels in the RMP project area for livestock grazing.
5. Identify opportunities and implement range and vegetation improvement projects to sustain and enhance livestock grazing and meet Wyoming Standards for Healthy Rangelands in cooperation, consultation, and coordination with the grazing permittees and the interested public (Appendix 19).
6. Mitigate direct, indirect, and cumulative livestock forage losses and impacts to livestock grazing (including impacts on livestock grazing operational capabilities and production performance) where opportunities exist.

Impacts to rangeland resources would be considered significant if:

1. Resource management actions result in greater than 10 percent permanent reduction in AUMs available for livestock grazing within a given allotment,
2. Resource management actions reduce or eliminate the opportunity to run the livestock of choice,
3. Wyoming BLM Standards for Healthy Rangelands are not met, or
4. Vegetation significance criteria are exceeded (**Section 4.6.2**).

4.18.3 Direct and Indirect Impacts

Impacts to livestock and grazing resources would occur under the Proposed Action and all action alternatives on all lands in the project area, as well as on private and state lands under the No Action Alternative. The impacts would include those caused by a reduction of total available forage, road construction and maintenance, well pad construction, pipeline construction, improperly fenced open pits, vehicle traffic, fugitive dust creation, accidental spills of hazardous or other materials, and creation of habitats conducive to invasive weed infestations.

The primary impact to grazing resources would be loss of available forage as a result of construction and production-related disturbances. Available forage would be reduced during drilling and field development and would be partially reclaimed as soon as feasible under direction of the current BLM reclamation guidelines and recommendations (**Appendix E**). A long-term loss of forage would occur under all alternatives by construction of roads, drill pads, and ancillary facilities that remain in place throughout the life of the project. In addition, in areas where vegetation resources have been enhanced, disturbance would not only reduce quality and quantity of diverse vegetation but would also result in wasted investments by the BLM and permittees (for example, tebuthiuron [Spike 20P™] treatments).

While new roads, pipelines, and well pad construction produce adverse impacts such as removing available forage, the construction of new roads could provide beneficial impacts for livestock permittees from improved access to remote facilities and grazing areas. However, increased access could produce an increased disturbance to livestock, an increased number of undesignated roads/trails, and increased distribution problems associated with unclosed cattle gates and/or cut fences. Vehicles would also present a potential collision hazard to livestock, especially during the calving/lambing season and at night.

For all of the alternatives, fugitive dust caused by vehicles traveling along proposed new roads, existing roads, and other areas of surface disturbance could settle on vegetation used as forage, especially alongside roadway corridors with heavy traffic. This dust would affect the quality and regenerative capacity of roadside grasses and forbs as well as decrease the palatability of the forage for livestock/wildlife use and potentially increase operating costs through increased livestock medical expenses (see **Section 3.6.3**). The graveling of roads reduces dust in the short term, but the scoria commonly used breaks down faster than other gravels and, in the long term, fugitive scoria dust covers the vegetation. Livestock forage would also be impacted should any spills of fuels, solvents, or drilling fluids occur.

Areas of disturbed soil would lead to the spread of invasive plant species. These species would reduce rangeland and forage values by replacing preferred forage species, leading to a reduction in grazing capacity. Without proper management and control, invasive plant species may become established and cause wide-spread infestations. Additionally, some invasive species such as halogeton, black henbane, and houndstongue are poisonous to livestock and can kill or impair them if ingested.

Livestock management concerns with development of natural gas resources on public lands in the CD-C project area include reclamation success, rangeland improvement functionality, dust from roads, and livestock losses. In general, adequate reclamation efforts within the project area have been hampered by inadequate reclamation techniques and extended drought conditions. Invasive weed control has been sporadic and random in implementation, which results in a threat to maintaining Wyoming BLM Standards for Healthy Rangelands and watershed health.

Cattle guards and gates are often damaged by overweight/over-width loads, leading to added maintenance and unwanted mixing of livestock. Numerous instances of gates being left open or fences cut for pipelines that have not been closed or repaired adequately have been recorded. This has led to mixing of livestock and additional time for herding. In large allotments, this may involve up to a week of additional time and expense for the livestock operator.

Improving roads leads people to drive faster, which has increased the incidences of young lambs, calves, and even full-grown animals being hit and killed or maimed.

4.18.3.1 Proposed Action

Under the Proposed Action (**Section 2.2.1**), approximately 8,950 new natural gas wells and the construction of required ancillary facilities would be anticipated over the course of the 15-year development phase within the CD-C project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1).** This total represents an initial forage loss equivalent to approximately 5,488 AUMs, based upon an allotment-wide average of about 8.6 acres per AUM stocking ratio. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres resulting in a long-term forage loss equivalent to about 2,193 AUMs.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated initial total of 60,176 historic disturbance acres already exist within the project area (**Table 4.0-1**). The existence of 60,176 initial historic disturbance acres added to Proposed Action disturbance acreage would result in a grand total of 107,376 initial disturbance acres or about 10 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the overall disturbance would be reduced to about 36,524 acres, or about 3.4 percent of the total land surface in the project area with successful reclamation on all disturbed acres. The driving factors for attaining pre-disturbance conditions would mainly depend upon time to achieve successful reclamation, future land uses, and future climatic conditions. This would hold true for the reclamation of herbaceous species, but not for native shrub establishment, especially in the more xeric portions of the project area where Wyoming big sagebrush and Gardner's saltbush are the primary land cover types on approximately 590,272 acres, which represents about 55.1 percent of the project's total land surface area (**Table 3.6-1**).

The first impact significance criterion described in **Section 4.18.2** says that impacts to rangeland resources would be considered significant if they were to result in a permanent reduction in AUMs available for livestock grazing within an allotment that was greater than 10 percent. Such a reduction would be a decision made by BLM on a case-by-case basis after a thorough examination of an allotment's historic and ongoing forage availability. Ultimately the decision would be based on the long-term loss of available forage within the allotment. While this analysis cannot say how much disturbance each allotment would receive as a result of the CD-C project and to what extent that would translate to a long-term loss of available forage, it is possible to estimate which allotments may be at a greater risk of long-term loss of forage in excess of 10 percent. According to **Table 3.18-2**, the Echo Springs and North LaClede allotments have already had historic initial surface disturbance in excess of 9 percent. Nine other allotments have had historic disturbance in excess of 5 percent but less than 9 percent. Assuming some degree of successful reclamation and a return to pre-disturbance vegetative conditions, none of these allotments may currently be near the 10 percent significance threshold, as the long-term disturbance figures in **Table 3.18-2** would indicate. However, the surface disturbance associated with the Proposed Action—47,200 acres—could bring total initial disturbance to almost 10 percent of the overall project area. If previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then the allotments described in the preceding sentences—and others—could be at risk of long-term forage reductions in excess of 10 percent.

Indirect impacts to vegetation due to dust from unpaved roads would be variable throughout the project area, depending upon the primary factors cited in **Section 3.6.3**. In addition to the primary factors that generate dust on unpaved roads, the amount and timing of precipitation events—especially in the hotter and drier summer season—could play an important role in the amount of dust generated. Wind speed and prevailing direction in relation to the horizontal azimuth of the road would be important secondary factors, especially with north/south-oriented roads such as Sweetwater County Road (SWCR) 23 which extends from Wamsutter to the north boundary of the project area. The poor palatability of dust-covered vegetation could cause animals to concentrate in dust-free locations, leading to over-utilization and lowered plant productivity/cover in these areas. Increased dust may also affect animal health. These impacts could include reduced weight gains or required lowering of stocking rates in affected allotments.

The Proposed Action could result in impacts to livestock operations as a result of increased death loss, unusable forage due to dust, declining rangeland health and forage productivity, and disruptions to livestock-management actions. Suggestions for voluntary coordination may or may not be implemented and death loss of young animals and disruptions to livestock-management actions would still be likely to occur. Existing standards and mitigations may not adequately address issues with dust and road alterations to overland hydrology. Therefore, reduction in forage palatability from dust and declining rangeland health and productivity due to accelerated erosion from roads could still occur.

The Proposed Action would result in increased traffic and increased speeds on the improved roads within the CD-C project area, particularly during the drilling and field-development phase. The potential for livestock/vehicle collisions would be increased, especially during the calving/lambing season and during nighttime hours. Roads on moderate to steep slopes that result in long-term changes to overland hydrology and desertification impacts below these locations would also lead to lower weight gains or require reduced stocking rates. New and improved access roads could, however, improve livestock operations by improving access for viewing the allotment, facilities, and animals; for doctoring sick animals; and for transporting animals in or out of an allotment.

The potential exists for disruptions to livestock management. Traffic along roads that pass through shipping pastures or by corrals when in use may interrupt or complicate this work, extending the time and increasing the cost to complete it. Herding of animals through areas being developed or moving around them would increase the complexity and time to accomplish these tasks. In some allotments, management flexibility may be sacrificed to avoid or to minimize these types of impacts.

There is also potential for damage to range improvements from the movement of heavy trucks, drilling equipment, and heavy construction equipment.

Disturbance of soils and increased vehicle activity would increase the potential for introduction, establishment, and spread of undesirable non-native weedy species. This can reduce forage palatability and animal weight gains, in addition to affecting trail routes and animal health, particularly increasing death loss with sheep.

4.18.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the range resource resulting from implementation of Alternative A would be similar to the Proposed Action with the exception that the total amount of initial disturbed area would increase from 47,200 acres to 61,696 acres, a 31-percent increase; the total long-term disturbed area following successful reclamation would increase from 18,861 acres to 24,133 acres.

Under Alternative A, the rangeland forage resource on the 47 CD-C grazing allotments would initially be reduced by the forage equivalent of approximately 7,174 AUMs (1,686 more AUMs than the Proposed Action). Assuming successful reclamation occurs, the long-term forage loss equivalent under Alternative A would be about 2,806 AUMs for the 47 allotments versus 613 more AUMs than the Proposed Action.

The greatly increased disturbance acreage under this alternative would make it more likely that an allotment would approach or exceed the 10-percent significance criterion. The 61,696 acres of new disturbance amounts to a 110-percent addition to historic disturbance. If historic development patterns were to continue, some allotments, including the eleven that have historic disturbance in excess of 5 percent, could be nearing the criterion percentage even if reclamation efforts were successful.

The greater amount of construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would likely increase the potential for introduction and spread of invasive weed species, as well as increasing the total fugitive dust load within the project area.

4.18.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) was developed to prevent significant impacts to the range and other resources by implementing protections and mitigations beyond those normally applied. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts to vegetation communities faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis.

The enhanced resource protections for the livestock resource would go into effect immediately and be applied to all future APDs. They include mitigation of impacts on livestock water features, annual meetings conducted by the BLM with natural gas Operators and grazing permittees to discuss project-specific impacts, notification of the affected grazing permittees when drilling is to take place within their allotment, thorough power-washing of all field vehicles associated with natural gas operations, and control of fugitive dust on well sites, pipelines, and access roads.

Surface-disturbance thresholds would trigger further mitigation activities. If surface disturbance were to reach 5 percent of an allotment, a review of reclamation success in the allotment would take place and planning for further development, including potential range improvement projects, would take place. If the amount of unreclaimed surface disturbance were to reach 8 percent, the BLM would require that mitigation be implemented to avoid reaching the significance level of a permanent 10-percent loss of vegetation.

Under Alternative B, the initial disturbance would be 45,516 acres (a decrease of 1,684 acres compared to the Proposed Action) resulting in an initial forage loss equivalent to approximately 5,293 AUMs (195 fewer AUMs than the Proposed Action). Assuming successful reclamation efforts, the long-term disturbance area would decrease to 18,249 acres (a decrease of 612 acres compared to the Proposed Action) resulting in a long-term forage loss equivalent of about 2,122 AUMs (71 fewer AUMs than the Proposed Action).

The decreased surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. More importantly however, the two thresholds would assure that timely intervention took place before the 10-percent significance threshold was approached.

The reduction in the amount of construction activities, reduced soil-surface disturbance, and diminished traffic volumes associated with Alternative B would decrease the potential for introduction and spread of invasive weed species, as well as decreasing the total fugitive dust load within the project area.

4.18.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the range resource would be similar to those described for the Proposed Action (**Section 4.18.3.1**). For this alternative, the scope and intensity of the impacts would be less widespread because of the surface cap restrictions. Under Alternative C, the maximum initial disturbance would be 42,955 acres (a decrease of 4,245 acres compared to the Proposed Action) resulting in an initial forage loss equivalent to approximately 4,995 AUMs (493 fewer AUMs than the Proposed Action). Assuming successful reclamation efforts, the long-term disturbance area would decrease to 17,318 acres (a decrease of 1,543 acres compared to the Proposed Action) resulting in a long-term forage loss equivalent of about 2,014 AUMs (179 fewer AUMs than the Proposed Action).

With this alternative there would be fewer well locations developed. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than for the Proposed Action. The impacts to the range resource associated with implementation of Alternative C would be similar in nature, but somewhat less in magnitude, compared to impacts associated with the Proposed Action (**Section 4.6.3.1**).

The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. The 42,955 acres of new disturbance would be a 9-percent reduction from the Proposed Action. However, this is still a substantial addition to historic disturbance and, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then the 11 allotments with historic disturbance in excess of 5 percent—and others—may be at risk of long-term forage reductions in excess of 10 percent.

On federal lands, invasive weed programs would be implemented per stipulations outlined in individual right-of-way applications and APDs.

4.18.3.4 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the range resource would be similar to those described for the Proposed Action (**Section 4.18.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated initial surface disturbance for this alternative would be 36,449 acres, a decrease of 10,751 acres from the Proposed Action. The forage lost initially under this alternative is estimated to be 4,238 AUMs (1,210 fewer than the Proposed Action). The estimated 14,952 acres of long-term disturbance would be 3,908 acres less than the Proposed Action, representing 1,739 AUMs (454 fewer AUMs than the Proposed Action).

The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. The 36,449 acres of new disturbance would be a 22.8-percent reduction from the Proposed Action. However, this addition to historic disturbance could cause the 11 allotments with historic disturbance in excess of 5 percent—and others—to be at risk of long-term forage reductions in excess of 10 percent if previously disturbed areas are not being returned to pre-disturbance vegetative conditions.

With this alternative there would be fewer well locations developed—an estimated 4,032 compared to the 6,126 estimated for the Proposed Action. This 35-percent reduction in well locations would likely lead to similar reductions in the number of access roads and road miles with associated reductions in potential collision hazard and dust accumulation on nearby forage.

4.18.3.5 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area and there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities. There would consequently be no new surface disturbance and no new impacts on rangeland. Grazing would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of forage caused by dust.

4.18.4 Impact Summary

Rangeland impacts associated with the Proposed Action and Alternatives would include disturbed land and associated loss of available forage. Other impacts include those from dust-reducing forage palatability, impacts to livestock operations (e.g. leaving gates open, impacts to fences or range improvements), possible increases in invasive plant species, and accidental injury or death of livestock from vehicle collisions. **Table 4.0-1** shows the anticipated surface disturbance for the alternatives compared to the Proposed Action.

Under the Proposed Action, assuming reclamation and reseeding efforts are successful, during the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres, resulting in a long-term loss of about 2,193 AUMs. Two allotments and possibly more would be at risk of exceeding the RMP significance criteria of a permanent reduction in AUMs greater than 10 percent.

Under Alternative A, the initial 61,696 acres of disturbance would be reduced to about 24,133 acres over the life of the project, resulting in a long-term loss of about 2,806 AUMs. Allotments would be at a greater risk of exceeding the RMP significance criteria of a permanent reduction in AUMs greater than 10 percent.

Under Alternative B, the initial 45,516 acres of disturbance would be reduced to about 18,249 acres over the life of the project, resulting in a long-term loss of about 2,122 AUMs. Many of the impacts associated with the Proposed Action would be reduced under this alternative (e.g. dust, controlling the spread of invasive plants, and impacts to range improvements). The two-phase process to identify allotments which are approaching the RMP significance criteria should reduce the risk of allotments exceeding the criteria.

The use of surface-disturbance caps under Alternative C would result in reduced surface impact. During the life of the project, the initial 42,955 acres of disturbance would be reduced to about 17,318 acres, resulting in a long-term loss of about 2,014 AUMs. The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion but, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then some allotments may be at risk of long-term forage reductions in excess of 10 percent.

Under Alternative D, the initial 36,449 acres of disturbance would be reduced to about 14,952 acres over the life of the project, resulting in a long-term loss of about 1,739 AUMs. The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion but, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then some allotments may be at risk of long-term forage reductions in excess of 10 percent.

Because it is assumed that there would be no development under Alternative E, No Action, there would be no new impacts of the type described in the Proposed Action, such as deaths of livestock and damage to fences and other range improvements. Grazing would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of forage caused by dust.

4.18.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Rangeland impacts associated with the CD-C project—a reduction in available forage, reduced forage palatability, negative effects on livestock operations (e.g. leaving gates open, damaged fences and range improvements), accidental injury or death of livestock from vehicle collisions—would continue throughout the life of the project. The most effective mitigation for reduced forage is to minimize the amount of new disturbance. Alternatives C and D would produce the least amount of new disturbance. Impacts would be further reduced with the application of mitigation measures found in **Appendix C** and the successful implementation of current BLM reclamation guidelines and recommendations described in **Appendix E.** The addition of the following measures not found in Appendix C would further minimize impacts to the range:

- The Operators could, in cooperation with the applicable county, establish reasonable speed limits within the project area, such as Carbon County has done on 20 Mile Road south of Rawlins, to enhance personnel safety, reduce fugitive dust, and reduce potential for livestock/wildlife/wild horse collisions
- Heavy equipment exceeding the recommended gross vehicle weight would not be allowed to use cattle guard crossings.

- All gates within the project area would be left as they are found (i.e., open gates would be left open, closed gates would be closed).
- The Operators could coordinate with affected livestock operators to minimize disruption during livestock operations, including lambing/calving season.
- The BLM could require that off-road activity be minimized.
- The BLM could require that no vehicle activity be allowed on recently reclaimed sites (including pipeline rights-of-way), wetland areas, or other sensitive sites.
- Sites undergoing reclamation could be signed at all possible entry sites, especially gathering pipelines that connect several well pads. Signs should state "Authorized Vehicles Only" to allow maintenance work on valves, for example, by responsible Operators.

Where vegetation improvement projects exist, additional acreage may be treated to replace disturbance impacts and balance or reimburse investment costs for the permittees and BLM.

4.19 OIL AND GAS AND OTHER MINERALS

4.19.1 Introduction

The Proposed Action and the action alternatives would involve recovery of natural gas resources, which would cause a loss of reserves in the ground. The recovered natural gas would provide a needed energy resource and would generate private and public revenues.

The occurrence and potential for occurrence of locatable and other leasable mineral resources have been identified in the project area (**Section 3.19**). Although potential for development of those resources is low, their development would not be precluded by the development of the oil and gas resource. Multiple development of public land minerals is anticipated by regulation and the granting of oil and gas leases and permits to develop those leases does not "preclude the issuance of other permits or leases for the same lands for deposits of other minerals with suitable stipulations for simultaneous operation, nor the allowance of applicable entries, locations or selections of leased lands with a reservation of the mineral deposits to the United States." (43 CFR 3000.7) The development of natural gas would in turn require the development of aggregate minerals—sand, gravel, and klinker—for building materials for roads, well pads, and other ancillary facilities.

4.19.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives for mineral resources:

1. Provide for exploration and development of locatable minerals, except in withdrawn areas.
2. Provide opportunities for exploration and development of conventional and unconventional oil and gas, coal, and other leasable minerals.
3. Provide opportunities for exploration and development of salable minerals.

Impacts of the CD-C project would be considered significant if they:

1. caused a substantial reduction in leasing and development of non-oil and gas leasable minerals.
2. caused a substantial reduction in the development of locatable and salable minerals.

4.19.3 Direct and Indirect Impacts

4.19.3.1 Proposed Action and All Action Alternatives

Some deposits of uranium are known to occur within the project area but no development is occurring and none is anticipated in the foreseeable future and so no impacts are expected. The principal leasable minerals found in the project area are coal and natural gas. Coal seams of the Fort Union Formation, the Lance Formation, and the Mesaverde Group are found within and adjacent to the project area but no development is occurring and none is anticipated in the foreseeable future. The Proposed Action and action alternatives are not expected to affect the coal resource in any way.

Development of the natural gas resource would be affected by the Proposed Action and alternatives. Successful natural gas field development would result in the ultimate recovery of the natural gas resource from the target formations, under economic conditions favorable to development, and would substantially increase natural gas supply, regionally and nationally. Under the Proposed Action and all action alternatives, recoverable natural gas reserves produced over the life of the project are estimated at 12.02 Tcf; liquid condensate is estimated at 167.3 million barrels (**Section 4.14.2.2, Socioeconomics**). With this amount of production from the target formations, it is expected that the oil and natural gas resource in the CD-C project area would have been substantially depleted, pending new technology or the discovery of new reserves.

Development of surface mineral material deposits mined in support of CD-C development activities would occur as a result of any of the action alternatives. Construction-grade materials such as sand, stone, gravel, pumice, pumicite, clay, and rock are likely to be obtained from local sources. Currently permitted sources have been identified (**Map 3.19-1**) and other sources are likely to be developed. The total quantities required are not known..

4.19.3.2 Alternative E -- No Action

Under Alternative E, No Action, it is assumed that no new development would take place and no more reserves of natural gas or liquid condensate would be produced in the CD-C project area.

4.19.4 Impact Summary

Under the Proposed Action and all action alternatives, the fluid mineral resources of the CD-C project area would be developed fully—12.02 Tcf of natural gas and 167.3 million barrels of liquids— in the context of known reserves and current extraction technologies. Under Alternative E, it is assumed that the fluid mineral resources would not be developed. Development of surface mineral material deposits mined in support of CD-C development activities would not occur. Deposits of coal and uranium are not expected to be affected by the Proposed Action and the action alternatives.

4.19.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Because no unmitigated adverse impacts are expected, no additional mitigation measures would be necessary.

4.20 HEALTH AND SAFETY

4.20.1 Introduction

Health and safety impacts associated with the action alternatives would be similar to those associated with existing conditions in the project area. As the level of gas development increases in the area the potential for accidents increases due to the number of vehicles, rigs, other heavy equipment, and personnel in the area. The greatest potential for health and safety impacts includes the occupational hazards associated with oil and gas exploration and development, and vehicular travel on improved and unimproved roads.

4.20.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) does not identify any specific health and safety standards or impact significance criteria.

In general, health and safety effects of the action alternatives would be considered significant if they resulted in substantially increased risk to the general public. Health and safety are regulated by state and federal environmental and safety agencies such as the WDEQ, the EPA, OSHA, Wyoming OSHA, and the WOGCC.

4.20.3 Direct and Indirect Impacts

4.20.3.1 Proposed Action

Direct and indirect health and safety risks arising from the Proposed Action include oil and gas occupational hazards, the operation of vehicles on improved and unimproved roads, natural gas pipeline operations, winter driving and working conditions, hunting-related firearms accidents, collisions with livestock and big game, and natural hazards associated with wildfires, flash-floods or winter blizzards. A wide variety of hazardous materials are handled and used in gas-field development and operations activities, resulting in an increased risk of inappropriate use, disposal, or accidental release.

Health and safety impacts to the project workforce include industrial and vehicle accidents. Impacts to the general public are generally limited to an increased risk of traffic accidents. The risk of occupational hazards declines substantially once development activities (drilling and completion operations) are concluded. The risk of vehicle accidents impacting the general public and the workforce may decrease during the field-operations phase depending on the volume of produced water and condensate being transported by truck to disposal or sale.

Hazardous materials storage/use and waste management are stringently regulated by the BLM, EPA, WDEQ and WOGCC, and are discussed in **Sections 3.21 and 4.21**. The risk to human health and the environment from these materials is limited to regulatory non-compliance situations and accidental releases or spills.

Occupational and Public Hazards

Health and safety concerns associated with the Proposed Action would be similar to those described in **Section 3.20**. Implementation of the Proposed Action would likely result in an increased risk to the workforce due to the increased number of personnel in the field, the increase in heavy equipment use and drilling operations, and the resultant increase in vehicle traffic. Compliance with the State of Wyoming Department of Employment Workers Occupational Health and Safety (WOSHA) program rules and regulations for construction and oil and gas well drilling, well servicing, and well special servicing operations would aid in reducing project-related occupational hazards. In addition, the BLM considers safety issues during the APD review process (Onshore Order #1) and reminds the Operator of its occupational health and safety responsibilities in 43 CFR Ch. II, 3162.5-3. Compliance with the OSHA standards works to reduce the opportunity for occupational injuries.

The remote nature of the project area further reduces the opportunity for development and production-related hazards to impact the general public. The public using state and federal highways would be affected by increased levels of traffic, specifically semi/haul truck units related to drilling and completion operations and produced-water and condensate-hauling activities. General public use of lease roads is generally related to livestock activities and recreation, including hunting. Persons pursuing these activities would be at a greater risk of collision with pick-up trucks being driven by field personnel (pumpers and field technicians) and semi-haul trucks. Compliance with WOGCC underground power certification regulations would reduce the opportunity for faulty electrical installations on well sites. In addition, the extremely rural nature of the area and land-ownership patterns (the “Checkerboard”) do not encourage or support residential development, further reducing the opportunity for the public to be affected by underground electrical hazards and other possible hazards.

Pipeline Hazards

Implementation of the Proposed Action would increase the miles of gas-gathering and transmission pipeline installed in the project area as well as the number of natural gas compression and stabilization facilities. Natural gas transmission and gathering pipeline operations are regulated by the federal Office of Pipeline Safety (OPS). Operators of the gas-transmission infrastructure are required to comply with the applicable OPS regulations including implementing stringent system maintenance programs, emergency response planning, risk-management planning, and task specific personnel training in operations and maintenance for each natural gas pipeline system. Compliance with the OPS program requirements reduces the opportunity for pipeline accidents and, likewise, the risk to the general public and employees.

Other Risks and Hazards

The opportunity for accidents involving the general public and the workforce increases as the volume of activity in the field and on the road increases. All actions required to implement the Proposed Action would result in some increased level of risk to the general public and the workforce. Effective contractor and personnel training, emergency-response planning, and coordination with emergency responders should reduce the risks associated with field development and operations.

Highway and road-safety impacts related to the Proposed Action and alternatives are discussed in **Section 4.16 Transportation**. There are inherent risks associated with the operation of vehicles on improved and unimproved roads. Awareness training alerts field personnel to variable road-surface conditions including the risk of collision with the general public, livestock, and wildlife. As a result of greater access to previously inaccessible areas, the public may also be exposed to hazardous driving conditions and wildlife on the roads. With the exception of semi-haul trucks, the public would be exposed to these same hazards wherever they were recreating; the hazards of backcountry recreation are not limited to the project area.

The public would be exposed to an increased number of large vehicles on county roads and state and federal highways resulting in a greater risk of being involved in an accident. For example, the number of semi trucks needed to accomplish a fracking operation is substantial; when multiplied by 600 wells being completed each year the number of additional large trucks on the roadways is also substantial. The drivers of these commercial big-rigs are required to hold commercial driver's licenses with special operations endorsements and receive training prior to operating such vehicles; however, this does not preclude the possibility of accidents.

Weather-related hazards due to winter driving and working conditions could impact the general public and the workforce.

Natural or accidental fires also pose a risk to the workforce and the public. Adherence to the BLM seasonal fire restrictions and the OPS pipeline regulations would reduce the opportunity of fire-related injury and property loss. Fire as a result of natural gas development and production activity would likely result in damage to the field equipment and the range resource. The opportunity for privately owned structures to be involved in such incidents would be limited; very few privately owned structures exist in the project area outside of Wamsutter.

Hunting-related firearms accidents would be a remote possibility. Site workers are generally proximal to field infrastructure and conscientious hunters avoid shooting toward facilities. The hunting public is at risk for such accidents regardless of where they are hunting. Operations personnel and contractors are not allowed access to firearms when working.

Risk to the public as a direct result of development and production operations is limited. Harm caused by extreme noise events would be limited to situations when individuals might place themselves in close proximity to the noise-emitting operation; noise is discussed in greater detail in **Sections 3.17** and **4.17**.

4.20.3.2 Alternative A: 100-Percent Vertical Drilling

The impacts of implementing Alternative A would be the same as those resulting from the Proposed Action with the exception that drilling vertical wells could result in fewer days of concentrated drilling activity per well when compared to drilling directional and pad wells and, therefore, a slightly lower risk of occupational hazard exposure for the drilling workforce.

4.20.3.3 Alternative B: Enhanced Resource Protection

The impacts of implementing Alternative B would be the same as those resulting from the Proposed Action.

4.20.3.4 Alternative C: Surface Disturbance Cap – High and Low-Density Development Areas

The impacts of implementing Alternative C would be the same as those resulting from the Proposed Action with the exception that travel-related risks to the recreating public may be higher in high-density development areas when compared to low-density development areas.

4.20.3.5 Alternative D: Directional Drilling

The impacts of implementing Alternative D would be the same as those resulting from the Proposed Action. The implementation of the Directional Drilling requirement could slow down development to the extent that it reduces, somewhat, road travel risk to the public.

4.20.3.6 Alternative E: No Action

Under the No Action alternative, occupational health and safety exposure to site workers and exposure to the public would be greatly reduced because it is assumed that no new wells would be drilled. Some exposure would still exist with ongoing production activities.

4.20.4 Impact Summary

The Proposed Action and all action alternatives would result in similar impacts to the public and site workers including increased risk of vehicle collisions on interstate highways and local road systems.

4.20.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Any increase in the volume of activity in the natural gas field required to implement the Proposed Action and alternatives would increase the risk of accidents and injury to the workforce from project-related activities as well as weather-related incidents, wildfires, and increased noise levels. The resulting increase in traffic using the local transportation network would increase the risk of vehicle collisions with other vehicles, wildlife, and livestock for the workforce as well as the general public. However, effective contractor and personnel training, emergency-response planning, and coordination with emergency responders should reduce the risks associated with field development and operations. The level of risk would be highest during project development.

The operating companies and their contractors are obligated to operate in compliance with applicable local, state, and federal regulations. The BLM recognizes these authorities and requires compliance with the applicable regulations.

In addition to required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**), the following mitigation measure would further reduce risks to human health and safety for the workforce and the public:

- Consider cooperatively permitting and operating in-field liquids-gathering and road systems.

4.21 WASTE AND HAZARDOUS MATERIALS

4.21.1 Management Objectives and Impact Significance Criteria

Appendix 32 to the Rawlins RMP (BLM 2008a) sets out objectives for the Hazard Management and Resource Restoration Program (HMRRP), an administrative program that emphasizes management of hazards on public lands to reduce risks to visitors and employees, restore contaminated lands, and carry out emergency response actions. The HMRRP contains the following objectives:

1. Identify and control imminent hazards or threats to human health and/or the environment from hazardous substance releases on public lands.
2. Promote working partnerships with states, counties, communities, other federal agencies, and the private sector to prevent pollution and minimize hazardous waste on public lands.
3. Provide hazardous materials management training to BLM employees and educate public land users concerning laws, rules, and standards.
4. Require potentially responsible parties to undertake response actions and to pay their fair share or face cost recovery.
5. Encourage public collaboration in environmental decision-making.
6. Inventory, assess, and manage the cleanup of hazardous substance release sites on public lands that present a potential risk to human health and/or the environment, and promote healthy ecosystems.
7. Ensure that solid and hazardous waste treatment, storage, and disposal facilities that might affect public lands are properly located, designed, and constructed, consistent with the law, as well as prohibit Resource Conservation and Recovery Act (RCRA) temporary storage facilities on public lands.
8. Reduce hazardous waste produced by BLM activities and from authorized uses of public lands through waste minimization programs that include: recycling, reuse, substitution, and other innovative, safe, and cost-effective methods of pollution prevention.
9. Ensure that authorized activities on public lands comply with applicable federal, state, and local laws, regulations, policies, guidance, and procedures.
10. Ensure appropriate review of authorized activities and application of effective management controls to correct weaknesses.

No specific waste and hazardous materials standards were identified in the Rawlins RMP; however, IM WY-2012-007, Management of Oil and Gas Exploration and Production Pits, includes several standards for waste management from oil and gas operations. This far-reaching IM is not restricted only to issues related to pit management. In general, waste and hazardous materials effects of the action alternatives would be considered significant if they resulted in substantially increased risk to the public.

4.21.2 Direct and Indirect Impacts

4.21.2.1 Proposed Action

Waste Management

Waste management impacts resulting from the Proposed Action would be similar to those currently in place in the project area. Most wastes that would be generated at project locations are exempt from regulation by the RCRA under the oil and gas exploration and production exemption and are considered to be solid wastes. Compliance with all applicable state and federal hazardous substance and waste-management regulations should minimize the threats to human health and the environment from generated waste streams (refer to **Section 3.20.1**).

Drilling wastes (mud and cuttings) would be generated from the drilling of each well. Fresh water/gel drilling mud would be used and reserve pits lined when site-specific conditions dictate. Oil-based fluid drilling would occur minimally and only in closed-loop drilling fluid systems. Reserve pit fluids (mud and water) would be recycled as much as possible to reduce water consumption and conserve mud products. Typically reusable fluids are transported and used to drill additional wells while the cuttings or solids are allowed to dry in the reserve pit before being buried onsite. If used, liners would also be buried onsite. In some situations the cuttings are solidified prior to burial, as allowed in the WOGCC regulations and with BLM approval. On multi-well pad sites the reserve pit would be used for all wells on the pad before being closed. Some Operators use closed-loop drilling fluids systems that reduce the need for reserve pit capacity and facilitate more efficient recycling and reuse of mud products. Reserve-pit management varies by Operator, contractor, and location. Commercial drilling mud-disposal facilities are limited and are experiencing disposal capacity problems. Reserve pits are fenced on three sides during operations and on the fourth side once the drilling rig moves off the location.

Completion/stimulation fluids recovered during flow-back and subsequent production operations would be temporarily contained in completion, flare, or reserve pits, depending on site design and APD approval conditions. These fluids would ultimately be disposed of at evaporation ponds or disposal wells or evaporated onsite. Well bore construction (cement, casing, perforation, pressure testing, etc.) is designed and authorized to preclude the opportunity for completion fluids to impact groundwater or non-target hydrocarbon-bearing zones.

Produced water from conventional wells would continue to be managed as described in **Section 3.21.1**. Produced-water injection is currently used on a limited basis in the project area. The anticipated volume of water produced per well is relatively low at an average of 18 barrels of water per day. However, given the number of additional wells to be drilled, the volumes anticipated are significant. The BLM considered requiring injection of produced water as the preferred method of management; however, the Operators have not been able to identify a reservoir that is capable of taking water at the volumes needed by the production rates projected in the area. Thirty additional water-injection wells are planned by the Operators to handle the anticipated volume of produced water, but injection appears to have limited potential for use within the overall project area. Some Operators currently have water evaporation ponds, which may need to be enlarged due to the increased volume of water produced. An additional 20 produced-water management facilities (i.e. evaporation ponds) are anticipated. Commercial water-disposal operations may also need to enlarge their facilities, as capacity is already limited. Produced water would be transported to off-site facilities by pipeline or truck when not managed at the well site. Produced water of appropriate quality would be used in drilling-mud systems and completion operations; this would reduce the volume of water to be disposed as well as the volume of fresh make-up water needed from other sources (water wells, etc.). Other produced-water disposal and re-use options, such as sub-irrigation drip systems, are being developed and would be considered by the BLM on a case-by-case basis. CBNG produced-water disposal considerations are discussed below.

Avian mortality can be an issue in produced-water disposal pits due to salinity in the water and possible hydrocarbon contamination from condensate carryover. Typically, these facilities are fenced to preclude entry by wildlife. Flagging, netting, or other bird-deterrent devices are the most commonly used methods for achieving compliance with the Migratory Bird Treaty Act and WOGCC regulations. Concern continues as to the effectiveness of these deterrents; the BLM staff advocates the use of netting to preclude or reduce avian losses.

Solid, non-hazardous wastes generated at drilling locations, man camps, and construction sites would continue to be handled as they are currently. Non-hazardous solid wastes would be accumulated in containers (dumpsters, trash cages, etc.) and hauled by commercial contractor to permitted disposal facilities. Alternative WDEQ-permitted disposal sites would need to be identified as local municipal solid-waste disposal facilities are experiencing capacity shortages and some are no longer accepting non-household waste. The need to access alternative disposal sites located further from the development area results in waste being hauled longer distances at greater cost to the companies and risk to the traveling public.

Industrial non-hazardous and/or exempt hazardous waste such as used glycol, antifreeze, lubricating oil, and batteries are recycled through third-party permitted companies or, as in the case of used lube oils, are legitimately recycled into crude-oil streams, when applicable and appropriate.

In the rare instance that hazardous waste is produced it would be managed as required in the RCRA regulations. The BLM does not allow disposal of hazardous waste on federally managed lands; the WDEQ Solid and Hazardous Waste Disposal (WDEQ SHWD) program is the appropriate regulatory authority for these waste streams. Disposal of hazardous wastes in reserve pits is not allowed by any agency.

Sanitary wastes would be transported by commercial contractors to permitted facilities. Alternatively, some permanent and long-term temporary facilities (such as man camps and field offices) would have approved septic systems in place. It can be anticipated that capacity concerns would arise relative to local municipal sanitary-waste disposal facilities.

Commercial disposal facilities are typically located on privately owned lands and are permitted through the WOGCC and/or WDEQ. The current and anticipated levels of development activity and the resultant waste-disposal demand would result in a reduced design life for permitted facilities (municipal or commercial), necessitating the enlargement of existing sites or the permitting and construction of additional facilities.

CBNG Produced-Water Management

Coalbed natural gas (CBNG) development has different produced-water management issues when compared to conventional gas production. The greatest of these concerns are the volume of water produced and the quality of the water, both of which depend on the producing formation. Various produced-water management scenarios would be considered by the BLM in project-specific NEPA analysis if and when proposals are brought forward by CBNG proponents in the project area. Technological advances may make it possible to separate water and gas down-hole, thereby reducing the volume of water removed and managed on the surface. As with conventional produced water, CBNG water may be used for drilling and completion operations, if the water quality is appropriate.

Hazardous Materials

Hazardous materials are used in drilling, field development, construction, completion, and production operations. Implementation of the Proposed Action would result in the increase in hazardous materials being transported, stored, and used in the project area. IM WY-1994-081, IM WY-1997-011 and WY-94-059 require that NEPA documents list and describe any hazardous or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project, this compilation can be found in **Appendix K, Hazardous Materials Management Summary**. The quantities of hazardous substances used in the development or operation of wells would be kept in limited quantities on all sites and at the production facilities as needed for operations. None of the chemicals that would be used meet the criteria for being an extremely hazardous material/substance (40 CFR 355) or meet the quantities criteria per IM WY-93-344. Materials would not be stockpiled at well locations.

Each Operator (and its subcontractors as applicable and appropriate) is required to comply with the following state and federal programs which are intended to reduce risk to human health and the environment from the use, storage, and transportation of hazardous materials. Implementation of the Proposed Action would require updating these program plans. Compliance with and implementation of the required plans would reduce the risk to human health and the environment from hazardous material releases in the project area.

- A **Hazard Communications Program** (Haz-Com or Worker Right-to-Know) is required by OSHA and is intended to reduce the risk of occupational exposure to hazardous materials.
- A **Community Right-to-Know** (the Superfund Amendments and Reauthorization Act, or the Emergency Planning and Community Right-to-Know Act), required by the EPA, is intended to provide state and local emergency responders with information regarding the material hazards, location, and volumes of material that may be encountered when responding to an emergency.
- **Spill Prevention, Countermeasure, and Control Plans** are required by the EPA and are intended to preclude the release of oils, such as diesel fuel, gasoline, crude oil, or condensate, into the waters of the United States; these plans must also provide response actions to be taken, and notifications to be made, in the event a release occurs.
- **Emergency Response Plans** are required by the BLM; these plans provide the BLM and operations personnel information about actions to be taken in the event an emergency situation (accidental fire, chemical or oil releases, well blow-out, etc.) should arise. These documents would be updated to include increased operations resulting from implementation of the Proposed Action.

4.21.2.2 Alternative A: 100-Percent Vertical Drilling

The impacts of implementing Alternative A would be the same as those resulting from the Proposed Action with the exception that drilling 100-percent vertical wells could result in a larger volume of drilling fluid being used in the development of the field.

4.21.2.3 Alternative B: Enhanced Resource Protection

The impacts of implementing Alternative B would be the same as those resulting from the Proposed Action except in the defined ERP areas. In these areas, stipulations for enhanced protection could result in concentration of buried reserve pit wastes in cluster development areas and could result in a reduction of vehicle traffic due to the consideration of pipelines to transport produced materials (condensate, produced water, etc.) out of the ERP area.

4.21.2.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

The impacts of implementing Alternative C would be the same as those resulting from the Proposed Action with the exception that the low-density drilling areas could realize a reduced volume of materials produced, transported, or disposed of in those areas of the project area compared to the high-density development areas.

4.21.2.5 Alternative D: Directional Drilling

The impacts of implementing Alternative D would be the same as those resulting from the Proposed Action with the exception that the requirement to drill all wells directionally from a single pad or existing location per section would likely extend the amount of time required to drill and complete each well therefore extending the time period over which development activities occur. While a slowing in project area development activities and associated waste generation may serve to extend the life of existing disposal facilities, the directional requirement may increase the volume of fluids needed for drilling operations but may also make recycling and re-use of these fluids more feasible.

4.21.2.6 Alternative E: No Action

Waste and hazardous material management activities would be greatly reduced because it is assumed that no new wells would be drilled. Some activities would still exist in support of ongoing production activities.

4.21.3 Impact Summary

Currently authorized and approved actions, which would continue under the No Action alternative, are already exerting stress on the permitted and authorized disposal facilities proximal to the project area. Authorization of the Proposed Action or Alternatives A through C would result in further stress to the capacity of permitted waste management units used by the operating companies, including those used for management of solid waste, produced water, and drilling mud. Alternative D may serve to extend the life of some existing disposal facilities because the increase in directional drilling would result in greater recycling of drilling mud and other on-site materials.

4.21.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Implementation of the Proposed Action would result in an increase in hazardous materials being transported, stored, and used in the project area, and therefore in an increased risk of spills or other accidental releases of these materials. These increased risks would primarily occur during project development. Although the BLM discourages the use of produced water pits, they can be permitted when necessary. Avian mortality may occur in produced-water disposal pits due to salinity in the water and possible hydrocarbon contamination from condensate carryover, despite the use of netting. This increased risk would occur throughout the life of the project.

The operating companies and their contractors are obligated to operate in compliance with applicable local, state, and federal regulations. The BLM recognizes these authorities and requires compliance with the applicable regulations. In addition to required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**), the following mitigation measure would further reduce risks resulting from the generation of waste and the use and transport of hazardous materials:

- Consider cooperatively permitting and operating in-field disposal facilities for solid waste, produced water, drilling mud, and other activities as feasible.

5. CUMULATIVE IMPACTS

Council on Environmental Quality (CEQ) regulations require an assessment of potential cumulative impacts. Cumulative impact is defined by those regulations at 40 CFR 1508.7 as:

> *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

Cumulative impacts for each affected resource are assessed in this section. The discussion of potential cumulative impacts assumes the successful implementation of the environmental protection and mitigation measures described in **Appendix C** and **Chapter 4** of this EIS, as well as compliance with the Rawlins RMP and all applicable federal, state, and local regulations and permit requirements. The analysis of cumulative impacts addresses both potentially adverse and beneficial impacts.

The cumulative impact analysis area for the CD-C project generally includes south-central Wyoming but is variable for each resource. No single geographic unit would serve as a cumulative impact analysis area for all resources. The Air Quality analysis, for example, analyzes cumulative impacts over an area that includes all of southwestern Wyoming and parts of Colorado, Utah, and Idaho. The Geology cumulative analysis, on the other hand, is concerned only with the CD-C project area itself. For the cumulative analysis in this draft EIS, each resource analysis includes a definition of the area considered in its cumulative impact analysis.

The cumulative impact analysis has an estimated future timeframe of 45 years—the 15-year period of development plus the 30- to 40-year operational life of a producing well. As with the impact analysis area, the time frame for cumulative impact analysis will vary from one resource to another. Each resource analysis section describes the approximate time frame during which cumulative effects would occur.

The “past, present, and reasonably foreseeable future actions” most commonly associated with the CD-C project area and south central Wyoming in general are grazing, transportation, and natural gas development. Livestock grazing—both sheep and cattle—began in the 1870s, continues today, and is expected to continue into the future. Sheep numbers have declined from their peak in the early part of the 20th century but cattle numbers remain high.

The area has been traversed by trails since humans first came to the area, and today includes major east-west and north-south transportation and utility corridors used for roads, railroads, and pipelines. The Overland and the Cherokee Trails—historic passageways—cross the area. The first transcontinental railroad, the Union Pacific, came to the area in the 1860s and still operates today, with heavy freight traffic crossing east and west. The nation’s first transcontinental highway, the Lincoln Highway, was built in the same corridor as the railroad in the early part of the 20th century. It has been replaced by Interstate 80 (I-80), which will remain a major east-west transportation route into the future. WY 789 and several county roads are the main north-south routes in the area. The Wamsutter hub is a major connection point for the many natural gas pipelines that traverse the area east-west and north-south.

Natural gas development in the CD-C project area and the surrounding area has been ongoing since the 1950s. The Wamsutter field, the first natural gas field in the area, was established in 1958. Since then, the rate of development has varied but has proceeded at the rate of about 200 wells per year since 2008. Prior development and existing activities within the project area are described in the introduction to Chapter 4, Environmental Consequences (**Section 4.0.1**). The 47,200 acres of new surface disturbance anticipated by the CD-C Natural Gas Development Project would be added to 56,647 acres of surface disturbance that has already occurred within the area. The CD-C project impacts for each of the resources and activities discussed in Chapter 4 are described in the context of those disturbances and impacts that have already occurred in the project area. Those discussions will not be repeated here. There are other defined areas in south-central Wyoming—the Atlantic Rim and the Hiawatha project areas, for example—where natural gas has historically been produced and will continue to be produced. Those will be discussed in this section to the extent that they are relevant. **Table 5.0-1** describes the principal natural gas projects that are ongoing or that are in planning. **Map 5.0-1** shows energy development projects that are ongoing or in the planning stage.

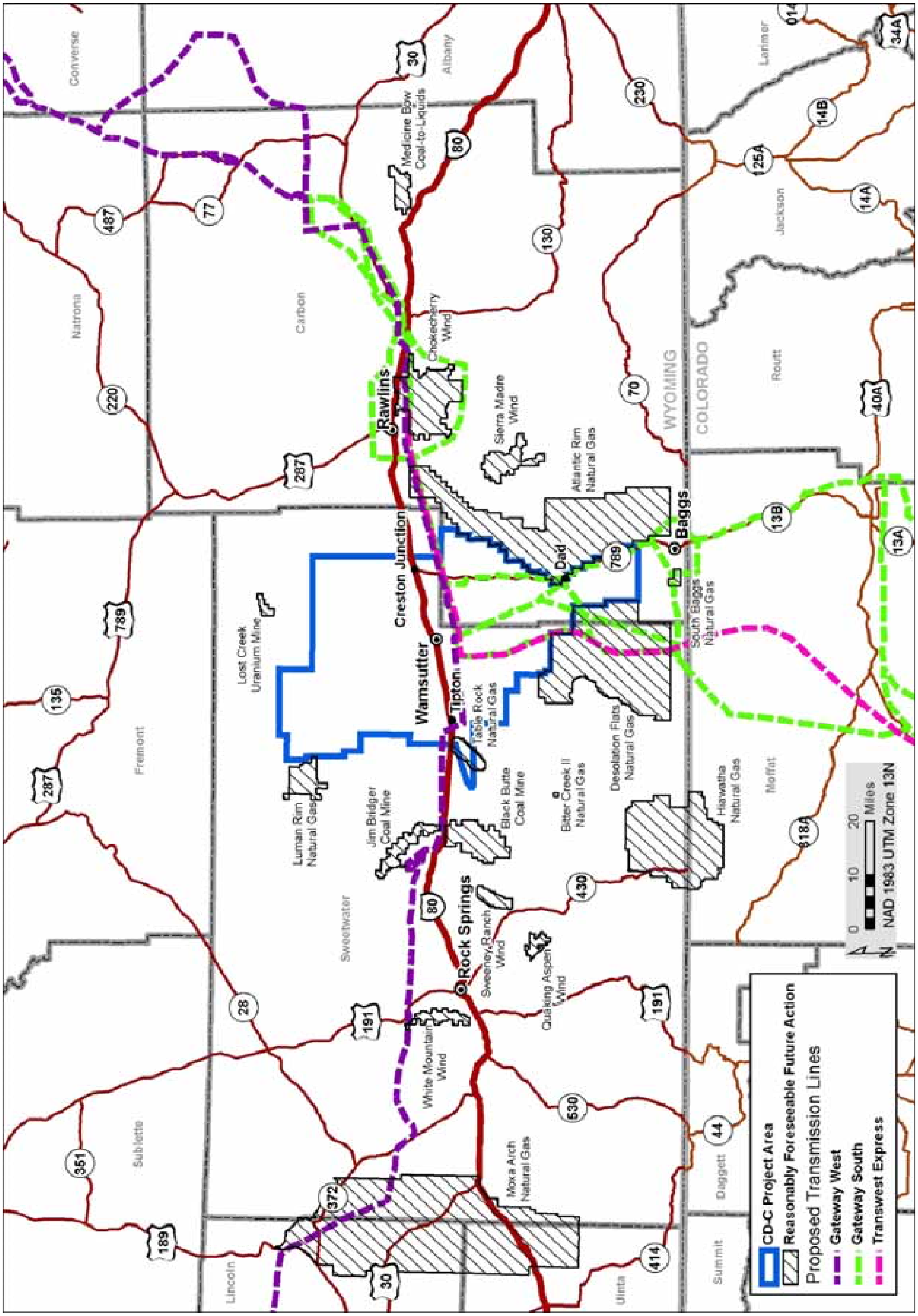
In addition to natural gas activities, **Table 5.0-1** also describes reasonably foreseeable future wind energy development projects, mining activity, and major electric transmission lines and industrial development projects.

Table 5.0-1. Ongoing and Reasonably Foreseeable Future Actions (RFFAs)

Project	Proponent	Location	County	Development Schedule	Scale
Natural Gas					
Atlantic Rim Natural Gas Field Development	Anadarko Petroleum Corporation and others	East of and adjacent to CD-C project area	Carbon	2007–2027	2,000 wells/270,080 acres
Beaver Creek Natural Gas Development Project	Devon	9 miles southeast of Riverton	Fremont	2013–2023	228 wells/16,515 acres
Bitter Creek Shallow Oil and Gas Project	Infinity / Yates Petroleum	30 miles east of Rock Springs between Bitter Creek and Point of Rocks	Sweetwater	2005–2009	61 wells/17,961 acres
Desolation Flats Natural Gas Development Project	Marathon Oil and others	Southwest of and adjacent to CD-C project area	Sweetwater/Carbon	2004–2024	385 wells/233,542 acres
Gun Barrel, Madden-Deep, Iron Horse (GMI) Natural Gas Development Project	EnCana Oil & Gas, Burlington Resources and Noble Energy	60 miles west of Casper	Fremont/ Natrona	2013–2043	3,500 wells/500,000 acres
Hiawatha Regional Energy Development Project	Questar/ Wexpro	65 miles southeast of Rock Springs	Sweetwater/Moffat CO	2013–2043	2,200 wells/157,361 acres
LaBarge Gas Exploration and Development Project	EOG Resources, Inc and others.	65 miles northwest of Rock Springs	Lincoln/ Sublette	2013–2023	838 wells/218,000 acres
Luman Rim	Yates Petroleum and others	Northwest of and adjacent to CD-C project area	Sweetwater	2011–2021	58 wells/19,548 acres
Moxa Arch Area Infill Gas Development Project	BP America and others	Northeast of Fort Bridger	Uinta/Lincoln/ Sweetwater	2013–2043	1,860 wells/476,300 acres
Normally Pressured Lance Natural Gas Development Project	EnCana and others	Immediately southwest of the Jonah Field	Sublette	2014–2026	3,500 wells/141,080 acres
Table Rock Unit Oil and Gas Development	Chevron U.S.A.	40 miles east of Rock Springs (partly in CD-C)	Sweetwater	2013–2027	88 wells/13,633 acres
Wind Energy					
Bridger Butte Wind Energy Project	Bridger Butte Wind Power LLC	West of Fort Bridger	Uinta	2021–	120 turbines/13,286 acres
Chokecherry and Sierra Madre Wind Energy Project	Power Company of Wyoming	South of Rawlins	Carbon	2012–2015	1,000 turbines/215,000 acres
Sweeney Ranch Wind Park	Sweeney Ranch Wind Park, LLC	15 miles southeast of Rock Springs	Sweetwater	2013–2016	150 turbines/5,360 acres
White Mountain Wind Farm	Teton Wind	Near Rock Springs	Sweetwater	2012–2018	240 turbines/ 13,165 acres

Table 5.0-1. Ongoing and Reasonably Foreseeable Future Actions, *continued*

Project	Proponent	Location	County	Development Schedule	Scale
Wind Energy, continued					
Quaking Aspen Mountain Wind Farm	Evergreen Wind Power Partners, LLC	11 miles SE of Rock Springs	Sweetwater	Unknown	38 turbines/ 5,157 acres
Transmission Lines					
Gateway West Transmission Line Project	Idaho Power and Rocky Mountain Power Companies	Glenrock, Wyoming to Melba, Idaho	Converse/ Albany/ Carbon/ Sweetwater and west	2014–2018	~500 miles
Gateway South Transmission Line Project	Rocky Mountain Power Company	Medicine Bow, Wyoming to Mona, Utah	Converse/ Albany/ Carbon/ and southwest	2017–2020	~400 miles/250’ ROW
TransWest Express Transmission Line Project	TransWest Express (Anschutz subsidiary)	Sinclair, Wyoming to southern Nevada	Carbon and southwest	2013–2016	~600 miles250’ ROW
Mining					
Lost Creek In Situ Uranium Project	UR Energy (Lost Creek ISR LLC)	15 miles southwest of Bairoil	Sweetwater	2011-2024	4,250 acres
Bridger Mine Expansion	Idaho Energy Resource Company/Pacific Minerals	North of Point of Rocks	Sweetwater	2011–2031	To keep mine operating at current level
Other					
Medicine Bow Fuel & Power Coal-to-Liquids Project	Medicine Bow Fuel & Power	South of Medicine Bow	Carbon	2014–	20,000 bbl/day



Map 5.0-1. Reasonably foreseeable future actions in the cumulative impact analysis area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

■ PHYSICAL ENVIRONMENT

5.1 GEOLOGY

The cumulative impact analysis area (CIAA) for geology is the CD-C project area. Geologic resources are not expected to be impacted by activities that occur outside the project area nor would implementation of CD-C project activities have impact outside the area. Cumulative impacts would be limited to past and ongoing oil and gas extraction, grazing, and transportation activities within the project area. Geological resources have not been significantly affected by past and continuing activities in the project area and are not expected to be notably affected by any future activities if mitigation measures described in **Appendix C** are implemented.

5.2 PALEONTOLOGIC RESOURCES

The CIAA for paleontology is the CD-C project area. Paleontological resources are not expected to be impacted by activities that occur outside the project area. Cumulative impacts would be limited to past and ongoing oil and gas extraction, grazing, and transportation activities within the project area. Paleontological resources have not been significantly affected by past and continuing activities in the project area and are not expected to be notably affected by any future activities if mitigation measures described in **Appendix C** and **Section 4.2.5, Unavoidable Adverse Impacts and Additional Mitigation Measures**, are implemented.

5.3 SOILS

The CIAA for soils is the CD-C project area. Past, present, and future actions would incrementally increase soil disturbances and soil productivity for the lifetime of development and gas production in the project area, approximately 45 years. The cumulative losses for soil resources would occur due to 47,200 acres of new surface disturbance in addition to 60,176 acres of historic surface disturbance related to natural gas development and other activities. The increased surface disturbance for the Proposed Action would represent a 78-percent increase relative to that for historic development, although the impacts would be mitigated by successful implementation of interim and final reclamation during the life of the project. The 47,200 acres of new disturbance under the Proposed Action is approximately 44 percent of the cumulative disturbance for the project area soils.

Impacts to soils in the project area related to the Proposed Action and various alternatives are described in **Section 4.3.3** of the EIS. Post-reclamation disturbances for the Proposed Action and various alternatives would be relatively low and successful reclamation would reduce the cumulative impacts to the soil resource that may result from the Proposed Action or the alternatives. Impacts to soil productivity, vegetation, and surface water would be more severe during development and production and would diminish during final reclamation and the post-reclamation phase of the project. Implementation of Best Management Practices (BMPs) to reduce erosion and sedimentation and promote revegetation would be used to reduce cumulative impacts.

Cumulative impacts to project area soils include past, present, and future actions that would affect surface-water quality due to erosion and sediment discharge, and increased surface disturbances that reduce soil productivity prior to successful reclamation. The geographic area of soils-related cumulative impacts includes surface disturbances within the project area in addition to the water quality related impacts.

The northern 70 percent of the project area is located in the Great Divide Basin, a closed basin which is bounded by the Continental Divide. Impacts from erosion and sediment within the basin are generally low and dependent upon localized soils and terrain. Since surface water would not discharge outside of the closed basin, impacts from erosion and sediment would not affect any other watershed. Future actions that would result in cumulative impacts within the Great Divide Basin include the Luman Rim Natural Gas Development located northwest of and adjacent to the project area.

The southern portion of the project area is primarily drained by Muddy Creek and its tributaries which are part of the Little Snake River Basin. The Muddy Creek Sub-basin has been historically impacted and is listed in the 2010 Wyoming 303(d) List as either not supporting or threatened for aquatic life, non-game fish and cold-water game fish (WDEQ 2010). Unstable stream channels and loss of riparian function have occurred throughout the basin due to season-long riparian grazing and accelerated erosion associated with oil and gas activities. In upper Muddy Creek the Little Snake River Conservation District (LSRCD), BLM, landowners, grazing permittees, Wyoming Game and Fish (WGFD), and other stakeholders have been involved in Coordinated Resource Management since 1992 including several Section 319 watershed improvement projects. These projects have included upland water development, cross fencing, and vegetation and grazing management. Deferred grazing has also been implemented in the Grizzly Wildlife Habitat Management Area to promote restoration of watershed function. LSRCD and WGFD data indicate that improvement to stream stability, aquatic habitat and riparian areas has resulted from both of these projects and several reaches in Muddy Creek, Littlefield Creek, and McKinney Creek are meeting their aquatic life uses and have been removed from the 303(d) list. These projects are located in the Upper Muddy Creek Drainage outside of the project area.

The LSRCD and other stakeholders have also implemented another watershed improvement project to address physical degradation of the Muddy Creek stream channel, which threatens aquatic life-use support. This project is located along Muddy Creek on the west side of WY 789 in the project area and includes wetlands development, reestablishment of the floodplain and irrigation water management. This project has resulted in improving trends in riparian condition and bank stability.

Future actions that would result in cumulative impacts to the Proposed Action within the Muddy Creek Sub-basin include the Desolation Flats Natural Gas Development Project located adjacent and southwest of the project area, and the Atlantic Rim Natural Gas Field Development located east of and adjacent to the project area.

5.4 WATER RESOURCES

The CIAA for water resources includes two components: (1) an analysis of cumulative impacts within the CD-C project area and (2) an analysis of cumulative impacts on portions of the watersheds that are associated with the CD-C project area. The cumulative surface water impacts analysis area includes portions of the White-Yampa, Great Divide, and the Upper Green drainage basins. The cumulative groundwater impact analysis area includes portions of the Green River, Great Divide, and Washakie structural basins, the Rock Springs and Rawlins uplifts, and the Wamsutter Arch. Cumulative impacts include water resource impacts from past, present, and reasonably foreseeable future oil and gas developments, agriculture (irrigated crops, livestock grazing, and ranch management), recreational activities/vehicular traffic, and other mining and industrial activities.

5.4.1 Cumulative Impacts Common to the CD-C Project-Specific and Watershed Analysis Areas

Surface Water. All action alternatives would result in increased natural gas development in the CD-C project area, with the difference between alternatives being the magnitude of disturbance. Including the CD-C project, there are 12 currently operating or planned oil and gas development projects within the CD-C larger watershed analysis area. The projects with the greatest potential to contribute to cumulative impacts to surface water resources would be the CD-C project and the Atlantic Rim Natural Gas Development Project. These projects are adjacent to Muddy Creek, which as discussed below, is under special protection by the State of Wyoming. Historic development in the project area accounts for 60,176 acres of initial disturbance and 17,663 acres of long-term disturbance. Total historic development in the watershed analysis area has not been calculated. The Proposed Action and the alternatives would add disturbance of between 36,499 acres (Alternative D) and 61,696 acres (Alternative A). The long-term disturbance would range from 14,952 to 24,133 acres. The main cumulative impacts to surface-water resources from oil and gas development would be brought about by contamination of surface water from both authorized and accidental surface discharge of fluids and the impacts (including sediment loading) from surface disturbance related to project development/maintenance. These cumulative impacts would be greatest within the CD-C analysis area but the contamination of surface water and off-site sedimentation would extend downstream of the CD-C watershed analysis area. As part of the Atlantic Rim project, Upper Muddy Creek is currently monitored for sediment delivery from eroding streambanks, measurement of habitat features and stream geomorphology, and measurement of sediment concentrations and other water quality parameters.

Agriculture (irrigated crops, livestock grazing, and ranch management) and other natural resource uses within the cumulative impact analysis areas would result in increased surface runoff, accelerated erosion, and off-site sedimentation that would cause channel instability and degradation of surface-water quality. Because livestock tend to concentrate around available sources of water (stock reservoirs, stock tanks associated with water wells, and flowing streams) there would be localized effects in these areas, which could lead to greater erosion where anthropogenic surface disturbances and livestock concentration areas overlap. Two portions of Muddy Creek, which is within the White-Yampa watershed (**Map 3.4-1**), are now listed on the State 303(d) list of Impaired or Threatened Waterbodies due to habitat alteration, primarily due to livestock grazing (WDEQ 2012) and exacerbated by oil and gas development. The Little Snake River Conservation District (LSRCD) has been working through a Coordinated Resource Management (CRM) process with the BLM, landowners, grazing permittees, WGFD, and other stakeholders since 1992 to address these water quality and riparian habitat problems. As part of the CRM process, LSRCD has managed several Section 319 watershed improvement projects in the upper Muddy Creek drainage. According to WDEQ, the projects have resulted in considerable improvement to stream stability, aquatic habitat and riparian health, especially in the upper Muddy Creek tributaries (WDEQ 2012). While the CRM process is no longer formally in place, the beneficial effects are still being realized. Although not agricultural in nature, accelerated erosion associated with oil and gas activities within the Muddy Creek sub-basin has been identified as having a role in exacerbating the degradation of lower Muddy Creek. Surface water impacts would be considered significant for at least one surface-water significance criterion through cumulative impacts if the Proposed Action or any of the action alternatives were selected. Cumulative surface water impacts would not be considered significant for Alternative E.

Recreational activities and vehicular travel would have minimal effects on surface water, but could be more pronounced in localized areas due to off-road travel and additional access provided by resource development. Off-road travel in drainage areas would cause local impacts to surface waters. Impacts could be more significant where there is continuous federal land and the project improves or creates new access. Recreational activities and off-road travel are not expected to have significant effects on surface-water resources and would not contribute to the significance impacts discussed in **Section 4.4.4**.

Other industrial activities (i.e., mining, wind energy development, and construction of power transmission lines) would impact surface-water quality in localized areas within the cumulative impact area. The proposed Gateway West, Gateway South, and TransWest Express transmission line projects would cross the cumulative impact analysis areas and would have the potential to affect surface water during construction, operation, and decommissioning of the projects, particularly where the transmission corridors cross drainages. The BLM is the lead federal agency for the NEPA process for these proposed projects.

Groundwater. As discussed in **Section 5.0**, natural gas development in the project area and the surrounding region has been ongoing since the 1950s. Since initiation of drilling, over 4,400 natural-gas wells have been drilled. All of the action alternatives would result in the same number of new wells drilled (8,950 natural gas and 30 injection), with the difference being the number of well pads and the extent of required access roads and pipelines needed for resource development. Cumulative groundwater impacts would occur during the removal of groundwater; from improper drilling operations; from accidental releases of fluids (spills) associated with drilling and fracturing operations, produced water, and other hazardous liquids to soils and surface-water systems; and through subsurface disposal (injection) of produced water. These impacts are the same as the project specific impacts described in **Section 4.4.4**. Cumulative groundwater impacts are not expected to be significant and would not contribute to the significance impacts discussed in **Section 4.4.4**.

5.4.2 Cumulative Impacts within the CD-C Project Area

Surface Water. The types of cumulative surface-water impacts would be the same as those discussed in **Section 5.4.1**. Disturbance related to current oil and gas development has already occurred. Cumulative impacts, particularly from the CD-C and Atlantic Rim projects, would exacerbate current degradation on Muddy Creek. Since the CD-C project would be the largest contributor to cumulative impacts, successfully utilizing BMPs and COAs listed in **Appendix C** would reduce the potential for adding to cumulative impacts. Surface water impacts would be considered significant for at least one surface-water significance criteria through cumulative impacts if the Proposed Action or any of the action alternatives were selected. Surface water impacts would not be considered significant for Alternative E.

Groundwater. The types of cumulative groundwater impacts would be the same as those discussed in **Section 5.4.1**. Using the available estimates of water use included in the NEPA analyses of projects still in development within the project area, the total cumulative water demand over the lives of the projects would be 40,470 ac-ft (BLM 2004, 2005e, 2006a, 2007f, 2010d, and 2011b). This amount is approximately 0.4 percent of the estimated volume of producible groundwater available (9.67 million ac-ft) in the Tertiary-age aquifers underlying the project area (calculated from information in Cleary *et al.* 2010). Available water is also found in Quaternary, Upper and Lower Cretaceous, and Jurassic age aquifers. Fisk (1967) estimated that the amount of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft within the Washakie Structural Basin. The combined annual recharge for the Great Divide and Washakie structural basins has been estimated at 11,300 ac-ft (Fisk 1967), which is well above the estimated annual 2,700 ac-ft. of water removed for development of the six projects. Cumulative groundwater impacts are not expected to be significant.

5.4.3 Cumulative Impacts within the Watershed Area

Surface Water. The types of cumulative surface-water impacts would be the same as those discussed in **Section 5.4.1**. Surface water impacts would be considered significant for at least one surface-water significance criteria through cumulative impacts if the Proposed Action or any of the action alternatives were selected. Surface water impacts would not be considered significant for Alternative E.

There are two existing large-scale coal mines (Black Butte and Jim Bridger) located within the watershed analysis area. Impacts to surface water from mining activities include increases in runoff, turbidity, and sedimentation within the project area due to disturbances to vegetation and soil resources. Permit requirements and compliance with rules and regulations associated with surface mining are under the jurisdiction of the WDEQ with Office of Surface Mining Reclamation and Enforcement (OSM) oversight. These mines are not expected to contribute measurably to the significance impacts discussed in **Section 4.4.4**.

The existing Sweetwater uranium mill (currently not operational) and the proposed Lost Creek/Lost Soldier in situ uranium recovery (ISR) projects are located in the Great Divide Basin, just north of the project area. These projects have the potential to impact surface water during construction/operation through ground disturbance and vegetation removal or if leachate is accidentally discharged into surface waters. The Nuclear Regulatory Commission (NRC) oversees uranium source and byproduct material license applications and the WDEQ has authority over permits to mine for uranium operations.

Wind-energy development and industrial development projects are under the jurisdiction of the Wyoming Industrial Siting Council and boards of county commissioners (through Wyoming HEA No. 0064). Wind-energy development projects have the potential to affect surface water during construction. These projects could result in contamination of surface water, increased surface runoff, erosion, and off-site sedimentation that would cause channel instability and degradation of surface-water quality, particularly where the development impacts drainage channels. The proposed Chokecherry/Sierra Madre Wind Energy Project is the nearest wind-energy development project and is located approximately 7 miles east of the project area in Carbon County. The proposed Sweeney Ranch Wind Park is located approximately 18 miles west of the project area in Sweetwater County and the Middlewood Wind Power Project is located approximately 22 miles east of the project area in Carbon County.

Downstream demands for water in the Green River and Little Snake River drainages would continue to influence water management in the Upper Green and White-Yampa basins, respectively. According to the 2010 Green River Management Plan, which provides a 50-year projection of water use in watersheds that include the Upper Green and White-Yampa basins in Wyoming, approximately 680,000 ac-ft/year would be depleted from the Basin from all sources (agriculture, municipal, domestic, industrial, recreational, environmental, and evaporation) under a moderate growth scenario by 2060 (Wyoming Water Development Office 2011). Wyoming's estimated 2060 allocation of the Upper Colorado River water under the Colorado River Compact totals approximately 847,000 ac-ft/year, which would mean that approximately 167,000 (847,000–680,000) ac-ft/year would remain under the Compact allocation (Wyoming Water Development Office 2011). No surface water would be used for any part of the well drilling or construction process so the proposed project would not contribute to surface-water depletion within the Colorado River system.

According to the WDEQ-WQD database, there are currently 23 active coalbed natural-gas (CBNG), oil-and-gas-related, industrial, or coal mining Wyoming Pollutant Discharge Elimination System (WYPDES) discharge permits in the cumulative watershed area (WDEQ-WQD 2011). The Proposed Action does not include plans for any surface discharge of produced water. It is therefore assumed that all water produced would be injected or evaporated and no additional discharge permits would be necessary for the surface disposal of produced water. Permitting for surface discharge of produced water related to federal land or minerals would require a separate NEPA evaluation.

Groundwater. The types of cumulative groundwater impacts would be the same as those discussed in **Section 5.4.1**. Using the available estimates of water use included in the NEPA analyses of oil and gas projects that are still in development in the watershed analysis area, the total cumulative water demand from oil and gas development would be approximately 46,000 ac-ft over the lives of the projects (BLM 2004, 2005e 2006a, 2007f, 2009b, 2010d, 2011b, and 2011c). This amount is approximately 0.1 percent of the estimated volume of producible groundwater available (75.2 million ac-ft) in Tertiary-age aquifers underlying the Greater Green River Basin (Cleary *et al.* 2010). Available water is also found in Quaternary, Upper and Lower Cretaceous, and Jurassic age aquifers. Fisk (1967) estimated that the amount of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft within the Washakie Structural Basin. The combined annual recharge for the Great Divide and Washakie structural basins has been estimated at 11,300 ac-ft (Fisk 1967), which is much greater than the estimated annual demand of 3,000 ac-ft removed for development.

The Black Butte and Jim Bridger coal mines are located within the watershed analysis area. Impacts of mining, including cumulative hydrologic impacts, are regulated by WDEQ/LQD with oversight by OSM. The mine pits/active workings would be completely dewatered, which would result in drawdown of formation aquifers in the vicinity of the mining activities. These mines are not expected to contribute measurably to contribute measurably to the significance impacts discussed in **Section 4.4.4** since the extent of drawdown would be limited due to the lack of lateral continuity of the water-bearing units in the affected formation.

The Sweetwater Mill project has the potential to impact groundwater through accidental discharge from the existing tailings impoundment; the impoundment is reported to have leaked several times between 1980 and 1984. Contamination did not leave the site but did enter the upper aquifer. Subsequent remedial actions are reducing the extent of contaminated groundwater. Contaminated soil is being excavated and placed into the existing tailings impoundment and contaminated groundwater is being extracted and placed into the existing tailings impoundment (NRC 2011). The proposed Lost Creek/Lost Soldier project will impact groundwater during recovery and injection well construction and completion or from spills and leaks, excursions, wellfield development drilling, or deep well injection. The NRC oversees uranium source and byproduct material license applications and the WDEQ has authority over permits to mine for uranium operations.

5.5 AIR QUALITY

The CAMx model was used to quantify the impacts to regional air quality and AQRVs resulting from the CD-C project, other proposed oil and gas developments in the study area (Reasonably Foreseeable Development, or RFD) and all other regional emissions sources within the study area. Since the CAMx photochemical grid model was used in the far-field air quality analysis, the impacts of emissions sources outside the Southwest Wyoming study area were also included via transport of these emissions and their chemical reaction products into the study area.

CAMx was used to assess the impacts to both ambient air concentrations and AQRVs from air pollutant emissions of CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and VOC expected to result from CD-C Project emissions combined with regional emissions throughout the study area. The cumulative study considers 2008 as a baseline year for emissions and assesses impacts to air quality at peak project year emissions levels that are expected to occur in year 2022. Air quality impacts are assessed for year 2022, and AQRV impacts are assessed for 2022 and relative to year 2008 levels. The CAMx model was run with both 2008 and 2022 emissions (including the CD-C project area emissions) for two years (2005 and 2006) of meteorological data.

The cumulative assessment was performed using the Proposed Action emissions. The cumulative impacts resulting from all project development alternatives (Alternatives A through D) would be similar to impacts of the Proposed Action. Under Alternative E (No Action) there would be no cumulative impact to air quality or AQRVs since there would be no new development associated with the CD-C project.

5.5.1 Emissions from Regional Sources

Maximum emissions from all RFD sources within the study area were estimated. RFD is defined as (1) air emissions from the undeveloped portions of authorized NEPA projects, and (2) air emissions from not-yet-authorized NEPA projects (if emissions are quantified when modeling commences). RFD information from not-yet-authorized projects was obtained from the BLM and was based on ongoing air quality analyses for NEPA projects.

Full development of proposed projects inventoried as RFD may or may not coincide with full development of the CD-C project. As a result, the assumption that all RFD are fully developed during the maximum year of CD-C project development results in some conservatism in the cumulative impact analysis. A listing of RFD projects which were included in this study, as defined in the paragraph above, is presented in **Table 5.5-1**.

Table 5.5-1. RFD emissions within the study area.

Project	Modeled Pollutant Emissions (tpy)					
	NO_x	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$
Moxa Arch Existing Project	1,519	16,444	1,152	1	212	75
Moxa Arch Preferred Alternative	1,257	2,099	2,002	0	582	131
Moxa Arch ROD Wells	63	166	123	0	30	6
Beaver Creek	68	228	60	1	102	11
Eagle Prospect	409	196	395	5	97	29
Gun Barrel-Madden Deep-Iron Horse	850	3,700	2,085	1	1291	160
Pinedale	1,381	2,286	1,250	53	79	79
Hiawatha Proposed Action	2,157	15,904	915	85	3,398	398
Jonah	1,099	2,705	686	62	28	28

Tables 5.5-2 and 5.5-3 summarize the complete regional emission inventories for the study area (the 4-km modeling domain shown in **Map 4.5-1**). The tables report the modeled emissions of CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$, and total organic gas (TOG), for each region and emissions source category. The CD-C project emissions that are included in these tables are for the Proposed Action. Emissions tables are presented for 2008, 2022 and the difference between the 2022 future year and 2008 baseline inventories (2022–2008). For each year and for the 2022–2008 difference, emissions are reported for the 2006 meteorological year. (Emissions for both the 2005 and 2006 scenarios are reported in Section 2 of the AQTSD.)

Tables 5.5-2 and 5.5-3 contain emissions for all portions of Wyoming, Colorado, Utah, and Idaho that are within the 4-km modeling domain that comprised the study area. The five counties in Southwest Wyoming covered by the detailed oil and gas emission inventory (described in Section 2 of the AQTSD) are broken out separately from the rest of Wyoming in all of the tables. Oil and gas emissions are broken down into drilling, compressor engine, and production emissions. In **Table 5.5-3**, there are zero entries for the 2022-2008 change in biogenic or fire emissions because the 2006 actual emissions were used in both 2008 and 2022 emission scenarios. The only trona facilities in the study area are located in Wyoming; therefore, trona emissions for Colorado, Idaho, and Utah are zero.

Table 5.5-3 shows that on-road mobile emissions would decrease for all pollutants in all areas between 2008 and 2022 due to increasingly stringent emissions controls. Non-road emissions also decline for all areas for all pollutants except CO. This would occur because of the implementation of non-road engine tier standards that require increasingly cleaner-burning engines as fleet turnover occurs. Non-oil and gas area source emissions would increase for all pollutants within Wyoming going from 2008 to 2022. NO_x and total organic gas (TOG) emissions increase for non-oil and gas area source emissions for all four states in 2022 relative to 2008. This is reasonable because future area source emissions are often projected using population changes as a basis for calculating changes in emissions. 2008 to 2022 changes in electricity generating units (EGU) emissions and non-EGU (NEGU) point source emissions vary by state and pollutant.

Table 5.5-2. Regional emissions summary table for the 2022 future year (tpy)

STATE	Source Category						
	Oil and Gas	Area	Onroad	Offroad	EGU	NEGU	Natural
CO							
Colorado	**799**	**2,519**	**15,246**	**8,426**	**1,735**	**67**	**12,535**
Idaho	**411**	**535**	**2,070**	**4,583**	**0**	**17,670**	**20,513**
Utah	**41,451**	**1,960**	**16,338**	**11,877**	**1,469**	**109**	**8,608**
Wyoming	**27,624**	**14,596**	**56,568**	**37,856**	**3,816**	**14,182**	**82,627**
Carbon Co, Wyoming	829	856	56,568	3,713	135	1,552	3,131
Lincoln Co, Wyoming	711	2,129		2,270	819	380	297
Sublette Co, Woming	1,885	716		2,828	0	389	16,203
Sweetwater Co, Wyoming	2,731	1,801		4,670	2,498	11,418	4,076
Uinta Co, Wyoming	534	1,307		2,877	330	99	803
Wyoming (rest)	1,797	7,789		21,498	33	345	58,117
RFD	8,665	0	0	0	0	0	0
CD-C Project	10,474	0	0	0	0	0	0
NO_x							
Colorado	**1,291**	**177**	**776**	**849**	**24,166**	**89**	**677**
Idaho	**152**	**402**	**128**	**478**	**0**	**2,378**	**864**
Utah	**13,706**	**244**	**857**	**1,272**	**8,386**	**112**	**347**
Wyoming	**30,556**	**8,261**	**3,590**	**15,066**	**39,072**	**12,748**	**2,911**
Carbon Co, Wyoming	2,297	620	3,590	3,149	153	478	111
Lincoln Co, Wyoming	1,820	1,187		1,278	10,880	1,662	16
Sublette Co, Woming	2,476	130		330	0	469	574
Sweetwater Co, Wyoming	4,748	1,478		5,444	27,338	9,601	207
Uinta Co, Wyoming	733	447		1,691	667	120	26
Wyoming (rest)	2,962	4,398		3,173	34	419	1,977
RFD	8,805	0	0	0	0	0	0
CD-C Project	6,717	0	0	0	0	0	0
SO_2							
Colorado	**15**	**83**	**10**	**3**	**7,002**	**5**	**16**
Idaho	**0**	**15**	**2**	**1**	**0**	**3,921**	**97**
Utah	**731**	**142**	**11**	**3**	**1,645**	**10**	**48**
Wyoming	**5,602**	**7,458**	**45**	**19**	**22,374**	**23,588**	**556**
Carbon Co, Wyoming	60	394	45	3	246	3,354	8
Lincoln Co, Wyoming	1,543	1,838		1	6,357	65	1
Sublette Co, Woming	4	63		1	0	240	117
Sweetwater Co, Wyoming	267	590		5	15,771	14,592	2
Uinta Co, Wyoming	98	237		2	0	876	7
Wyoming (rest)	3,419	4,337		7	0	4,461	422
RFD	208	0	0	0	0	0	0
CD-C Project	4	0	0	0	0	0	0

Table 5.5-2. Regional emissions summary table for the 2022 future year (tpy), *continued*

STATE	Source Category						
	Oil and Gas	Area	Onroad	Offroad	EGU	NEGU	Natural
TOG							
Colorado	**20,767**	**1,850**	**830**	**1,147**	**183**	**323**	**54,199**
Idaho	**44**	**5,214**	**120**	**1,174**	**0**	**7**	**32,486**
Utah	**1,060,778**	**2,668**	**861**	**2,300**	**114**	**1,673**	**13,407**
Wyoming	**1,473,030**	**22,192**	**3,257**	**4,261**	**683**	**25,291**	**89,977**
Carbon Co, Wyoming	27,263	22,192	3,257	4,261	12,495	25,291	7,497
Lincoln Co, Wyoming	75,250						878
Sublette Co, Woming	159,573						19,459
Sweetwater Co, Wyoming	313,200						14,911
Uinta Co, Wyoming	8,310						113
Wyoming (rest)	209,909						47,120
RFD	379,714	0	0	0	0	0	0
CD-C Project	299,812	0	0	0	0	0	0
PM_{10}							
Colorado	**37**	**10,544**	**37**	**75**	**592**	**3,504**	**261**
Idaho	**0**	**9,454**	**6**	**62**	**0**	**0**	**1,513**
Utah	**469**	**7,134**	**41**	**112**	**887**	**267**	**756**
Wyoming	**8,929**	**73,379**	**164**	**610**	**3,399**	**13,320**	**9,139**
Carbon Co, Wyoming	91	8,616	164	118	3	683	131
Lincoln Co, Wyoming	72	3,323		53	1,457	440	16
Sublette Co, Woming	22	5,276		30	0	0	1,915
Sweetwater Co, Wyoming	80	11,445		184	1,939	12,086	30
Uinta Co, Wyoming	3	1,461		62	0	1	110
Wyoming (rest)	90	43,256		163	0	111	6,936
RFD	5,818	0	0	0	0	0	0
CD-C Project	2,753	0	0	0	0	0	0
$PM_{2.5}$							
Colorado	**37**	**1,191**	**18**	**70**	**0**	**0**	**233**
Idaho	**0**	**206**	**3**	**58**	**0**	**0**	**1,311**
Utah	**460**	**772**	**21**	**106**	**561**	**169**	**675**
Wyoming	**1,951**	**6,410**	**83**	**611**	**4,114**	**1,776**	**8,377**
Carbon Co, Wyoming	91	940	83	118	0	111	118
Lincoln Co, Wyoming	72	560		53	821	2	15
Sublette Co, Woming	22	532		30	0	0	1,768
Sweetwater Co, Wyoming	80	1,313		184	3,295	1,658	24
Uinta Co, Wyoming	3	298		62	0	0	101
Wyoming (rest)	90	2,768		164	0	6	6,351
RFD	916	0	0	0	0	0	0
CD-C Project	677	0	0	0	0	0	0

Table 5.5-3. Regional 2022-2008 emissions difference summary table (tpy)

STATE	Source Category						
	Oil and Gas	Area	Onroad	Offroad	EGU	NEGU	Natural
CO							
Colorado	-230	**71**	-3,116	**495**	**379**	**9**	0
Idaho	**149**	**48**	-510	**38**	0	**6,760**	0
Utah	**23,068**	-14	-3,260	-335	**1,043**	-535	0
Wyoming	**15,311**	**754**	-16,099	**1,512**	**478**	-3,191	0
Carbon Co, Wyoming	-343	-1	-16,099	-136	**135**	**902**	0
Lincoln Co, Wyoming	-434	3		-263	241	**52**	0
Sublette Co, Woming	-2,543	-8		-572	-20	**305**	0
Sweetwater Co, Wyoming	-447	**6**		**223**	-227	-3,375	0
Uinta Co, Wyoming	-57	-6		-127	**330**	-4	0
Wyoming (rest)	-5	**759**		**2,387**	**19**	-1,070	0
RFD	**8,665**	0	0	0	0	0	0
CD-C Project	**10,474**	0	0	0	0	0	0
NO_x							
Colorado	-422	**25**	-959	-396	-4,523	**4**	0
Idaho	-1,129	**63**	-173	-197	0	**445**	0
Utah	**2,216**	**30**	-1,067	-499	**1,177**	-1,017	0
Wyoming	**8,921**	**1,126**	-4,999	-4,028	**544**	-2,065	0
Carbon Co, Wyoming	-319	**55**	-4,999	-950	**153**	-144	0
Lincoln Co, Wyoming	-449	**147**		-453	-3,614	**247**	0
Sublette Co, Woming	-5,134	**9**		-177	-204	**365**	0
Sweetwater Co, Wyoming	-632	**125**		-1,551	**3,535**	-1,584	0
Uinta Co, Wyoming	-60	**38**		-564	**667**	**74**	0
Wyoming (rest)	-7	**752**		-334	**7**	-1,022	0
RFD	**8,805**	0	0	0	0	0	0
CD-C Project	**6,717**	0	0	0	0	0	0
SO_2							
Colorado	-5	**3**	-1	-30	-792	1	0
Idaho	-1	1	0	-17	0	-4,997	0
Utah	**550**	-2	-1	-42	**672**	**4**	0
Wyoming	**100**	**1,039**	-7	-387	-21,604	**8,017**	0
Carbon Co, Wyoming	0	**62**	-7	-82	**246**	**2,252**	0
Lincoln Co, Wyoming	-4	**343**		-36	-16,413	-129	0
Sublette Co, Woming	-132	**2**		-13	0	**224**	0
Sweetwater Co, Wyoming	-1	**29**		-135	-5,436	**2,195**	0
Uinta Co, Wyoming	0	**8**		-46	0	**862**	0
Wyoming (rest)	**26**	**595**		-75	-1	**2,613**	0
RFD	**208**	0	0	0	0	0	0
CD-C Project	**4**	0	0	0	0	0	0
TOG							
Colorado	-56,252	**241**	-574	-555	**46**	**56**	0
Idaho	-504	**1,320**	-88	-284	0	-3	0
Utah	650,722	**653**	-574	-1,233	**49**	-384	0
Wyoming	345,625	**3,629**	-2,539	-1,555	-396	**2,555**	0
Carbon Co, Wyoming	-131,161	**3,629**	-2,539	-1,555	11,417	**2,555**	0
Lincoln Co, Wyoming	-93,086						6
Sublette Co, Woming	-24,304						**696**
Sweetwater Co, Wyoming	-48,612						**11**

Table 5.5-3. Regional 2022-2008 emissions difference summary table (tpy), *continued*

STATE	Source Category						
	Oil and Gas	**Area**	**Onroad**	**Offroad**	**EGU**	**NEGU**	**Natural**
				TOG			
Uinta Co, Wyoming	-34,022						**40**
Wyoming (rest)	-2,716						**2,510**
RFD	**379,714**	0	0	0	0	0	0
CD-C Project	**299,812**	0	0	0	0	0	0
				PM_{10}			
Colorado	-25	**2,048**	-11	-60	**182**	-348	0
Idaho	0	**394**	-3	-34	0	-468	0
Utah	**26**	**1,043**	-14	-90	**316**	**42**	0
Wyoming	**8,406**	**24,037**	-77	-369	-6,199	-1,419	0
Carbon Co, Wyoming	-10	**240**		-74	3	415	0
Lincoln Co, Wyoming	-8	**426**		-43	-5,085	-908	0
Sublette Co, Woming	-130	**928**		-34	-3	-34	0
Sweetwater Co, Wyoming	-9	-1,239	-77	-93	-1,107	-350	0
Uinta Co, Wyoming	-1	-78		-43	0	-53	0
Wyoming (rest)	-9	**23,761**		-81	-7	-489	0
RFD	**5,818**	0	0	0	0	0	0
CD-C Project	**2,753**	0	0	0	0	0	0
				$PM_{2.5}$			
Colorado	-24	-11	-13	-58	0	0	0
Idaho	0	**22**	-3	-33	0	-376	0
Utah	**25**	-64	-16	-86	**90**	**24**	0
Wyoming	**1,428**	-311	-79	-328	-5,484	-902	0
Carbon Co, Wyoming	-10	-18		-67	0	**107**	0
Lincoln Co, Wyoming	-8	**11**		-40	-5,720	-297	0
Sublette Co, Woming	-130	-2		-31	-3	-22	0
Sweetwater Co, Wyoming	-9	-180	-79	-84	**248**	-528	0
Uinta Co, Wyoming	-1	-18		-40	0	-1	0
Wyoming (rest)	-9	-103		-68	-7	-162	0
RFD	**916**	0	0	0	0	0	0
CD-C Project	**677**	0	0	0	0	0	0

5.5.2 Criteria Pollutants Impacts

The results of the cumulative modeling showed that there would be no exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant within the study area, except in the immediate vicinity of sources unrelated to the CD-C project. There would be predicted exceedances of the CO (8-hour), PM_{10}/$PM_{2.5}$ (24-hour), ozone, and SO_2 (1-hour) standards within the study area; however, the CD-C project emissions would not make a significant contribution to these values. In addition, PSD increments would not be exceeded at any Class I or sensitive Class II area within the study area. Additional detail on the modeling results are provided in Section 4 of the AQTSD.

Mid-Field Impacts

CAMx-estimated criteria pollutant impacts from the CD-C project and regional sources, within and near the CD-C project area and these are shown in **Table 5.5-4**. As indicated in Table 5.5-4, the cumulative impacts resulting from project and regional sources would be below the WAAQS and NAAQS.

Table 5.5-4. CD-C project and regional sources: mid-field criteria pollutant modeling results

Pollutant	Averaging Time	Modeled Concentration from All Sources (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
CO	1-hour 8-hour	491.3 357.0	40,000 10,000	40,000 10,000
NO_2	1-hour Annual	81.4[1] 17.1	n/a 100	188 100
O_3	8-hour	142.4	147	147
SO_2	1-hour 3-hour 24-hour Annual	30.8[2] 30.0 11.3 3.1	n/a 1,300 260 60	196 1,300 365 80
PM_{10}	24-hour Annual	55.8 7.5	150 50	n/a 50
$PM_{2.5}$	24-hour Annual	18.7 3.8	n/a n/a	35 15

1 *NO_2 1-hour concentration is 8th highest daily maximum 1-hour concentration. Value includes contribution from NO.*

2 *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

5.3.3 Visibility Impacts

In the cumulative analysis, changes in light extinction from CD-C project sources combined with all cumulative emissions sources were calculated for each day at Class I and sensitive Class II areas within the study area (**Map 4.5-1**). The daily average differences in modeled concentrations between the 2022 future and 2008 baseline years were calculated for each Class I/II area, and these concentration differences were used to estimate visibility impairment following FLAG 2010 guidance. The maximum and number of days greater than the 0.5 and 1.0 Δdv thresholds are disclosed. Two additional methods for evaluating cumulative visibility impacts were explored and a discussion of these methods and the results obtained from applying them are presented in Section 4.6.1 of the AQTSD.

Cumulative visibility impacts at Class I and sensitive Class II areas estimated using the FLAG 2010 method are shown in **Table 5.5-5**. The largest impacts would occur at Dinosaur National Monument, which would have the greatest number of days that exceed 0.5 Δdv and 1.0 Δdv thresholds. All Class I/II areas within the study area would have days in which the 2022–2008 concentration differences produce changes in extinction greater than 0.5 Δdv. The Mount Zirkel, Rawah, and Savage Run Wilderness areas would not have any days with impacts above 1.0 Δdv, but all other Class I/II areas would have days that exceed 1.0 Δdv. Using the 98th percentile value as a threshold, impacts at the Popo Agie Wilderness area are at the 0.5 Δdv threshold, and impacts at the Bridger, and Fitzpatrick Wilderness areas, the Wind River Roadless area, and Dinosaur National Monument would be above the 0.5 Δdv threshold, and the 1.0 dv threshold would be exceeded at only Dinosaur National Monument.

Table 5.5-5. Cumulative visibility results

Class I or Sensitive Class II Area	Number of Days > 0.5 Δdv	Number of Days > 1.0 Δdv	Maximum Δdv	98th Percentile Maximum Δdv
Bridger Wilderness Area	9	1	1.30	0.52
Fitzpatrick Wilderness Area	8	3	1.71	0.62
Savage Run Wilderness Area	4	0	0.76	0.40
Mount Zirkel Wilderness Area	5	0	0.77	0.43
Rawah Wilderness Area	5	0	0.78	0.38
Popo Agie Wilderness Area	7	3	1.73	0.50
Wind River Roadless Area	9	3	1.55	0.55
Dinosaur National Monument	30	12	2.11	1.29

5.3.4 Atmospheric Deposition Impacts

Modeled wet and dry fluxes of sulfur- and nitrogen-containing species due to emissions from the CD-C project and all other cumulative regional sources were processed to estimate total annual sulfur (S) and nitrogen (N) deposition values at each PSD Class I and sensitive PSD Class II area. Maximum predicted S and N deposition impacts were estimated for existing emissions sources within the CD-C project area taken together with the cumulative effects of all sources in the region.

Table 5.5-6 shows maximum predicted total nitrogen and sulfur deposition impacts from all emission sources for the year 2022. Estimated cumulative nitrogen deposition impacts at all Class I and sensitive Class II areas within the study area would be above the critical load threshold of 1.5 kg/ha/yr. Estimated sulfur deposition impacts would be below the 3.0 kg/ha/yr threshold at all areas except for the Mount Zirkel Wilderness area and Dinosaur National Monument. Cumulative nitrogen deposition impacts can be addressed by a number of mitigation or development strategies designed to minimize NO_x emissions from the project. These mitigation strategies are further described in **Section 4.5.6, Unavoidable Adverse Impacts and Additional Mitigation Measures**. Deposition impacts are summarized in detail in Section 4.6.2 of the AQTSD.

Table 5.5-6. Cumulative nitrogen and sulfur deposition impacts

Class I or Sensitive Class II Area	Nitrogen (kg/ha)	Sulfur (kg/ha)
Bridger Wilderness Area	2.76	2.88
Fitzpatrick Wilderness Area	2.36	3.25
Savage Run Wilderness Area	2.48	2.68
Mount Zirkel Wilderness Area	4.17	5.43
Rawah Wilderness Area	3.14	4.47
Popo Agie Wilderness Area	2.56	3.66
Wind River Roadless Area	2.26	3.60
Dinosaur National Monument	4.51	6.02

Table 5.5-7 shows the 2022–2008 change in maximum nitrogen and sulfur deposition at all Class I/II areas. The modeling results indicate that cumulative nitrogen and sulfur deposition impacts in 2022 would decrease in all Class I/II areas relative to year 2008.

Table 5.5-7. 2022-2008 Change in cumulative nitrogen and sulfur deposition

Class I or Sensitive Class II Area	Nitrogen Deposition		Sulfur Deposition	
	Deposition (kg/ha)	% Change	Deposition (kg/ha)	% Change
Bridger Wilderness Area	-0.28	-9.0	-0.14	-9.1
Fitzpatrick Wilderness Area	-0.23	-6.6	-0.08	-4.7
Savage Run Wilderness Area	-0.28	-9.4	-0.11	-9.2
Mount Zirkel Wilderness Area	-0.51	-10.1	-0.27	-10.5
Rawah Wilderness Area	-0.40	-10.1	-0.19	-10.0
Popo Agie Wilderness Area	-0.29	-8.1	-0.15	-7.1
Wind River Roadless Area	-0.20	-5.2	-0.11	-5.1
Dinosaur National Monument	-0.36	-7.3	-0.25	-7.8

Acidification at Sensitive Lakes

Modeling results for cumulative sources indicated that there would be no ANC changes at any of the 12 analyzed lakes that exceed the 10-percent threshold or the ΔANC<1 μeq/L threshold for the two extremely sensitive lakes. Lake ANC impacts are summarized in Section 4.6.3 of the AQTSD.

5.3.5 Climate Change Impacts

As discussed in sections **3.5** and **4.5 Air Quality**, the current scientific consensus is that anthropogenic emissions of GHGs are causing the climate system to warm, and the impacts of this warming are likely to be larger in the 21st century than in the 20th century if emissiontrends continue unabated (IPCC, 2007). Forecasts of changes in the climate system under differing GHG emissions scenarios are made with global climate models. Forecasts of regional effects of global change derived from integrations of global models are available but are highly uncertain. In North America, predicted regional impacts of global warming include warming in western mountains, decreased snowpack, and increased frequency and intensity of heat waves (IPCC, 2007).

The GHGs to be emitted by the Proposed Action and the action alternatives, and from other RFD projects in the study area, are CO_2, CH_4, and N_2O, all of which have atmospheric lifetimes on the order of years (IPCC, 2007). Emissions of GHGs from any particular source become well-mixed throughout the global atmosphere. GHG emissions from all sources contribute to the global atmospheric burden of GHGs, and it is not possible to attribute a particular climate impact in any given region to GHG emissions from a particular source. Therefore, no modeled climate change impact predictions from Proposed Action or action alternative GHG emissions sources or cumulative GHG emissions sources in the vicinity of the project area are available.

■ BIOLOGICAL ENVIRONMENT

5.6 VEGETATION AND RIPARIAN/WETLAND COMMUNITIES

The CIAA for vegetation communities is the CD-C project area. Historic development in the project area accounts for 60,176 acres of initial disturbance and 17,663 acres of long-term disturbance. Added to this total, the Proposed Action and the action alternatives would disturb between 61,696 acres (Alternative A) and 36,499 acres (Alternative D) in the short term (**Table 2.4-1).** The long-term disturbance would range from 24,133 to 14,953 acres. Due to the long timeframe needed to recover shrub habitat, there would be an increase of acreage dominated by herbaceous vegetation versus that dominated by shrubs throughout the CD-C project area.

Factors impacting vegetation besides removal include the indirect impact of dust accumulation on vegetation, resulting in reduced photosynthetic activity and growth and lower palatability for herbivores. Additionally, the increase in invasive species in the project area has already affected the native vegetation and would continue to do so. Vegetation is also impacted by other existing uses such as livestock grazing, wildlife foraging, and wild horse grazing. These uses will continue into the future and as available vegetation is removed, competition among these species (especially on critical winter range) could further impact the vigor of the vegetation in those areas. Soil loss and compaction in areas of construction can also contribute to the difficulty of reclamation.

Wetlands and riparian communities are a very small component of the vegetation cover in the CD-C area. Protections are in place to protect these areas from physical impact, but those adjacent to gravel or dirt roads could be impacted by dust.

Other actions within and near the CIAA could add to this impact. Roads within the project area are utilized to travel to adjacent projects such as the Atlantic Rim Natural Gas Field to the east and Desolation Flats to the west. Secondary roads may also be used to access the Luman Rim project adjacent to the northwest border of the project area. Additionally, three new transmission lines are proposed to cross the project area which would increase traffic during the planning and development stages. This additional use of the gravel and dirt roads within the project area would contribute additional dust and the vehicles could transport seeds of noxious plant species both into and out of the project area.

5.7 INVASIVE, NON-NATIVE SPECIES

The CIAA for invasive species is the CD-C project area and adjacent areas of development that could provide a seed source for invasive plants and also could provide sites for potential infestation by invasive species from the CD-C project area.

Impacts to vegetation and range resources would occur on all lands in the project area under the Proposed Action and all action alternatives, as well as on private and state lands under the No Action Alternative, due to an increase in surface disturbance which could provide more suitable habitat for invasive weed infestations.

Vehicles and equipment traveling from weed-infested areas, within and outside the project area, could facilitate the spread of invasive weeds into previously weed-free areas in addition to facilitating the spread of seeds of existing invasive populations. Surface-disturbing activities could increase the potential for infestation and spread of invasive plant species. Invasive weed species usually thrive on newly disturbed surfaces and out-compete more desirable native plant species. Creation of new sites for weed infestations may occur in proximity to roads where fugitive-dust deposition on roadside plants reduces their density due to reduced photosynthetic activity and reduced vigor, thus providing a suitable habitat for invasive plants to establish.

In addition to the CD-C project, several other natural gas projects are located adjacent to the project area and could provide potential seed sources for establishment of invasive species in the project area. They include Atlantic Rim on the east of the project area, Desolation Flats on the southwest, and Luman Rim on the northwest. Additionally, three transmission-line projects are proposed to cross the project area and vehicles/equipment associated with the planning and construction of those projects provide other potential seed sources and seed vectors.

5.8 WILDLIFE

The cumulative impact analysis areas (CIAAs) for wildlife resources differ with respect to species. This analysis examines the proportion of the wildlife habitat within respective CIAAs that may be disturbed from all past, present, and RFFAs. The combination of individual projects results in a large area potentially exposed to increased fragmentation, disturbance of wildlife and their habitats, disruption of migratory corridors, and the loss of refuge areas. Additional effects are expected on wildlife dispersal, the reduction of non-fragmented habitats, competition with livestock, and competition with other wildlife species. The generalized increase of human presence and associated disturbance across such a broad scale are a concern. Remaining ranges with increased competition for forage leading to reduced carrying capacity and juvenile survival can also be expected for some species. Mitigations, COAs, and other BMPs would reduce the impacts of these developments, but not eliminate them. Reduced populations and population viability can be expected in high-density development areas.

Cumulative indirect effects from the Proposed Action or alternatives and RFFAs to all wildlife species in general would come from road/traffic impacts, including vehicle collisions, noise, and dust. As roads are developed within and adjacent to the project area, habitat is fragmented. Roads can serve as barriers to some animal movement. The displacement of species away from roadsides can be reasonably predicted. Roads also provide access to the public into areas that were previously undisturbed/undeveloped. Human encroachment in the form of casual backcountry recreation, hunting, and poaching could occur at higher rates resulting in effects such as disturbance during sensitive periods, displacement, or increased mortality.

Insects, birds, and amphibians all avoid dust and noise from roads, which compounds impacts to adjacent habitats throughout the CIAA. Sagebrush-obligate species would be affected by the cumulative removal of habitat (reduction or fragmentation of patch size or vertical habitat structure) and the expanded road system throughout the area.

For raptors, small mammals, and neotropical migratory birds, the impacts anticipated from the Proposed Action, alternatives, and RFFAs would be similar with the exception of Alternative A (100-Percent Vertical Drilling) which would disturb more acreage over the long term. The Proposed Action and the action alternatives provide a variety of mitigations and protections for various wildlife species. Alternative B, with enhanced mitigations and protections, would enhance habitat for prey and grassland species. Alternative D, with required directional drilling on federal mineral estate, would reduce surface disturbance, and associated shrub habitat removal, by about 23 percent when compared to the Proposed Action. Under all Alternatives, with the exception of Alternative E (No Action), sagebrush obligates would experience an overall reduction in suitable habitat for the life of the various projects within the CIAA.

5.8.1 Big Game

Disturbance during construction and production, such as human presence, dust, and noise may displace or preclude big game use during all seasons. Prohibiting construction, drilling, and other activities potentially disruptive to wildlife during sensitive time periods (e.g. winter) would minimize the probability of displacement during these critical times. The extent of displacement would be related to the duration, magnitude, and visual prominence of the activity, as well as the extent of construction and operational noise levels above existing background levels. Displacement would result in local reductions in wildlife populations if adjacent, undisturbed habitats are at carrying capacity. In this situation animals are either forced into less-optimal habitats or they compete with other animals that already occupy unaffected habitats. Possible consequences of such displacement are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations (WGFD 2010). Refer to **Section 4.8.3** for a more in-depth discussion of possible direct and indirect impacts of the CD-C project or other CIAA projects to big game.

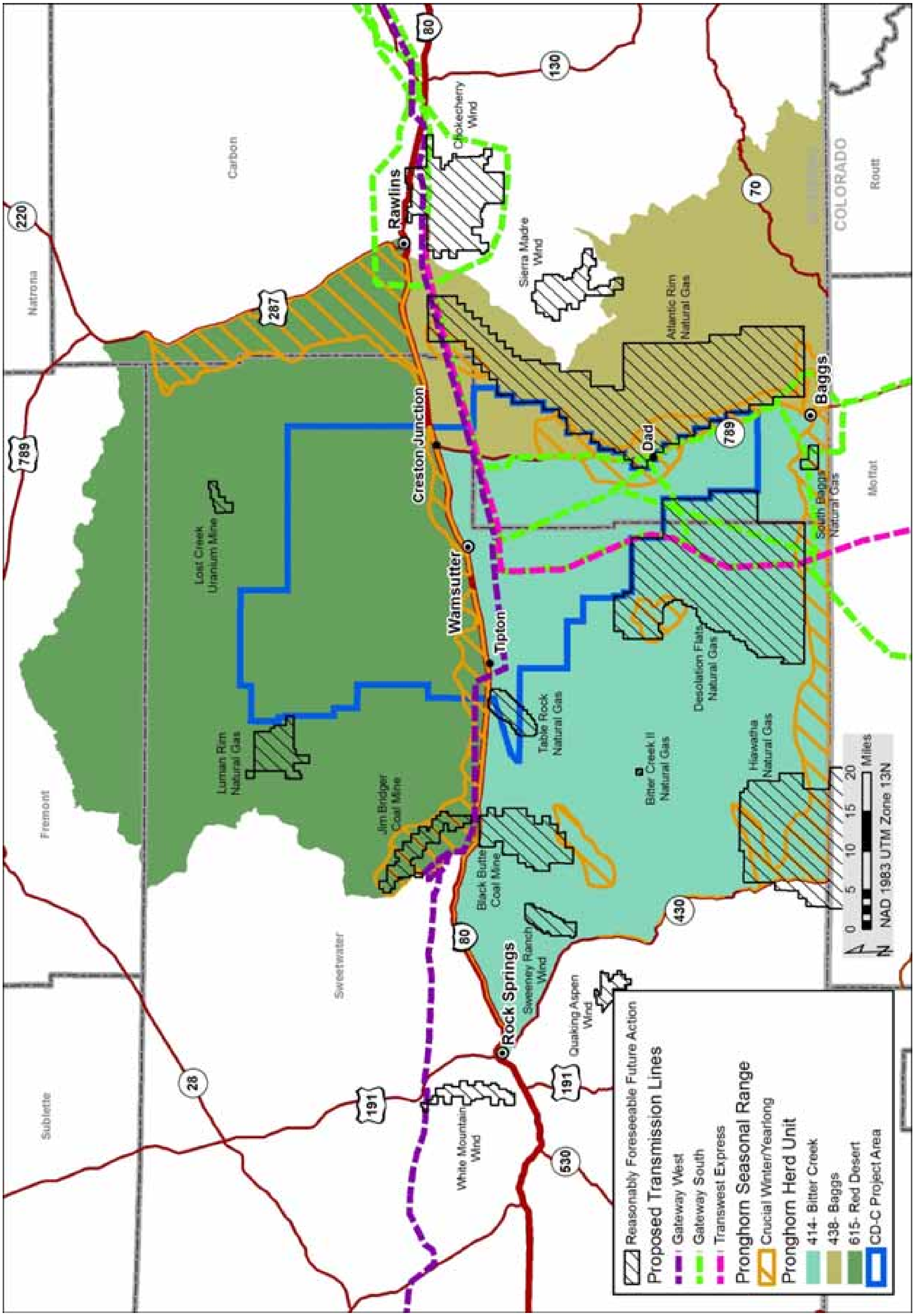
Construction, such as building well pads and roads, reduces forage available to big game. The significance of this forage reduction is greater in big game CWR, especially as development cumulatively and concurrently occurs outside the project area in adjacent oil and gas development areas. The application of seasonal restrictions intended to minimize CWR disturbance could serve to further concentrate big game in those refuge areas. These seasonal restrictions are not generally applied in state and fee energy development areas. In addition, new gas field-related roads provide unconstrained access to the general public which could result in increased human presence during sensitive periods such as winter. Recreational “antler hunting” has been identified by WGFD as an issue in CWR in some areas of the state.

Big game populations are managed within Herd Units designated for each species and cumulative impacts are discussed in the context of these areas. Implementation of the proposed project would affect crucial winter/winter yearlong range for these big game species. Elk are not considered in this cumulative impact analysis as CWR for the species would not be impacted by the CD-C project. The specific locations of future disturbances within the CD-C project area and the other RFFAs (**Section 5.0**) that fall within the Herd Units and crucial seasonal habitats are unknown; therefore, the exact location of each seasonal big game range or migration route that may be affected by development activity is unknown. The cumulative portion of each CD-C big game CWR that could be affected by the combination of existing, proposed, and RFFA disturbances for pronghorn and mule deer is discussed below. Cumulative impacts to big game would include permanent, short-term, and long-term loss of habitat, as well as increased stress due to human/wildlife encounters, potential reductions in birth/survival rates, and possible alterations of migration routes.

Pronghorn. The cumulative impact analysis area for pronghorn comprises the Herd Units impacted by the CD-C project (**Map 5.8-1**). Cumulative impacts to pronghorn migration routes are unknown at this time; however, the current fencing along WY 789 creates a barrier to pronghorn attempting to migrate across this highway. The WGFD has constructed highway underpasses along WY 789 in an effort to provide safe access during migration and reduce the frequency of vehicle collision; however, pronghorn do not appear to use these accommodations (WYDOT 2012, J. Gregson pers. com. January 2012). I-80 constitutes a significant barrier to pronghorn seasonal movements. Dependent on the severity of the winter, there are miles of rangeland fence that also create migration barriers for pronghorn.

It is assumed that most, if not all, of the Baggs herd transition range is located within the interface of the CD-C and Atlantic Rim project areas (BLM 2007) along WY 789. Approximately 76 percent of the Baggs Herd Unit crucial winter/yearlong range could be affected by long-term development in the following areas: 30 percent within the CD-C project area, 42.6 percent within the Atlantic Rim project area, and 3.4 percent within new transmission line corridors. Virtually all of the Baggs pronghorn crucial winter range lies within one or more oil and gas project boundary.

Approximately 44.5 percent of the Bitter Creek Herd Unit CWR is located within the project area for the Proposed Action and other RFFAs including Hiawatha (22.7 percent), CD-C (10 percent), Desolation Flats (6.5 percent), and new transmission line corridors (3 percent), as well as other existing oil and gas development actions. The CD-C project and new transmission line corridors could affect approximately 19 percent of the Red Desert Herd Unit CWR. It is anticipated that the CWR in the Red Desert Herd Unit would also be affected by scattered oil and gas development activities.



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Map 5.8-1. Cumulative impact analysis area, pronghorn

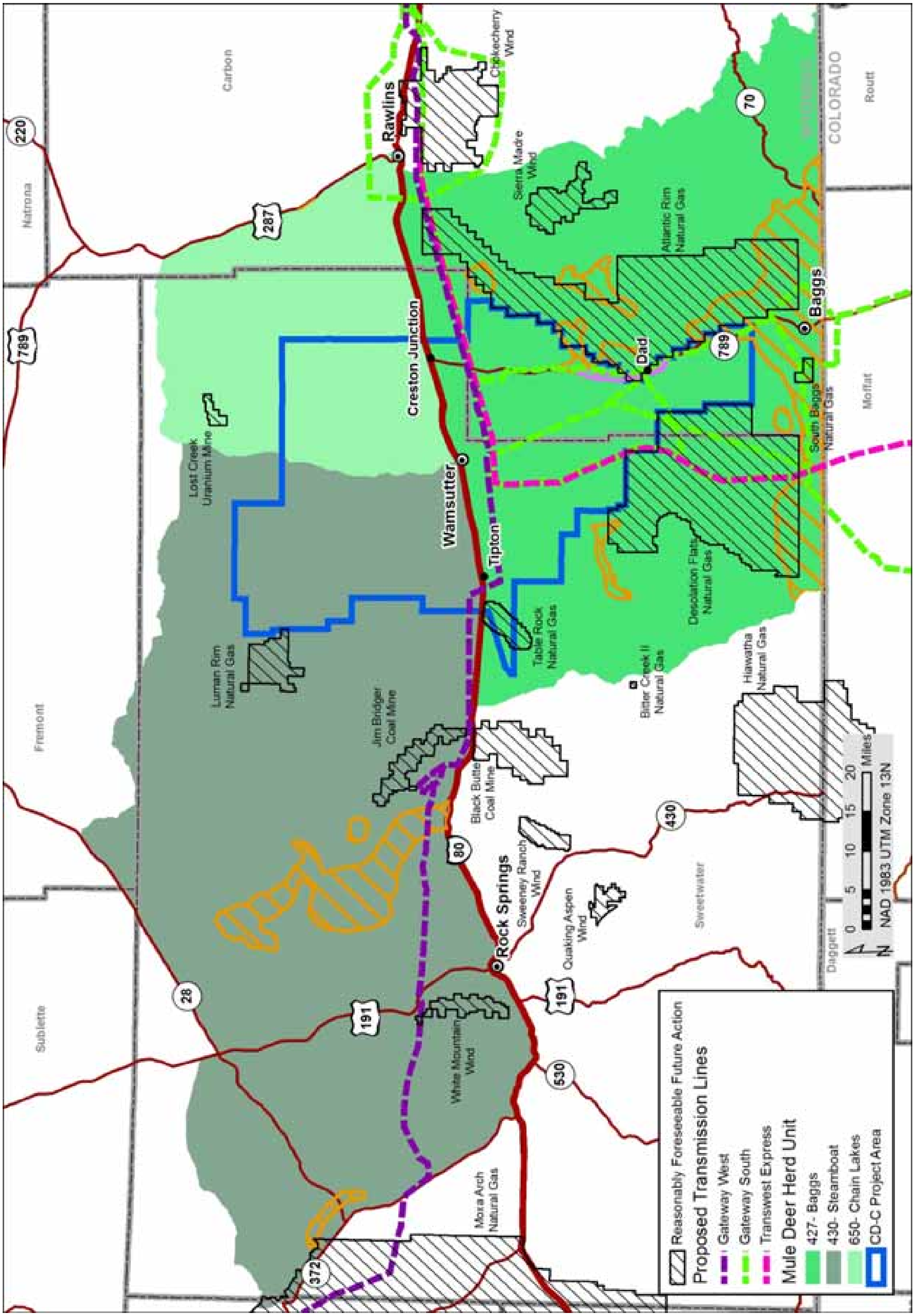
Mule deer. The cumulative impact analysis area for mule deer comprises the Herd Units impacted by the CD-C project (**Map 5.8-2**). Cumulative impacts upon mule deer migration routes within the Baggs Herd Unit are unknown; however, WGFD and the Wyoming Department of Transportation have constructed highway underpasses along WY 789 in an effort to provide safe access during migration and reduce the frequency of vehicle collision. Mule deer are successfully using these underpasses (WYDOT 2012, J. Gregson pers. com. January 2012).

As with pronghorn, it is assumed that most, if not all, of this herd's transition range is located within the interface of CD-C and Atlantic Rim project areas (BLM 2007) along WY 789. Approximately 6 percent of the Baggs Herd Unit crucial winter/year-long range could be affected by long-term development within the CD-C project area, another 26 percent falls within the Atlantic Rim project area, 7 percent would be affected by the Desolation Flats project, and approximately 4 percent is located within 0.5 mile of proposed new transmission-line corridors. Over 44 percent of the Baggs mule deer CWR may lie within one or more reasonably foreseeable oil and gas project or transmission line corridors. As discussed in **Section 4.8.3.1**, predictive maps suggest some habitats considered "high probability of use" areas prior to development would change to "low probability of use" areas as development progresses. These impacts would be increased as the CD-C, Atlantic Rim, and Desolation Flats projects are developed. Approximately 31 acres of mule deer CWR are identified in the Chain Lakes Herd Unit, none of which would be affected by the CD-C project or other RFFAs. None of the CWR in the Steamboat Herd Unit would be affected by the CD-C project; approximately 2 percent could be influenced by new transmission line corridors.

Elk. The cumulative impact analysis area for elk comprises the Herd Units impacted by the CD-C project. No elk CWR or migrations routes have been identified in the CD-C project area.

Overlapping big game crucial winter ranges are located at the interface of the CD-C project area and the Atlantic Rim project area along WY 789 (**Map 3.8-7**). As discussed above, this area is expected to see additional development and production activity resulting in additional stress and displacement of pronghorn and mule deer, as well as reduced winter forage as a result of increased surface disturbance. Impacts to these herds would be exacerbated by the current fair to poor condition of forage in crucial winter habitat designated areas (see **Section 4.8.3.1**). Over the long term, the impacts anticipated from the CD-C project and RFFAs would be similar for the various CD-C project area development alternatives with the exception of Alternative A (100-Percent Vertical Drilling) which would disturb more acres over the long term, and Alternative D which would reduce total surface disturbance, and associated shrub habitats, by approximately 23 percent, when compared to the Proposed Action. Alternative B (Enhanced Resource Protection) and Alternative C (Surface Disturbance Cap with High and Low Density Development Areas) would both provide protection to big game CWR areas over the life of the project. The ERP provides a variety of impact thresholds, each of which enhances the mitigation and protection for wildlife species and their respective critical seasonal ranges. BLM seasonal restrictions and those enhancement provided under Alternative B are not generally applied in state and fee energy development areas.

An indirect impact of these CIAA actions includes unrestricted access by the general public using gas field-related roads which could result in increased human presence in CWR during sensitive periods. Recreational "antler hunting" has been identified by WGFD as an issue in CWR in some areas of the state.



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Map 5.8-2. Cumulative impact analysis area, mule deer

5.8.2 Raptors

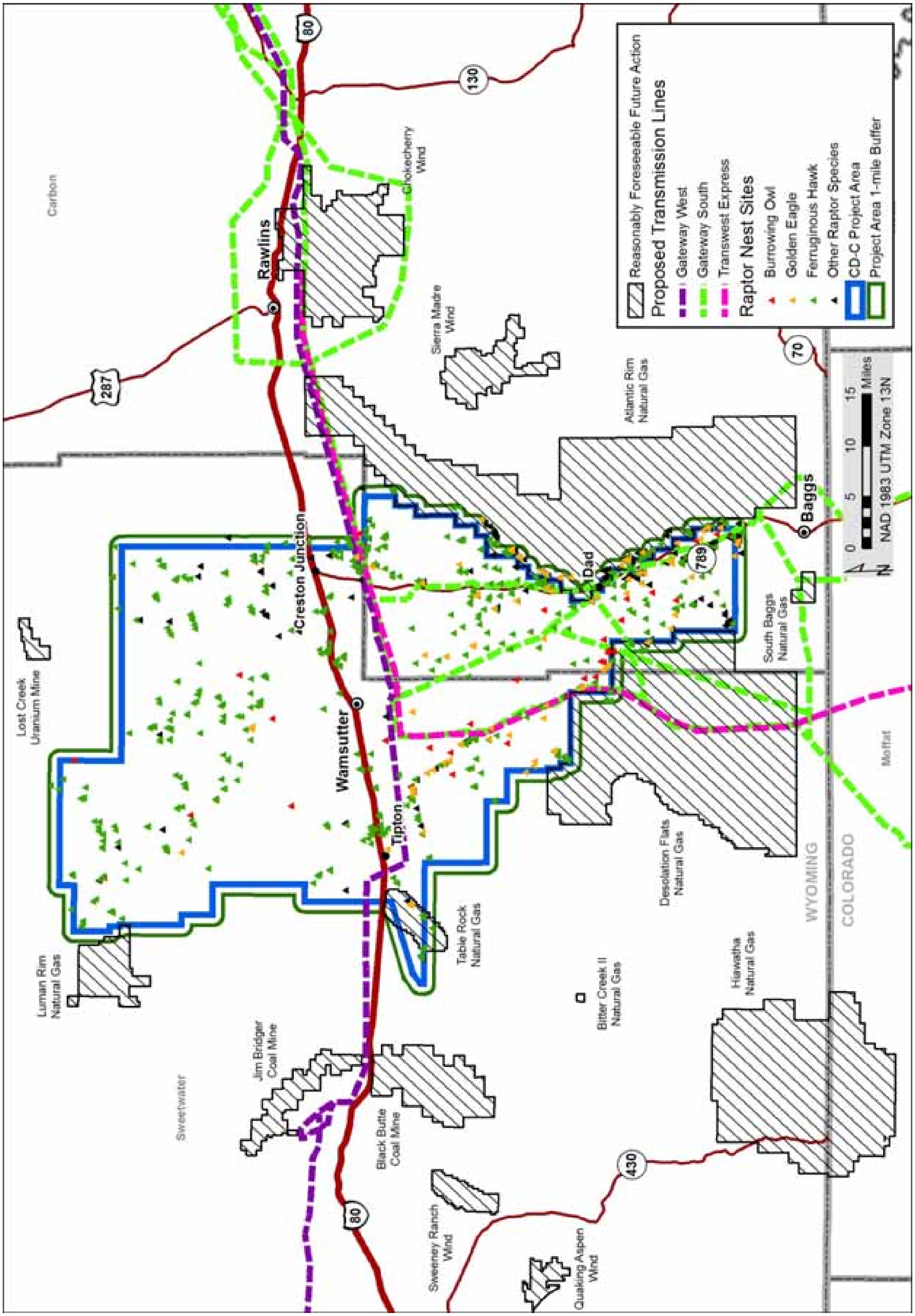
The CIAA for raptors includes the CD-C project area plus a 1-mile buffer (**Map 5.8-3**). This area covers approximately 1,226,825 acres, all of which would be considered raptor foraging habitat. Approximately 939 nests are known to occur in the CIAA; 780 known nests (83 percent) are within the project area, 122 nest sites are located in the CIAA of overlap between Atlantic Rim and CD-C project area, 14 would possibly be affected by transmission lines, and another 14 lie in the overlap area between Desolation Flats and the CD-C project area. Approximately 61 percent of the known nests are ferruginous hawk, 10 percent are golden eagle, and 5 percent are red-tailed hawk; the remaining 25 percent are various species including burrowing owl, prairie falcon, American kestrel, and unknowns. Potentially positive cumulative impacts from the creation of additional nesting sites (i.e., artificial nesting structures including hydrocarbon stock tanks) are known from other conventional oil and gas projects in the vicinity of the CD-C project area.

As with the Proposed Action and the various alternatives analyzed, the required buffers and restrictions on activity around active raptor nests and the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impacts on most raptor species in the CD-C project area and associated RFFA overlap areas is not expected to exceed the significance criteria. However, the BLM timing stipulations for protection of raptor nests is not applied on State and fee energy development actions. Refer to **Section 5.9.3** for a discussion of CIAA on the ferruginous hawk.

5.8.3 Fish

Cumulative impacts to fish species would include the effects of the CD-C project and other developments upstream in Muddy Creek, the most notable of which is the Atlantic Rim Natural Gas Project. At this time there are no known additional proposals to analyze or assess.

About 10 game-fish species and 20 non-game fish species may occur within or upstream/downstream from these two project areas. Of these, about 14 species, including six native species, are likely to be present within the project areas. Of the 14, four are BLM Sensitive Species and 10 are not. All of the 10 species that are not BLM sensitive would be subject to the same types of impacts described in **Section 4.9.3.1**. **Sensitive Fish Species**; however, they have a wide distribution within Wyoming (Baxter and Stone 1995). Consequently, the project area and other human activities within the Muddy Creek and Great Basin watersheds may have localized population impacts, but these impacts should not impact their status range-wide.



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Map 5.8-3. Cumulative impact analysis area, raptors

5.9 SPECIAL STATUS PLANT, WILDLIFE, AND FISH SPECIES

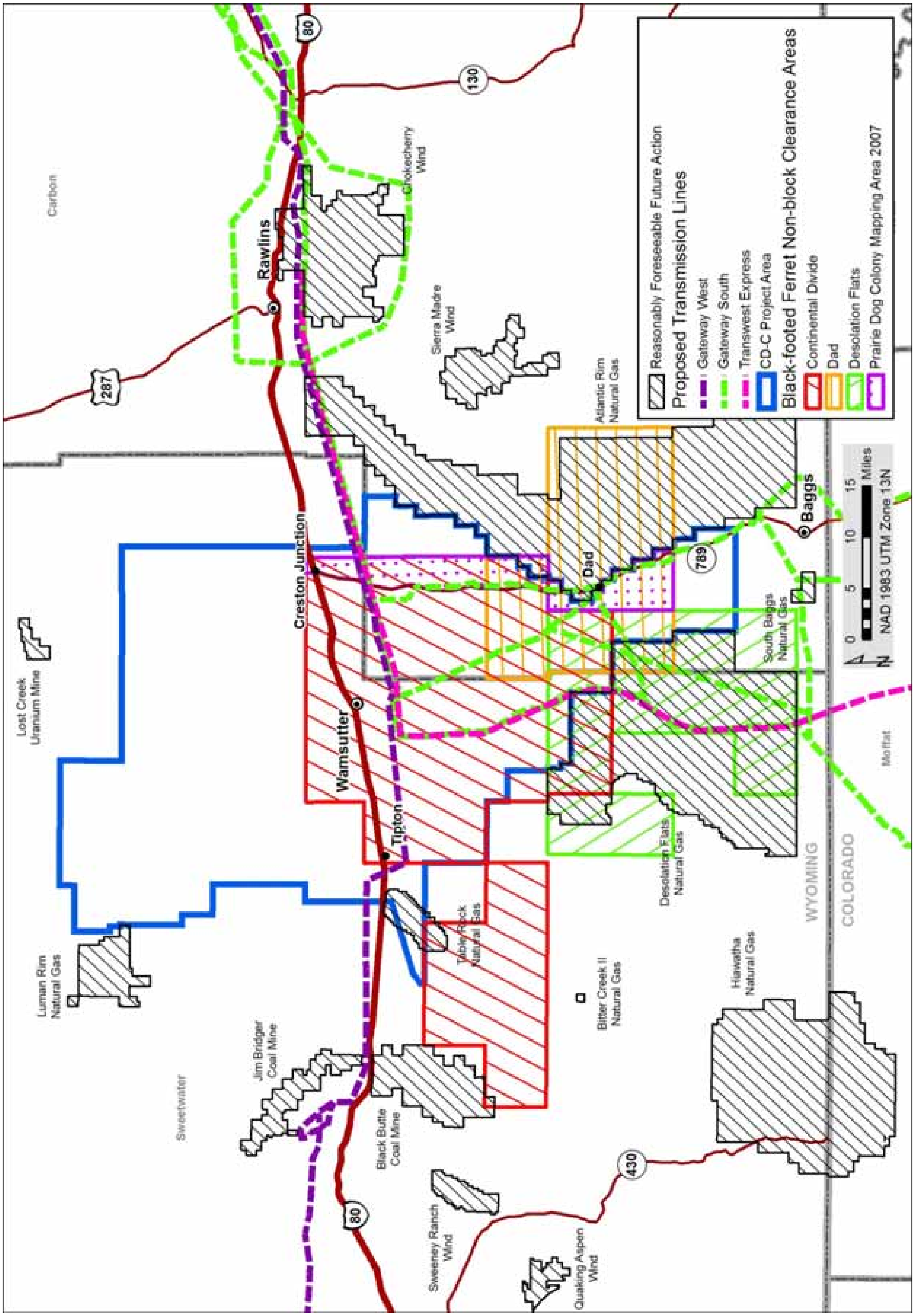
The CIAAs for wildlife resources differ with respect to species. The combination of the individual projects could result in a large area of increased fragmentation, disturbance of wildlife and their habitats, disruption of migratory corridors, and the loss of refuge areas. Additional effects could be wildlife dispersal, the reduction of non-fragmented habitats, competition with livestock, and inter-specific competition. The generalized increase in human presence and associated disturbance across such a broad scale are a concern. It can also be expected that competition for forage would increase in the remaining habitats leading to reduced carrying capacity and juvenile survival for some species; see **Section 4.9.3** for a more detailed discussion of potential impacts to special status species. Mitigations, COAs, and other BMPs would reduce the impacts of these developments, but not eliminate them. Reduced populations and population viability for some species can be expected in high density development areas. However, the BLM mitigations, COAs, BMPs etc., are not generally applied on state and fee energy development actions.

5.9.1 Threatened, Endangered, Proposed or Candidate Wildlife Species

Threatened and Endangered Wildlife Species

Black-footed ferret. The presence of black-footed ferret in the CD-C project area is very unlikely (see **Section 3.9.1.1**). The various CD-C alternatives would likely disturb colonies of white-tailed prairie-dogs, which are the black-footed ferret's primary habitat and prey source in this area. Surveys for black-footed ferrets may be required before ground-disturbing activities within identified prairie-dog complexes located in the Continental Divide, Dad, and Desolation Flats non-block clearance areas for all RFFAs potentially affecting those areas **(Map 5.9-1).** Without pre-disturbance surveys, significant impacts could occur in the non-block cleared areas; for example, almost 95 percent of the Dad and 80 percent of the Desolation Flats non-block clearance areas could be affected by the CD-C project area and other RFFAs. However, of the white-tailed prairie dog complexes identified as potential black-footed ferret habitat (Map 5.9-1**)**, it is anticipated that only Complex 1 would be impacted and only by the CD-C project. Complexes 2 and 3 are located to the west of CD-C and are not encroached upon by any of the other CIAA project boundaries.

The remaining white-tailed prairie-dog colonies within the CD-C project are in the "Block clearance" area, where surveys for black-footed ferrets are no longer warranted. The CD-C project area and RFFAs are not expected to exceed the impact significance criteria for black-footed ferret populations.



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Map 5.9-1. Cumulative impact analysis area, black-footed ferret

Greater sage-grouse. Approximately 60 percent of the CD-C project area is comprised of sagebrush and other shrub species, which represents potential greater sage-grouse nesting habitat. Recovery of shrubs, in locations that have been disturbed by development, to pre-disturbance levels is not expected to occur during the life of the project. Therefore, even locations that are successfully reclaimed would represent a long-term loss of nesting habitat; however, these areas would be used as early brood-rearing and foraging habitats throughout the seral stages.

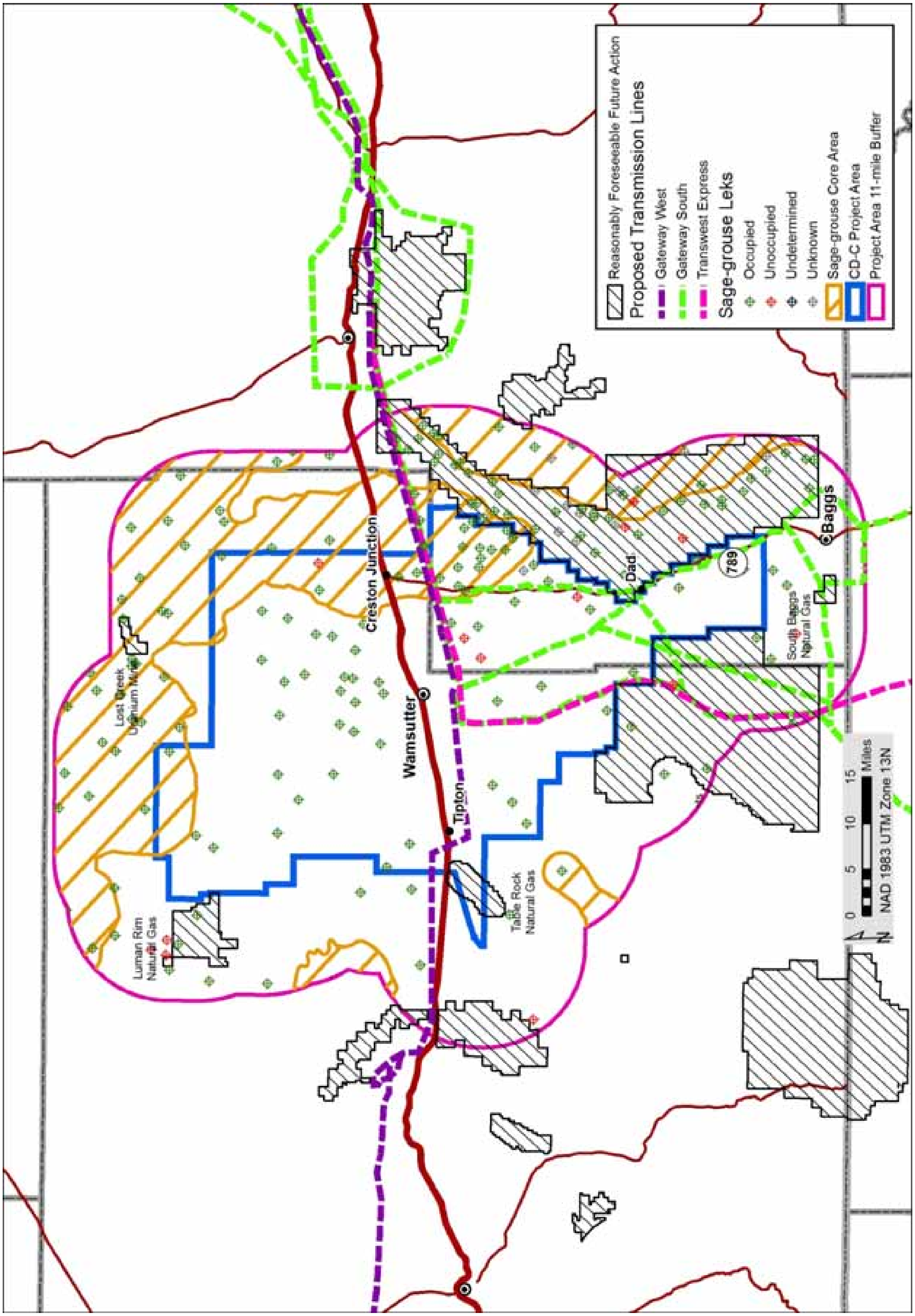
Per IM WY-2012-019, an 11-mile analysis area buffer is required around the project boundary for large-scale proposed actions (e.g. oil and gas full-field developments). This 11-mile buffer (**Map 5.9-2**) was used as the CIAA for greater sage-grouse breeding and nesting habitats potentially affected by the CD-C project and associated RFFAs, including the Luman Rim, Lost Creek, Desolation Flats, South Baggs, and Atlantic Rim projects. This area encompasses portions of the South Rawlins, Greater South Pass, Continental Divide, and Salt Wells Core Population Areas. Of these only the Greater South Pass and South Rawlins Core Population Areas would be directly affected by the CD-C project or RFFAs.

One-hundred ninety-two (192) known leks are located within 11 miles of the CD-C project area; 105 are occupied, 13 are unoccupied, and 74 have undetermined status (see **Map 3.9-2**). Another 67 known sage-grouse leks are located within the CD-C project area, for a total of 259 leks within the CD-C project CIAA. One-hundred sixty-eight (168) of these leks are occupied. All 259 leks would potentially be affected by the CD-C project or RFFAs as indicated on Map 5.9-2. Sixty-three (63) would possibly be directly affected by the CD-C project, 44 by Atlantic Rim, 18 by transmission line corridors and another 7 by various oil and gas projects. Other areas within the 11-mile buffer and associated Core Population Areas would be affected by scattered energy developments and anthropogenic features on the landscape.

Greater sage-grouse inhabit the CD-C project area and surrounding area year-round and require a wide range of seasonal habitats. The area of highest sage-grouse lek concentration in the 11-mile CIAA falls to the south of I-80 and east of WY 789, along the interface of CD-C and Atlantic Rim (**Map 3.9-2**). Approximately 81 occupied leks are known to be located in this area of high-quality/high-potential nesting and brood-rearing habitat. This area also contains large expanses of high-quality/high-potential severe winter use habitat.

Development activity may result in bird displacement and nest abandonment from direct and indirect impacts, such as long-term habitat fragmentation; loss of nesting or brood-rearing habitat; displacement or additional stress due to increased human activities including increased vehicle traffic, dust, excessive noise levels proximal to occupied leks; removal or modification of winter habitats; and increased predation due to an increased number of roosting sites available for raptors on power poles, tanks, and other man-made structures (see **Section 4.9.3**), especially in high-density development areas.

Regardless of the alternative selected, application of the Core Population Area density and disturbance limitations and mitigations (IM WY-2012-019 and SWED 2011) is intended to reduce disturbance to the habitat and the species to the point that sage-grouse populations within Core Population Areas are not negatively impacted. These restrictions would apply on all surface ownerships. Alternative D (100-Percent Directional Drilling) would reduce surface disturbance from road and well site locations by about 23 percent compared to the Proposed Action. Alternative E (No Action) would limit CD-C development activities to private and state mineral estates, thereby limiting additional impacts sage-grouse habitat and populations within the CD-C project area.



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Map 5.9-2. Cumulative impact analysis area, greater sage-grouse

In non-core areas, application of applicable IM WY-2012-019 and SGEO (Greater Sage-grouse Core Area Protection program) standards for avoidance of potential nesting and brood-rearing habitat as well as the Rawlins RMP (BLM 2008a) standard COAs, BMPs, Timing Limitations, and mitigation would reduce the potential impact to sage-grouse but impact to those populations would still be anticipated. Alternative A would have the greatest potential for impact to non-core sage-grouse populations. Alternative B would provide enhanced mitigations and protections for sage-grouse as well as other high-value resources. Under Alternative C, the disturbance cap would place a limit on the amount of unreclaimed surface at any one time in a section of public land. Alternative D (required directional drilling on federal mineral estate) would reduce surface disturbance from road and well-site locations by about 23 percent compared to the Proposed Action. Restrictions applied for protection of sage-grouse habitat in non-core areas, found in IM WY-2012-019 and SGEO, would apply on state, fee, and federal lands. Alternative E (No Action) would limit CD-C development activities to individually permitted federal activities and private and state mineral estates, thereby limiting additional impacts to project area sage-grouse habitat and populations.

5.9.2 Threatened and Endangered Fish Species

Cumulative impacts to Threatened and Endangered fish species would include the effects of the CD-C project and other developments upstream in Muddy Creek, of which the most notable is the Atlantic Rim Natural Gas Project. At this time there are no known additional proposals to analyze or assess.

Four federally endangered fish species may occur as downstream residents of the Colorado River system: **Colorado pikeminnow** (*Ptychocheilus lucius*), **bonytail** (*Gila elegans*), **humpback chub** (*Gila cypha*), and **razorback sucker** (*Xyrauchen texanus*) (USFWS 2003). Suitable habitat for these species does exist downstream of the CD-C and Atlantic Rim project areas in the Little Snake, Yampa, and Green Rivers. Because the Colorado pikeminnow is found in the Little Snake River, it could migrate into Muddy Creek, which makes Muddy Creek potential habitat for this species. Muddy Creek, however, is not suitable habitat for this species. Neither of the action alternatives for these projects is expected to affect this habitat, provided that mitigation measures for water resources and soils outlined in this document are implemented. Though they currently exist only downstream of the project area, water draining from the project area affects the downstream habitat for these species. Under the Proposed Action, the sources of potential risks to these fish species are water depletions, discharges of produced water, and spills of toxic materials.

Water Depletions. Under the Recovery and Implementation Program for Endangered Fish Species in the Upper Colorado River Basin, “any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish.” A small amount of water depletion may occur for the Atlantic Rim Natural Gas Project, and the Proposed Action may deplete an average of 510 acre-feet of water per year from aquifers in the Wasatch formation that may have contact with and contribute to the Little Snake River and its tributaries, including Muddy Creek.

Discharges of Produced Water and Spills of Toxic Chemicals. Produced water from the CD-C project area will not be discharged to Muddy Creek within the Little Snake River drainage; therefore, produced-water discharges will not pose a potential risk to these species. The Atlantic Rim project, however, has produced-water discharges to Muddy Creek that may be altering the hydrology of the creek.

Accidental releases (e.g., spills) of toxic chemicals also could occur. However, accidental releases of toxic chemicals should become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences are negligible (BLM 2007).

5.9.3 Threatened and Endangered Plant Species

The CIAA for Threatened and Endangered Plants is the CD-C project area. As described in **Section 4.9.3**, direct impacts to the threatened Ute ladies’-tresses (*Spiranthes diluvialis*) are not anticipated to occur. The application of the 500-foot buffer for riparian areas would provide protection for this species. If suitable habitat (i.e. riparian areas) were present, the proposal would be modified so impacts were avoided. The BLM stipulation for avoidance of riparian areas is not applied to state and fee energy development actions.

5.9.4 Sensitive Wildlife Species

Chapter 4 analyses determined that implementation of the Proposed Action or other analyzed alternatives is not expected to exceed the impact significance criteria for pygmy rabbit, swift fox, white-tailed prairie dog, Wyoming pocket gopher, bald eagle, burrowing owl, sagebrush obligate avian species, or mountain plover with the caveat that BLM mitigation measures be applied regardless of alternative selected. In addition, Alternative B provides enhanced protections for: greater sage-grouse leks, nesting/brood-rearing habitat, and winter concentration areas (**Section 4.9.3**) and ferruginous hawk nesting habitat. Alternative D reduces surface-disturbing activity by almost 23 percent compared to the Proposed Action.

The caveat regarding application of BLM mitigation measures for special status species would apply to all RFFAs as well as the CD-C project but would not apply to privately-owned checkerboard lands or state or private mineral estate in the CIAA. While some disturbance of these species would likely occur on private lands, it is not expected that impact significance criteria would be exceeded.

Ferruginous hawk. Concerns are identified **(Section 4.9.3**) regarding potential impacts to ferruginous hawk from disturbance to nesting/foraging habitats. The CIAA for raptors includes the CD-C project area plus a 1-mile buffer (see **Map 5.8-3)**. This area covers approximately 1,226,825 acres, all of which would be considered raptor foraging habitat. Approximately 577 ferruginous hawk nests are known to occur in the buffered CD-C project area. Potentially positive cumulative impacts from the creation of additional nesting sites (i.e., artificial nesting structures including hydrocarbon stock tanks) are known from other conventional oil and gas projects in the vicinity of the CD-C project area. However, an undetermined number of active nest sites would not be protected by application of the BLM timing stipulation and 1-mile buffer on state and fee lands/minerals, especially in the “checkerboard.” Overall, because of the required buffers and restrictions on activity around raptor nests and because of the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impact on ferruginous hawks in the project area and associated RFFA overlap areas is not expected to exceed the significance criteria.

Sensitive Fish Species. Cumulative impacts to sensitive fish species would include the effects of the CD-C project and other developments upstream in Muddy Creek, of which the most notable is the Atlantic Rim Natural Gas Project. At this time there are no known additional proposals to analyze or assess.

Sensitive fish, described in **Section 4.9**, would be significantly impacted by both the CD-C and Atlantic Rim projects (Criteria 3 and 4). The types of impacts resulting from both projects would be similar and cumulative in their effects. The primary cause of impacts would be increases in suspended sediments and sedimentation. One difference in the Atlantic Rim project as compared to the CD-C project is that Atlantic Rim has produced-water discharges to Muddy Creek that may be altering the hydrology of the creek.

Impoundments downstream of the CD-C project may be blocking sensitive fish movement into Muddy Creek, but are not attributable to the CD-C project. As detailed in Chapter 4, additional impoundments and alterations to natural flow characteristics (such as crossings) within Muddy Creek could have serious additional impacts to fish populations. Alteration of hydrology from roads, culverts, and other disturbances that result in re-channeling of overland flows into new channels or increasing the intensity/volume of flows within existing channels can affect sensitive fish. Blockage of fish migration within the CD-C project area as a result of channel crossings would seriously impact the viability of fish populations if it should occur.

Alternative B, the Enhanced Resource Protection Alternative for the Muddy Creek Corridor/ Watershed described in **Section 2.2.3.4** could significantly reduce project impacts to sensitive fish species, if they were applied to both BLM and private and state land within the CD-C project area. Without the application of these protections to private and state land, however, the benefits of these enhanced resource protections could be negated by increased drilling activities on private and state land. Consequently, alteration of fish habitat suitability from increases in suspended sediments and sedimentation could result in significant impacts to sensitive fish species.

5.9.5 Sensitive Plant Species

The CIAA for sensitive plants is the CD-C project area. As described in **Section 4.9.3**, direct impacts to sensitive plant species on federal land are unlikely to occur because the potential presence of these species would be determined by soils survey or rare-plant surveys prior to site development. Management practices identified on a case-by-case basis would be applied to surface-disturbing activities to maintain or enhance Special Status Plant Species and their habitats (BLM 2008b, p. 2-47). Indirect impacts include dust affecting plant health and reproduction and invasive species being introduced in the adjacent habitat and competing with the sensitive plants.

Adjacent projects that could increase the dust and invasive species problem within the CD-C project area include Atlantic Rim on the east of the project area, Desolation Flats on the southwest, and Luman Rim on the northwest. Additionally, three transmission-line projects are proposed to cross the project area and vehicles/equipment associated with the planning and construction of those projects would provide other potential sources of dust and seed. The only sensitive plant that might be encountered during transmission-line construction is the Gibben’s beardtongue. The surveys mentioned above should ensure that these plants, if encountered, would be avoided. The protections applied to sensitive species plants relative to BLM actions are not applicable to state and fee energy development actions.

5.10 WILD HORSES

The CIAA for wild horses includes the Lost Creek and Adobe Creek Herd Management Areas (HMAs). Impacts to wild horses associated with the CD-C project would include disturbed land and associated loss of available forage along with dust affecting forage palatability. There is also the potential for horse/vehicle collisions.

The Adobe Town HMA is generally located within the Desolation Flats Natural Gas Project area and impacts to the herd are more likely to happen in that area than in the CD-C project area. Two of the proposed transmission lines have potential routes through the Adobe Town HMA. During planning and construction, increased activity along their alignments would increase chances for collisions and generation of dust and remove small amounts of forage at the tower sites.

The Lost Creek HMA is located in the northwestern portion of the CD-C project area. It continues north from the CD-C boundary. The Luman Rim field is located to the west of the HMA and effects from vehicles accessing that field through the CD-C are possible. The Lost Creek HMA may also receive impacts from traffic associated with the Lost Creek Uranium Project.

■ HUMAN ENVIRONMENT

5.11 VISUAL RESOURCES

The CIAA for visual resources is the VRM Class III area within the CD-C project area. At roughly 1.1 million acres, the project area is large enough to enclose virtually all the potential foreground to middleground views of VRM Class III.

VRM Class III is the highest management classification within the project area. For the combination of landscape quality and viewer sensitivities prevalent within the project area, identifying visual impacts that might dominate a foreground to middleground view is critical to evaluating management actions for compliance with the VRM Class III standard. As described in **Section 4.11.2**, the RFO manages VRM Class III land for moderate change to visual resources by mitigating impacts through the use of BMPs as conditions of approval to APDs and right-of-way permits.

Cumulative actions that could affect VRM Class III in the CD-C project area are oil and gas development and electrical transmission line systems and rights-of-way. Development on BLM land combined with the same or similar actions on state and private land would result in cumulative visual impacts. Cumulative impacts would be especially likely to occur in the checkerboard and other areas of mixed ownership because BLM does not have the jurisdiction to mitigate these actions.

<u>Cumulative impacts due to oil and gas development</u>

Cumulative impacts due to oil and gas development would occur within the CIAA solely because of the CD-C project alternatives. No major oil and gas developments listed in **Table 5.0-1** overlap the CIAA.

Consistent with the analysis in Chapter 4, the greatest potential for cumulative impacts to visual resources from oil and gas development in the CIAA would occur under Alternative A, which would allow the highest level of surface disturbance.

Alternatives B through D would reduce the amount of surface disturbance due to oil and gas development. Alternative E, No Action, would generate no new surface disturbance. Alternative D would cause the least amount of surface disturbance among the action alternatives (as described in **Section 4.11.3.5**) by requiring the Operators to drill multiple wells from a single pad; multiple-well pads would not be required under the Proposed Action or other alternatives. Under Alternative E, much of the project area now affected by oil and gas development could gradually return to a reclaimed condition as oil and gas facilities on BLM land gradually become obsolete over time; therefore, the cumulative effect of Alternative E to scenic quality could be neutral to positive over the long term.

The actual visual contrast rating of wells, roads, and other facilities of the Proposed Action and action alternatives would be conducted after approval of the CD-C project, when development targets are identified and as the required site-specific APDs and right-of-way permits are evaluated. It is the site-specific location and intensity of development that actually determines the level of contrast perceived from a given view of the foreground to middle distance from a sensitive observation point. Site-specific location and intensity of development also determine the amount and type of mitigation required to achieve the management objective required by VRM Class III. This means that there is likely to be uncertainty for sometime as to whether cumulative impacts to specific viewsheds within the CIAA can be managed to a VRM Class III standard for the long term.

Even on federal land, the Operators' desired intensity and specific location of development could prevail over attempts to mitigate to a VRM Class III objective. This could occur despite BLM's mandate to implement measures to manage VRM Class III viewsheds. The BLM's authority to manage visual impacts in particular cases could be precluded when valid existing lease rights protect Operator activities. This limitation could leave a residual of unmitigated impact. In addition, parts of the CD-C project that target private and non-federal lands in areas of mixed land ownership are beyond BLM jurisdiction and could develop without adequate mitigation, leading to indirect impacts to visual resources on adjacent federal land

Developed areas where roads, well pads, tanks, and drill rigs dominate a view may accumulate within the project area to the detriment of existing rural landscapes that were previously intact. If this level of disturbance occurs and is viewable from sensitive observation points, the VRM Class III standard would be exceeded.

<u>Cumulative impacts due to transmission lines</u>

Two electrical transmission line projects listed in **Table 5.0-1** would cross VRM Class III parts of the CD-C project area: the Energy Gateway South Transmission Line Project (Gateway South) and the TransWest Express 600kV Project (TransWest). A third reasonably foreseeable transmission line from Table 5.0-1, Energy Gateway West, would cross only VRM Class IV land. Class IV land accommodates transmission lines by allowing a high level of modification to the existing landscape. Gateway South and TransWest are extended corridors that potentially would enter into many views as they traverse the CD-C project area. The three reasonably foreseeable transmission line projects are illustrated in **Figure 5.0-1**.

The Approved Rawlins RMP has provided for future utility development by designating the routes of existing transportation and utility lines as corridors that would be suitable for new transportation and utility ROW systems (ROD Map 2-2). The RMP also recommends the exclusion from the designated corridors of incompatible uses, among which are range and wildlife habitat improvements and any facilities "that would attract public use" (ROD p. 2-17). As they are shown on **Figure 5.0-1**, the preliminary alternatives for the proposed Gateway South and TransWest fall within designated corridors identified by the Rawlins RMP (ROD Map 2-2).

Although generally provided for by the Rawlins RMP, specific proposals for the Gateway South and TransWest projects would require site-specific environmental analysis and compliance with established permitting processes. Site-specific mitigation measures that could be applied during permitting to reduce the impact of transmission lines to a viewshed or to a specific observation point within the CD-C project area include properly siting latticed or appropriately colored towers against existing backgrounds or using topographical features to reduce visibility.

While effective when available, site-specific mitigation treatments are in fact limited in their utility for transmission lines because of what is typically the sparse, low-lying vegetation and flatness of the terrain in the CD-C project area. Therefore, the development of the Gateway South and TransWest projects would likely introduce strong vertical elements of an industrial character (tower structures) which would clash with the strong horizontal, natural elements (plains, rims, low vegetation and wide horizons) of existing settings within the CD-C project area.

The impact of the Gateway South and TransWest projects would likely be greatest where the utility ROW crosses or parallels travel routes. As shown on **Figure 5.0-1**, the southern extent of the western-most route alternative of the two transmission lines would cross interior BLM roads and the corridors of two historic trails, the Overland Trail and the Cherokee Trail. At those crossings, the transmission lines would adversely affect the viewshed of the roads and historic trails. Although the historic trail corridors are designated as "avoidance areas" for linear utility systems by the Rawlins RMP (Map 2-33b), a crossing of these corridors by a long-distance, north-south transmission line corridor is not explicitly excluded and may be impossible to avoid.

In addition, the southern extent of the easternmost route alternative of the Gateway South project would co-locate with the WY 789 corridor. The WY 789 corridor includes, at its south end within the CD-C project area, two topographical features known as Flat Top Mountain and The Bluffs. Although they are mostly of local interest to residents of Carbon and Sweetwater counties, these prominent features contribute to settings of moderate scenic quality, which is the highest level of scenic quality found within the CD-C project area (BLM 2011a). As prominent features, Flat Top Mountain and The Bluffs are focal points of foreground to middleground views that present themselves to travelers on WY 789 between Rawlins and Baggs, Wyoming.

The typical adverse impacts caused by a transmission line project are visual clutter in the foreground to middleground of a view and the visibility of the tall towers, which are 140 to 190 feet high for high-voltage lines of this type. From many perspectives, tower structures would rise above the CD-C project area's horizontal landforms and would likely appear prominently above the project area's wide skylines, perhaps competing with prominent natural features. Since high-voltage transmission lines are industrial in character, introducing such facilities would alter the scenic quality of existing VRM Class III viewsheds that would be affected by the Gateway South or TransWest projects within the CD-C project area.

Cumulative impacts conclusion

The combination of CD-C project oil and gas development and the development of the Gateway South and TransWest transmission line right-of-way systems in the area south of I-80 and west of WY 789 could combine to create a high cumulative impact in some viewsheds in the VRM Class III parts of the CD-C project area. In addition, development of oil and gas facilities throughout the CD-C project area may expose existing VRM Class III areas to under-mitigated, site-specific visual impacts. These could accumulate within a given viewshed because of minerals lease terms that limit the BLM's ability to mitigate visual impacts or because of the BLM's lack of jurisdiction over visual resources management in mixed ownership areas.

Visual impacts from these two kinds of planned or reasonably foreseeable development may add up to a high enough level of incompatible contrast with existing settings to be non-compliant with VRM Class III. If this occurs repeatedly in a number of VRM Class III areas of the CIAA, BLM may find it necessary to reconsider its resource allocation decisions through an RMP amendment process. This could lead in the future to an amendment of the RMP and a new set of resource allocations that would expressly lower VRM management classifications as needed to reflect the cumulative impact of development on the condition of the visual resources of the CIAA.

5.12 RECREATION

The CIAA for recreation is the Western Extensive Recreation Management Area (ERMA) of the RFO. The CIAA/ERMA covers all public land in the RFO west of Rawlins.

The recreation resources of the CIAA are those of the CD-C project area plus areas beyond the project area that include more of the same Hunt Areas, big game Herd Units, wild-horse management areas, contiguous blocks of public lands, and interconnected public roads. These combined resources support the recreation values of concern for the cumulative impacts analysis, namely big game hunting and dispersed, non-consumptive recreational uses that center on wild horses, other wildlife, and the character of the landscape.

Projects potentially affecting recreation in the CIAA are the CD-C project and other projects identified in **Table 5.0-1**. Other existing and reasonably foreseeable future projects are the Atlantic Rim Natural Gas Field Development, the Desolation Flats Natural Gas Development, the Luman Rim natural gas project and the Sierra Madre part of the Chokecherry and Sierra Madre Wind Energy Project.

Cumulative impact to hunting, which is the main recreation activity in the CIAA, would occur as surface disturbance from development of the CD-C and other projects accumulates. Cumulative impact to hunting recreation begins with displacement of big game species within Hunt Areas because of disturbance to critical habitat and development activity within those habitats at key times of year. Cumulative impacts to hunting recreation also may include impacts to big game populations at the herd level of the primary big game targets in the CD-C project area, pronghorn and mule deer, because of long-term disturbance to sagebrush habitat.

When big game species leave a Hunt Area, hunters soon leave as well, because hunting success declines. If Herd Units are affected, the animals available for harvest and therefore the supply of hunting recreation, as reflected in the number of licenses issued, may decline. The potential for cumulative effects to Hunt Area displacement and potentially reduced availability from the herd is perhaps highest for pronghorn pronghorn hunting. As indicated by **Table 3.8-1**, estimated populations in the largest pronghorn Herd Units of the CIAA (Red Desert Herd Unit north of I-80 and Bitter Creek Herd Unit south of I-80) had a slightly decreasing population trend from 2001 to 2009 and an estimated population lower than the objective in 2009. Mule deer also may be affected by cumulative, long-term disturbance of habitat.

There are also indirect impacts associated with hunting in the CIAA that may arise as development disturbance and activity accumulate. One is the potential for financial impact to big game outfitters whose commercial success depends on access to, and hunter success in, the CIAA. Another is potentially lower hunter safety because of higher accident risk as hunter density rises where displaced game has concentrated. Finally, some hunters wishing to avoid industrial facilities locations for safety and aesthetic reasons may find it more difficult to do so as development density rises in the CIAA; this would raise the likelihood of a lower-quality experience for some recreational hunters.

Relatively undisturbed scenery is an integral part of the recreation experience for activities such as wildlife viewing. Accumulating development would decrease the availability of this type of recreational setting throughout the CIAA, so recreationists seeking natural-appearing landscapes would have to travel elsewhere and perhaps for greater distances as the CD-C and other projects are fully developed over time and before landscapes are fully reclaimed.

The re-establishment of mature vegetation after final reclamation would take as much as 30 years in some parts of the CIAA. Localized areas may not achieve successful revegetation for much longer. With project lives of 45 to 55 years underway or reasonably foreseeable, the CIAA is not likely to be fully reclaimed for habitat or appearance for 70 to 80 years from its initial status. Long-term cumulative impacts in the CIAA would be likely to affect from two to four generations of hunters, wildlife viewers, and dispersed recreational users that value solitude in a natural-appearing landscape.

The greatest cumulative impacts to recreation would occur under Alternative A because of increased surface disturbance and less protection to visual resources, which contribute to the recreation setting. Cumulative impacts to recreation would be less under all other action alternatives within the CD-C project area, which implies lesser impact to the recreation resources of the CIAA as a whole.

Under Alternative E, No Action, the recreation resources of the CD-C project area, which in turn is a large part of the CIAA for recreation as a whole, could gradually improve as new oil and gas development is avoided and as existing oil and gas facilities gradually become obsolete over time and are reclaimed.

Under Alternative E, No Action, the recreation resources of the CD-C project area, which in turn is a large part of the CIAA for recreation as a whole, could gradually improve as new oil and gas development is avoided and as existing oil and gas facilities gradually become obsolete over time and are reclaimed.

5.13 LANDS WITH WILDERNESS CHARACTERISTICS

No Lands with Wilderness Characteristics have been identified within the CD-C project area.

5.14 CULTURAL AND HISTORICAL RESOURCES

The CIAA for cultural and historical resources is the CD-C project area. Archaeological sites generally are located in discrete areas and effects on these sites are a consequence of implementing surface-disturbing activities associated with a development proposal. Impacts from past and present actions within the project area could occur as a result of the following mineral development projects which overlap the CD-C project area: Continental Divide, Continental Divide/Wamsutter II, Creston/Blue Gap, and Patrick Draw. In addition to the Proposed Action, impacts from reasonably foreseeable future actions (**Table 5.0-1**) include three transmission lines: the TransWest Express, Gateway West, and Gateway South. The TransWest Express is proposed to run from Sinclair, Wyoming to southern Nevada. The proposed route would begin just south of I-80 and east of Rawlins, heading west-southwest into the project area, and turning south in Sweetwater County toward the Wyoming/Colorado border. In all, the proposed route would traverse approximately 45–50 miles within the project area. The Gateway West transmission line from Glenrock, WY to Idaho would bisect the project area from east to west, running to the south of and roughly paralleling I-80 until approximately 10 miles from the western boundary, where it would turn northwest across I-80, and then west toward Rock Springs. Approximately 72 miles of the route would lie within the project area. The Gateway South transmission lines would also originate in Glenrock, following the same route as Gateway West into the project area, and then splitting into multiple routes running south toward Nevada (**Map 5.0-1**). In all, approximately 140 miles of routes would cross the southern portion of the project area. Assessment of impacts from these transmission lines would be speculative at this time since the final routes have not been approved.

Given the average site density of .04 cultural sites per acre, approximately 1,888 sites could be located within accumulated disturbance areas for the Proposed Action compared to 2,467 for Alternative A; 1,821 sites for Alternative B; 1,718 sites for Alternative C; 1,458 sites for Alternative D; and no sites for Alternative E, No Action. It should be noted that sites are not evenly dispersed throughout the study area, but are typically found along the major drainages and lower benches of escarpments that dominate the terrain in the project area.

In addition, segments of the Cherokee and Overland Trails, the Lincoln Highway/Union Pacific Grade, and the historic Rawlins-Baggs Road traverse the project area. These segments, including those that contribute to overall eligibility for listing on the NRHP, are summarized in **Table 5.14-1**.

Table 5.14-1. Historic trails and roads in the CD-C project area

Trail/Road	Total Miles, All Segments	Total Miles, NRHP-Contributing Segments
Overland Trail	22.49	14.08
Cherokee Trail	13.32	4.49
Lincoln Highway/Union Pacific Railroad Grade	45.24	16.24
Rawlins to Baggs Wagon Road	15.18	0.00

Source: D. Johnson, Western Archaeological Services, personal communication; 2011.

As directed by law, cultural resources inventories and consultations would be conducted for any projects involving federal lands, and adverse effects to NRHP-eligible sites would be avoided or mitigated as appropriate. All activities associated with the Proposed Action would be in accordance with federal laws and agency guidelines. Impacts to any previously unknown NRHP-eligible sites that may be discovered during construction activities would be mitigated in accordance with this EIS. Although sites located within disturbance areas are avoided or mitigated, sites located outside of and adjacent to disturbance areas are vulnerable to indirect impacts such as vandalism, illegal collection, dust, and erosion. It is anticipated that there would be a cumulative increase in vandalism, illegal collection, and dust due to the increase in roads throughout the entire natural gas field, and increased erosion at sites located in the vicinity of well pads and associated pipelines where vegetation cover has been reduced or eliminated.

5.15 SOCIOECONOMICS

The CIAA for socioeconomic conditions includes Carbon and Sweetwater Counties. Given Rock Springs' position as a regional service center for the natural gas industry in southwest Wyoming, the indirect effects of past, ongoing, and reasonably foreseeable future effects of regional natural gas development are also considered.

Within the project area, 224 new wells were drilled during 2010 and an estimated 3,738 wells were in production at the end of 2010. Production activities, maintenance and workover expenditures, employment, and tax revenue generation associated with these wells will be ongoing, regardless of which alternative is selected by the BLM. Because much of the infrastructure to support this level of drilling and production is in place, ongoing production activities, expenditures, and employment associated with wells currently in production are considered part of both the baseline and cumulative effects analyses.

Past and current natural gas drilling and production in the project area and elsewhere in the CIAA have resulted in the development of substantial infrastructure capable of supporting future development and production. In some cases this infrastructure has excess capacity relative to the current (mid-2011) levels of development. Examples of infrastructure put in place to support past and ongoing development include the natural gas operator and service company operations yards in Rock Springs, Wamsutter, Rawlins and Baggs, described in **Section 3.15.1.1**, as well as pipelines, service roads, and other ancillary facilities. Past and ongoing activities have also resulted in human resource development, such as a cadre of employees in natural gas drilling, production, and support companies. Finally, natural-resource and other industrial development has supported construction and operation of substantial commercial and public infrastructure in communities in the CIAA. This industrial, human, commercial, and public infrastructure is capable of supporting a certain level of ongoing and future natural resource and industrial development activity and serves as a base for expansion of capacities to support higher levels of development.

A number of the reasonably foreseeable projects identified in **Table 5.0-1** require regulatory approval to proceed. If approved, the wind energy, transmission line, and other projects could contribute to cumulative socioeconomic effects in specific areas of the CIAA. The potential for adverse cumulative effects such as labor force competition, housing shortages, and strained community infrastructure and services would occur primarily in the event of concurrent construction of these projects. The potential beneficial cumulative effects, including increases in tax revenues, would be longer-term.

In contrast, the reasonably foreseeable natural gas projects, both currently approved and as yet unapproved, would contribute to cumulative socioeconomic effects over longer time periods and would affect socioeconomic conditions in a broader portion of the CIAA.

Although each of the natural gas projects identified in **Table 5.0-1** has or will have an assumed pace of drilling and development identified in the relevant NEPA document, as noted in **Section 4.15.2**, the actual pace of natural gas development in southwest Wyoming is variable and unpredictable because development depends on a variety of factors including energy demand, pricing, regulatory approvals, rig and manpower availability, transmission pipeline capacity, weather, and the investment and development strategies of individual energy companies. Consequently, the potential for cumulative socioeconomic effects would be greater during extended periods of natural gas demand.

In the eastern portion of the CIAA, identified cumulative projects by 2020 include construction of the proposed Chokecherry and Sierra Madre (CCSM) Wind Energy Project, the Gateway West, Gateway South and TransWest Express transmission line projects, the Lost Creek In Situ Uranium Project, and the Medicine Bow Fuel & Power Coal-to-Liquids (CTL) Project.

The proposed CCSM Wind Project would primarily affect the Rawlins portion of the socioeconomic CIAA, although some construction workers might also seek housing in Rock Springs and the Wamsutter and Baggs areas. Due to timing stipulations related to wildlife, active construction would likely occur during a six-month period of three or four consecutive years, with 800 to 1,200 construction workers during the peak periods. Consequently, the potential for adverse temporary and short-term cumulative socioeconomic effects during construction would be high. Once construction is complete, socioeconomic effects would be largely beneficial.

Construction of the TransWest Express, Gateway West and Gateway South transmission line projects could each affect one or more communities in the region, depending on routing, as the construction workforce moves through the area over one or two construction seasons. The effects would again be associated with demand for housing, community services, and fiscal effects related to project activity and the construction workforces. Operating work-force requirements of the wind energy and transmission lines are substantially smaller than the construction workforce needs.

The Lost Creek In Situ Uranium Project would affect Bairoil and Rawlins during construction and operation.

The Medicine Bow Fuel & Power CTL Project, a combination mining and industrial project, could create cumulative socioeconomic effects in Rawlins and other communities in Carbon and Albany Counties located outside the CIAA. This large project poses a potential for cumulative socioeconomic effects in Rawlins during the multi-year construction phase and initial staffing period for project operation. Once full-scale operations begin and housing and public infrastructure and services are in place to serve demand, the socioeconomic effects would be largely beneficial.

The Bridger Mine expansion and proposed Sweeney Ranch, White Mountain, and Bridger Butte wind energy projects would primarily affect western Sweetwater County and the communities of Rock Springs and Green River. In the case of the Bridger Butte project, Uinta County and its communities could also be affected. The expansion of the Bridger Mine is ongoing and most socioeconomic effects of the project were considered in the baseline. Adverse socioeconomic effects of the wind energy projects would occur primarily during construction, with beneficial effects occurring as tax revenues began to flow to local and state governments.

The final construction schedules for the proposed wind energy, transmission line, mining and other projects listed in **Table 5.0-1** will not be known until they receive the required authorizations, approvals, and financing. It is also not possible to predict with accuracy the level of natural gas drilling that will occur in southwest Wyoming during the construction period for these projects.

If construction for all or some of these projects were to overlap concurrently with an increase in natural gas drilling levels to 2007–2008 levels, another "boom" could ensue in the CIAA. In that case, cumulative impacts on area socioeconomic conditions would include short-term and long-term positive effects on local economic conditions, increased employment opportunities and increased local and state government tax royalties.

Adverse effects would include demand for temporary and long-term housing resources that substantially exceed local supplies, demand for local government services that exceed some service capacities, and changes in local social conditions that could include social disruption in some communities. Increased employment opportunities in relatively high-paying construction and energy-development jobs would result in competition for workers to the detriment of existing businesses and government agencies that could lose existing employees and experience difficulty recruiting new employees. On the other hand, workers would benefit from the increased wages that would result from this competition, while simultaneously potentially facing higher costs of living.

Shortfalls in temporary housing availability could be mitigated by development of temporary housing facilities. Medicine Bow Fuel & Power has proposed such facilities to accommodate construction workers on its CTL Project and the Power Company of Wyoming has indicated it would consider providing such facilities for CCSM. It is also becoming increasingly common for natural gas Operators and drilling companies to develop temporary housing; three such facilities, several rig camps, and the placement of dormitory units in local mobile-home parks were operational near the project area in 2007–2008.

The pace of residential construction in most communities in the CIAA would need to increase substantially to accommodate cumulative demand for longer-term housing units, were several of the projects listed in **Table 5.0**-1 to overlap with an increase in natural gas development activities.

Demands on housing and local government services associated with some of the wind energy and transmission line projects and natural gas development would be seasonal, presenting staffing challenges for counties and communities. Excess capacity exists in many public-utility infrastructure systems (e.g., water and wastewater systems) in the communities that would likely host the bulk of the construction and natural gas development workforce. Recent experience in the CIAA has been that relatively few families and school-age children have accompanied construction and natural gas workers to the area; consequently, local school districts could likely accommodate cumulative enrollment with existing facilities in the near term. In the longer term some schools may need to add or expand facilities and the lead-time to secure approval and funding from the Wyoming School Facilities Commission and plan and construct school facilities could mean that certain facilities would experience crowding until new facilities are available.

Community services such as law enforcement, emergency response, social services, and road and bridge departments, which in some cases experienced reductions in funding levels, service provision, and staff cutbacks in recent years, would initially face constraints in responding to increased demand. For most projects, local receipts of sales and use tax revenues lag the increases in demand. In other cases, a jurisdictional mismatch could occur between jurisdictions benefitting from tax revenue accrual and those facing the demands. This lack of revenue, coupled with competition for workers and the difficulty in staffing for seasonal demand, would present substantial challenges for local governments in the early years of a boom.

When ad valorem and production-related revenues—and for wind energy projects, energy production tax revenues—begin to flow from the cumulative projects, counties and special districts (and in some instances, school districts) will benefit from substantially increased revenues. However, municipalities will not benefit directly from these revenues.

Cumulative development in the CIAA also holds potential to affect local attitudes, opinions, and lifestyles and these effects are likely to be mixed. Development of the wind energy, transmission line, mining, and other projects listed in **Table 5.0-1**, coupled with a moderate increase in natural gas development, would result in economic growth and increased employment opportunities in relatively high-paying jobs. These changes would create the prospect for improved financial status of many residents, which would correspondingly increase support for cumulative development activities, particularly among those segments of the community that would benefit directly or indirectly from the increased economic activity. On the other hand, dissatisfaction may occur among those residents whose economic activities and/or recreation activities rely on use of the same geographical areas as the Proposed Action and projects listed in Table 5.0-1, including ranchers, grazing operators, outfitters, hunters, and other recreationists. Moreover, if area residents perceive that wildlife habitat, scenic vistas, and other resources are being degraded by development, levels of dissatisfaction could become greater and more widespread.

Given the cyclical nature of natural gas development and the potential for other energy development to occur, it is difficult to predict development and associated population levels with any certainty. Following population gains in response to cumulative construction activities, population in the CIAA would decline as construction is completed, perhaps dramatically in the event of multiple concurrent construction schedules. Exceptions to this pattern would include the mining projects and the Medicine Bow Fuel & Power CTL project, which have relatively large operating workforce requirements. If employment and population were to fall dramatically, businesses that expanded or opened to accommodate the temporary population influx would need to transition to accommodate the decreased demand. Some business closures would be likely. Effects on area housing conditions could range from moderate to severe, depending on whether the construction and natural gas development demands were accommodated in temporary housing or if housing to accommodate the temporary workforce was developed with a post-boom use in mind. In those cases, communities in the CIAA could reduce the amount of unoccupied temporary housing after construction is completed or if a slowdown in natural gas development were to occur. Similarly, the fact that most community infrastructure including water and sewer systems is already in place should help communities avoid substantial debt that would be difficult to service when population levels decrease.

5.16 TRANSPORTATION

The CIAA for transportation includes western Carbon County, eastern Sweetwater County, and the highway transportation network providing access to and within the project area. Cumulative effects on transportation would include changes in traffic volumes. These changes, when combined with traffic associated with the CD-C project, would affect overall travel conditions on the CIAA transportation network. Past, ongoing, and reasonably foreseeable activities expected to produce incremental and cumulative impacts within the CIAA are summarized in **Table 5.0-1**.

Historic and ongoing traffic within the project area is associated primarily with natural gas drilling and production, grazing, and outdoor recreation. Within the project area, 224 new wells were drilled during 2010 and an estimated 3,738 wells were in production at the end of 2010. Production-related traffic associated with these wells will continue for their remaining productive life and during abandonment and reclamation, regardless of which alternative is selected by the BLM. Using the trip-generation factors developed for this assessment, an estimated 726 AADT would be associated with drilling under the Proposed Action in the peak year and an estimated 798 AADT associated with production activities in the peak year.

Within the project area, the reasonably foreseeable actions that could result in cumulative transportation impacts would be the previously authorized Desolation Flats and Luman Rim natural gas projects.

Two county roads serving the project area also provide access to the Desolation Flats project area (DFPA): SCR 23/CCR 701 (Wamsutter–Dad Road) and CCR 700. Although these two roads have served development in both the project area and the DFPA for years, incremental increases in traffic on these roads could occur if natural gas demand and prices support an acceleration of drilling and field-development activities.

Cumulative effects on county roads associated with the Luman Rim project are not anticipated. Primary access to the Luman Rim project area (LRPA) from I-80 is via SCR 21, which is outside the project area. It is possible to access the LRPA via two roads that traverse the CD-C project area; SCR 67 travels north from I-80 and intersects with SCR 20, which then exits the project area to the west and intersects with SCR 21 south of the LRPA. However, the longer travel distance from I-80 associated with this route discourages its use to access the LRPA for all but contractors and vendors who may be traveling to/from the LRPA from other job worksites within the CD-C project area.

All of the projects listed in **Table 5.0-1** could generate traffic increases on I-80, particularly during construction, although some of the affected sections of I-80 would be outside of the CIAA. Under an accelerated drilling scenario, periods of traffic impedance and congestion could be anticipated, and some increases in the number of accidents could be anticipated. Cumulative traffic effects could also increase road maintenance requirements for WYDOT and for both county road and bridge departments.

The highest volume of incremental traffic on I-80 would likely be in conjunction with the CCSM Wind Energy project, proposed for development south of Rawlins. Materials, equipment and supplies deliveries for the CCSM project are anticipated to arrive by rail and be offloaded at an intermodal facility located either southeast of Sinclair or on the south side of I-80 west of Sinclair, which would result in relatively little cumulative truck traffic on I-80. However, daily commuting by workers and others, including trips by contractors, would result in incremental traffic on I-80. One option under consideration by the Power Company of Wyoming includes housing construction workers in Rock Springs and Laramie. Workers commuting from/to these communities to the CCSM project area would contribute to cumulative traffic effects on I-80 between Rock Springs and Rawlins or east of Rawlins for six to eight months during each of the anticipated four-year construction periods. These effects would be minimal given the substantial baseline volumes of traffic on I-80 in these locations.

The Medicine Bow Fuel & Power CTL Project and the Sweeney Ranch, White Mountain, and Bridger Butte wind energy projects are all located some distance from the project area. The TransWest Express, Gateway West and Gateway South transmission line corridors projects pass through the project area, and some substations and ancillary facilities may also be located within the project area. Construction equipment, supplies, and materials for these projects could be transported by rail or, for the CTL project and some segments of the transmission projects, via US 30 from Laramie. Transport of materials, equipment, and supplies to these projects would also occur on I-80 and, when considered in conjunction with the forecast traffic for CD-C, would generate cumulative traffic increases on the highway. Large increases would occur primarily during construction of these projects and would therefore be temporary and short-term in nature.

Construction and operations of the Lost Creek In-Situ Uranium Project could contribute to cumulative traffic impacts along I-80, although materials coming from the north—e.g., from Casper—would likely access the Lost Creek project via US 287. Construction and operations materials coming from the east or west on I-80 would travel through Rawlins to access US 287, and a portion of the project's construction and operations workforce would likely reside in Rawlins. Both of these scenarios would result in cumulative transportation effects within the city if the Lost Creek project's construction schedules were to coincide with natural gas development within the CD-C project area. Given the relatively minor increases in CD-C-related traffic anticipated for US 287, no substantial adverse cumulative impacts are anticipated.

Development associated with the previously approved Atlantic Rim Natural Gas Field Development Project would also use WY 789 to access the western portions of its project area. Cumulative transportation impacts would be anticipated for WY 789 between Creston Junction and Baggs, particularly during periods when market conditions promote higher levels of new development activity in the Atlantic Rim and CD-C project areas. Under an accelerated drilling scenario, periods of traffic impedance and congestion could be anticipated, particularly around the Dad area.

All of the natural gas projects listed in **Table 5.0-1** would generate additional traffic on I-80. If there were a regional acceleration of drilling and development in response to sustained high sales prices for natural gas, those increases could be substantial.

5.17 NOISE

The CIAA for the discussion of Noise is limited to the CD-C project area due to the localized nature of this issue. Noise will continue to be generated by project area operations for the life of the field.

Cumulative impacts of the Proposed Action and action alternatives include the addition of development- and production-related noise sources to those that already exist within the project area. These noise sources include, but are not limited to the I-80 corridor, the railroad, gas compression, fluid transport by truck, gas-stabilization equipment, hydrocarbon production, and maintenance activities. In some areas the density of development could be considered by some individuals to be "noisy." This continual (though likely low-level) noise may be disruptive or objectionable to individuals such as recreationists or livestock operators and may result in displacement of such activities. Displacement of wildlife in general and sensitive wildlife species may also occur in "busy" or "noisy" areas in the greater CD-C field-development area; refer to **Sections 5.8** and **5.9** for this discussion.

■ MANAGEMENT ENVIRONMENT

5.18 RANGE RESOURCES

The CIAA for range management includes the entire area of all of the allotments that are located within or partially within the CD-C project area. The number of well pads projected for the action alternatives varies from a high of 8,950 under Alternative A (100-Percent Vertical Drilling) to a low of 4,032 in Alternative D (Directional Drilling). Many of the allotments in the southern portion of the CD-C project area cross the project boundary into other natural gas developments (Atlantic Rim on the east and Desolation Flats on the west). One allotment managed by the Rock Springs Field Office has minimal acreage within the CD-C project area, as well as acreage in the Luman Rim natural gas project.

Those allotments that cross into the other project areas would have impacts from both natural gas projects including forage loss, reduced palatability of forage from dust, potential damage to fences and other improvements, possible increase in invasive plant species that can out-compete native vegetation and poison sheep, possible collisions, and increased difficulty in management of stock (gates left open, etc.).

Depending on the location of well pads and the number of locations and associated facilities, some of the allotments may reach the level of significance for loss of AUMs described in **Section 4.18.2**. Surface-disturbance totals described in **Table 3.18-2** would likely be higher for allotments that are affected by developments in addition to the CD-C project. It is possible that in these allotments, the combination of impacts from several projects could result in the loss of AUMs that reached the level of significance, which if not mitigated by range-improvement projects, could result in a reduced number of livestock being permitted on the allotment.

Construction of the three transmission lines planned to cross the CD-C project area and development of adjacent oil and gas fields may cause many of the same indirect impacts identified above and would increase overall impacts on the affected allotments.

5.19 OIL AND GAS AND OTHER MINERALS

The CIAA for oil and gas and other minerals is southwestern Wyoming. The natural gas fields of the CD-C project area make up the largest single—but not the only—source of oil and gas in the analysis area. The Atlantic Rim, Desolation Flats, Luman Rim, Table Rock, Moxa Arch, and Hiawatha project areas are among the other sites of fluid mineral development in the analysis area. The production from all these project areas is transported out of the analysis area by pipeline to national markets. Many of the same Operators that develop natural gas in the CD-C project area also work in other fields in the analysis area. Employees, facilities, and infrastructure of one Operator are often utilized in support of various projects within the analysis area.

5.20 HEALTH AND SAFETY

The cumulative impacts analysis area for the discussion of Health and Safety includes all Reasonably Foreseeable Future Actions listed in **Table 5.0-1**. Two aspects of safety—increased traffic and additional natural gas pipeline construction—are common to all activities across southern Wyoming. These issues are long-term in duration and would continue as part of project area operations for the life of the field, approximately 45 to 55 years.

Cumulative impacts of the Proposed Action would include the addition of vehicles associated with natural gas development and the other reasonably foreseeable activities to the interstate highway and local road systems. The additive number of semi-truck rigs and passenger vehicles would add to the risk of collision for the project workforce as well as the general public. I-80 will continue to be a major east/west transportation corridor for all aspects of transportation including materials needed for continued gas-field development and operations, as well as transportation of materials from the field including produced condensate, produced water, and solid wastes; refer to **Section 5.16 Transportation and Access** for this discussion.

Natural gas pipelines may be constructed or enlarged to accommodate the volume of gas being produced across the southern tier of Wyoming. Conversely, as fields are depleted, gas production declines and pipelines may be abandoned; refer to **Section 5.16** for this discussion.

5.21 WASTE AND HAZARDOUS MATERIALS MANAGEMENT

The cumulative impacts analysis area for the discussion of Waste and Hazardous Materials Management includes all Reasonably Foreseeable Future Actions listed in **Table 5.0-1**. Wastes will continue to be generated and hazardous materials will continue to be used in the project area operations for approximately 45 to 55 years, the anticipated life of the field.

Cumulative impacts of the Proposed Action include: the addition of wastes generated from 15 years of operating man camps, drilling and completion of 8,950 additional wells, and the associated produced water. Over its lifetime the project would add significantly to the volume of solid waste, drilling and completion operations wastes, and produced water, as well as to the wastes generated from well-site and pipeline compression and liquids stabilization facilities. The need to appropriately dispose of these wastes would significantly stress the existing permitted capacity of local municipal and third-party disposal facilities and would necessitate the permitting and construction of additional disposal facilities in proximity to the project area. The cumulative impacts would be similar for all the analyzed alternatives, although at a reduced level for the No Action alternative.

6. CONSULTATION AND COORDINATION

6.1 INTRODUCTION

An EIS must be prepared when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. An EIS aids federal officials in making decisions by presenting information on the physical, biological, and social environment of a proposed project and its alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of action alternatives, and the impacts to be included in the document.

The Council on Environmental Quality regulations (40 CFR Parts 1500–1508) require an early scoping process to determine the issues related to the Proposed Action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis.

This EIS was prepared by the BLM RFO in Rawlins, Wyoming. A third-party contractor was used by the BLM to conduct studies, gather data, and prepare documents. Cooperating agencies for the Continental Divide-Creston project include the State of Wyoming, Sweetwater County, Little Snake River Conservation District, and the Sweetwater County Conservation District.

6.2 PUBLIC PARTICIPATION

The scoping process for this project is described in detail in Section 1.9, Public Participation, beginning on page 1-12 of this EIS.

During preparation of the EIS, the BLM and the consultant interdisciplinary team (IDT) have communicated with, and received or solicited input from, cooperating agencies; other federal, state, county, and local agencies; elected representatives; environmental and citizen groups; industries; and individuals potentially concerned with issues regarding the Proposed Action. The contacts made are summarized in the following sections. The following organizations/individuals either provided comment or were provided the opportunity to comment during the scoping period.

Federal Offices
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
U.S. Department of Interior, Bureau of Land Management, Wyoming State Office
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Congresswoman Barbara Cubin
U.S. Senator John Barrasso
U.S. Senator Michael B. Enzi

State of Wyoming
Governor Matt Mead
Governor’s Planning Office
State Representatives Stan Blake, Bernadine Craft, Allen Jaggi, and Bill Thompson
State Senators John Hastert, Marty Martin, and Bill Vasey
Wyoming Department of Agriculture
Wyoming Department of Environmental Quality
Wyoming Department of Family Services, Carbon and Sweetwater County offices
Wyoming Department of Transportation

Wyoming Game and Fish Department
Wyoming State Engineer's Office
Wyoming State Historic Preservation Office
Wyoming State Planning Coordinator
Wyoming Oil and Gas Conservation Commission

Carbon County
Comprehensive Planning Consultant
Department of Planning & Development
Emergency Management
Road and Bridge Department
Sheriff's Office
Weed and Pest Control

Sweetwater County
Board of County Commissioners
Community Development Division
County Engineer
Emergency Management
Road and Bridge Department
Sheriff's Office

Municipalities
City of Green River
- Community Development
- Fire Department
- Police Department
- Public Works

City of Rawlins
- City Manager
- Fire Department
- Police Department
- Planning Department
- Public Works
- City Housing Consultant (Kirkham & Associates)

City of Rock Springs
- Fire Department
- Police Department
- Planning Department
- Public Services
- Wastewater Treatment

Town of Baggs
- Mayor
- Town Clerk
- Utility Engineering Contractor (Lidstone & Associates)

Town of Bairoil
- Mayor

Town of Dixon
Town of Sinclair
- Mayor

Town of Wamsutter
- Community Development
- Town Clerk

Native American Tribes
Northern Arapahoe Tribal Council
Shoshone-Arapahoe Joint Tribal Council
Shoshone Tribal Council
Uinta-Ouray Tribal Council
Ute Mountain Tribe
Ute Tribal Council

Grazing Permittees

Lease and Right-of-Way Holders

Landowners

Other Agencies, Industry Representatives, Individuals, and Organizations
Carbon County Economic Development Corporation
Carbon County Higher Education Center, Baggs
Carbon County School District #1
Carbon County Senior Services, Inc.
ESS Support Services, Wamsutter Base Camp
Memorial Hospital of Carbon County
Memorial Hospital of Sweetwater County
Noyes Medical Clinic, Baggs
Rawlins Main Street Downtown Development Authority
Rock Springs Chamber of Commerce
Sweetwater County Joint Travel and Tourism Board
Sweetwater County School District #1
Sweetwater County School District #2
Sweetwater County Solid Waste Disposal District #1
Sweetwater County Solid Waste Disposal District #2
Sweetwater Economic Development Association
University of Wyoming Cooperative Extension
Wyoming State Grazing Board
Wyoming Tourism Board

6.3 LIST OF PREPARERS

The following tables identify the BLM IDT (**Table 6.3-1**) and the consultant IDT (**Table 6.3-2**) that were principally involved with preparing this EIS.

Table 6.3-1. Rawlins Field Office Interdisciplinary Team

Name	Responsibility
Dave Simons	Team Lead
Lynn McCarthy	GIS
Rhen Etzelmiller	Wildlife Biologist
Mary Read	Wildlife Biologist
Jennifer Fleuret	Hydrology
David Hullum	Recreation / Visual Resources
Patrick Lionberger	Fisheries
Susan Foley	Soils / Weeds
Bonni Bruce	Archeology
Nina Trapp	Archeology
Mike Calton	Range Conservationist
Cheryl Newberry	Range Conservationist
Ray Ogle	Reclamation Specialist
Annette Treat	Realty Specialist
Mark Newman	Geologist
Jerry Dickinson	Petroleum Engineer
Melanie Mirati	Wild Horse Specialist
Ben Smith	Wild Horse Specialist
Nyle Layton	HazMat Specialist
Serena Baker	Public Affairs

Table 6.3-2. Consultant Interdisciplinary Team

Name	Affiliation	Responsibility
Gary Holsan	Gary Holsan Environmental Planning	Interdisciplinary Team Leader, Project Manager
Steve Moore	Gary Holsan Environmental Planning	Assistant Project Manager
Linda Schuemaker	Otak, Inc.	Writer/Editor, Project Coordinator
Larry Bennett	Integrated Technologies	Vegetation and Wetlands, Special Status Plants, Reclamation, Range Resources
Jim Mudd	Hayden-Wing Associates, LLC	GIS, Data Management
Connie Hedley	Hayden-Wing Associates, LLC	Project Coordination for Biological Sciences and Mapping
Sue Moyer	Gary Holsan Environmental Planning	Wildlife, Special Status Species
Ben Parkhurst	HAF, Inc.	Fisheries
Jana Pastor	Western Archeology Services	Cultural/Historical Resources
Renee Taylor	Taylor Environmental Consulting, LLC	Hazardous Materials, Health and Safety, Noise, Wildlife, Special Status Species
George Blankenship Ron Dutton	Blankenship Consulting, LLC	Socioeconomics, Transportation
Lloyd Levy	Lloyd Levy Consulting	Visual Resources and Recreation
Jim Zapert Susan Connell Brian Mitchell	Carter Lake Consulting	Air Quality
Dave Cameron	KC Harvey, LLC	Soils
Gustav Winterfeld	E-V Geological	Geology, Paleontology, Minerals
Mike Evers John Berry	WWC Engineering	Water Resources

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8. GLOSSARY

abandon: To cease producing oil or gas from a well when it becomes unprofitable. Usually, some of the casing is removed and salvaged, and one or more cement plugs placed in the borehole to prevent migration of fluids between formations.

acre-foot or acre-feet (ac-ft): The volume of water that covers an area of one acre to a depth of one foot (43,560 cubic feet or 325,851 gallons).

ad valorem: Levied according to assessed value.

affected environment: The resource values potentially affected by the Proposed Action and alternatives analyzed in a NEPA document.

air quality: The properties and degree of purity of air to which people and natural and heritage resources are exposed (National Park Service website <http://www2.nature.nps.gov/air/ AQBasics/glossary.htm>).

algal: Of, pertaining to, or composed of algae.

alkaline: Having the quality of a base (pH of 7.0 or greater).

allotment: An area of land where one or more permittees graze their livestock. Generally consists of public land but may include parcels of private or state lands. The number of livestock and season of use are stipulated for each allotment. An allotment may consist of several pastures or be only one pasture.

alluvium: Clay, silt, sand, and gravel or other rock material transported by flowing water and deposited as sorted or semi-sorted sediments.

ambient: The environment as it exists at the point of measurement and against which changes or impacts are measured.

ambient air: The portion of the atmosphere, external to buildings, to which the public has general access (40 CFR 50).

ambient concentration: The mass of a pollutant in a given volume of air, typically measured as micrograms of pollutant per cubic meter of air.

ambient standards: The absolute maximum level of a pollutant allowed to protect either public health (primary) or welfare (secondary).

American Petroleum Institute (API): API is the governing authority on oil industry standards and practices. "API Gravity" is a reference system for the density of crude oils and constituent hydrocarbons.

ancillary facilities: Facilities often required in an oil and gas field other than the wells and pipelines, such as compressor stations.

animal unit month (AUM): A standardized unit of measurement of the amount of forage necessary for the sustenance of one animal unit for 1 month; also, a unit of measurement that represents the privilege of grazing one animal unit for 1 month.

anticline: A geological formation described usually as a dome or inverted saucer. If covered by an impermeable layer of rock, the anticline is a potential oil or gas reservoir.

Application for Permit to Drill (APD): The Department of the Interior's application permit form to authorize oil and gas drilling activities on federal land or mineral estate.

aquifer: A water-bearing bed or layer of permeable rock, sand, or gravel capable of yielding water.

aquitard: A bed of low permeability adjacent to an aquifer that may serve as a storage unit for groundwater, although it does not readily yield water.

archaeological: The scientific studies of past peoples and cultures by analysis of physical remains (artifacts).

Aridosols: Soils formed in arid climates; they are often dry and have little organic accumulation in the upper layers.

arkose: a sedimentary rock, specifically a type of sandstone that contains at least 25% feldspar.

area of critical environmental concern (ACEC): An area on public lands designated for special management to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes or to protect life and safety from natural hazards.

background concentration: The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources but not future emission sources.

badland: Steep or very steep, commonly non-stony barren land dissected by many intermittent drainage channels. Badland is most common in semi-arid and arid regions where streams are entrenched in soft geologic material. Runoff potential is very high, and geologic erosion is active in such areas.

berm: A raised area with vertical or sloping sides.

biodiversity: The variety of plant and animal life on a given area.

borehole: The circular hole made by drilling, extending from the surface to the gas resource to be recovered.

brush hog: A heavily built rotary-type mower that is typically attached to the back of a farm tractor, with dull blades that are propelled outward by centrifugal force, installed on hinges so that they bounce backward and inward if they hit a rock or stump.

calcareous: Containing calcium carbonate.

capability: In the context of the Standards for Healthy Rangelands for the Public Lands Administered by the Bureau of Land Management in the State of Wyoming, the highest ecological status a riparian-wetland area can attain given political, social, or economical constraints (i.e., human-caused limiting factors).

casing: Steel pipe placed in an oil or gas well to prevent the hole from collapsing.

CD-C consultation group: An interagency group that BLM would consult on implementation of the CD-C Preferred Alternative.

cement: Cement is used to “set” casing in the well bore and to seal off unproductive formations and apertures.

collector roads: BLM roads that provide primary access to large blocks of land and connect with, or are extensions of, a public road system.

colluvium: A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.

completion: The activities and methods to prepare a well for production. Includes installation of equipment for production from an oil or gas well.

condensate (gas condensate): Hydrocarbons (oil) contained in the natural gasstream, often removed by condensation.

conditions of approval (COAs): A set of restrictions, or conditions, included in the approval of a federal permit, including NEPA documents.

conglomerate: Rounded water-worn fragments of rock or pebbles cemented together by another mineral substance.

conglomeratic: Sandstones derived from rounded water-worn fragments of rocks or pebbles.

contrast: The effect of a notable difference in the form, line, color, or texture of the landscape features within the area being viewed.

Controlled Surface Use (CSU): A category of stipulation that allows some use and occupancy of public land while protecting identified resources or values. A CSU stipulation identifies the location protected, activities prohibited or restricted, and the resources protected. The extent of protection may range from a limited area for only one activity to all uses.

corridor: A narrow strip of land.

corvid: A member of the crow family (*corvidae*), which includes ravens, rooks, jackdaws, jays, magpies, treepies, choughs, and nutcrackers.

Council on Environmental Quality (CEQ): An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Cretaceous era: The latest system of rocks or period of the Mesozoic era, between 136 and 65 million years ago.

criteria pollutants: Air pollutants for which the EPA has established state and national ambient air quality standards. These include particulate matter (PM), nitrogen oxides (NO_X), sulfur dioxide (SO2), carbon monoxide (CO), and volatile organic compounds (VOCs).

critical elements of the human environment: A list of resource concerns that must be addressed in every NEPA document.

crucial range: Any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain itself at a certain level over the long-term.

cubic feet per second (cfs): The rate of discharge representing a volume of 1 cubic foot of water passing a given point during 1 second.

cubic foot: The volume of gas contained in one cubic foot of space at a standard pressure base of 14.7 pounds per square inch and a standard temperature base of 60 °F.

cuesta: A geological term dscribing an asymmetric ridge formed by gently tilted hard rock layers. Every cuesta has a steep slope, where the rock layers are exposed on their edges, called an escarpment or, if more severe, a cliff. Usually an erosion-resistant rock layer, a cuesta also has a long, more gentle slope on the other side of the ridge called a "dip slope."

cultural resources: The physical remains of human activity (artifacts, ruins, burial mounds, petroglyphs, etc.) and the conceptual content or context (as a setting for legendary, historic, or prehistoric events, such as a sacred area of native peoples, etc.) of an area of prehistoric or historic occupation.

culvert: A drain or conduit often under a road.

cumulative impact: The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time (40 CFR 1508.7).

cuttings: The material removed from the borehole by the drill bit and lifted to the surface.

decibel: A unit of measurement of noise intensity. The measurements are based on the energy of the sound waves and units are logarithmic. Changes of 5 decibels or more are normally discernible to the human ear.

deciduous: Trees or shrubs that lose their leaves each year during a cold or dry season.

deciview: The unit of measurement of haze developed to uniformly describe levels of monitored and modeled visibility impairment. A ***delta deciview*** is a change in haze index calculated between baseline haze levels and predicted future levels.

delta: An alluvial deposit, usually triangular, at the mouth of a river.

deltaic: Related to or like a delta.

diffusion: A process by which substances are transferred from regions of higher concentrations to regions of lower concentrations (National Park Service website <http://www2.nature. nps.gov/air/AQBasics/glossary.htm>).

directional drilling: The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the surface drilling site.

discharge: The volume of water flowing past a point per unit time, commonly expressed as cubic feet per second (cfs), gallons per minute (gpm), or million gallons per day (mgd).

dispersion: The spreading out of pollutants. Generally used to show how much an air pollutant will spread from a particular point.

displacement: As applied to wildlife, forced shifts in the patterns of wildlife use, either in location or timing of use.

disposal well: A well into which produced water from other wells is injected into an underground formation for disposal.

dissolved solids: The total amount of dissolved material, organic and inorganic, contained in water or wastes.

diversity: The distribution and abundance of different plant and animal communities and species.

drainage: Natural channel through which water flows some time of the year. Natural and artificial means for effecting discharge of water as by a system of surface and subsurface passages.

drill rig: The mast, draw works, and attendant surface equipment of a drilling unit.

drilling fluid: Fluid used to lubricate and cool the drill bit, to assist in lifting cuttings from the borehole, and to control pressures in the borehole.

drilling mud: The circulating fluid used to bring cuttings out of the well bore, to cool the drill bit, and to provide hole stability and pressure control. Drilling mud includes a number of additives to maintain the mud at desired viscosities and weights. Some additives that may be used are caustic, toxic, or acidic.

drought: Prolonged dry weather (precipitation less than 75 percent of average annual amount).

ecosystem: An interacting system of organisms considered together with their environment (e.g., forest, marsh, and stream ecosystems).

edaphic: Relating to soil, especially as it affects living organisms. Edaphic characteristics include such factors as water content, acidity, aeration, and the availability of nutrients.

emergent vegetation: Erect, rooted, herbaceous plants that project out of or emerge from the water.

emission factor: An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

emission: Air pollution discharge into the atmosphere, usually specified by mass per unit time.

Endangered species (animal): Any animal species in danger of extinction throughout all or a significant portion of its range. This definition excludes species of insects that the Secretary of the Interior determines to be pests and whose protection under the Endangered Species Act of 1973 would present an overwhelming and overriding risk to man.

Endangered species (plant): Species of plants in danger of extinction throughout all or a significant portion of their ranges. Existence may be endangered because of the destruction, drastic change, or severe curtailment of habitat or because of over exploitation, disease, predation, or even unknown reasons. Plant taxa from limited areas (e.g., the type localities only) or from restricted fragile habitats usually are considered endangered.

environment: The aggregate of physical, biological, economic, and social factors affecting organisms in an area.

environmental impact statement (EIS): An analysis of alternative actions and their predictable environmental impacts, including physical, biological, economic, and social consequences and their interactions; short-and long-term impacts; and direct, indirect, and cumulative impacts.

Eocene: 1) The next to the oldest of the five major epochs of the Tertiary period in the Cenozoic era. 2) The series of strata deposited during that epoch.

eolian: The erosive action of the wind and deposits that are transported by the wind.

ephemeral drainage: A drainage area or a stream that has no base flow. Water flows for a short time each year but only in direct response to rainfall or snowmelt events.

epicenter: The portion of the earth's surface directly above the focus of an earthquake.

erosion: The removal, detachment, and entrainment of earth materials by weathering, dissolution, abrasion, and corrosion, later to be transported by moving water, wind, gravity, or glaciers.

fault: A fracture in bedrock along which there has been vertical and/or horizontal movement caused by differential forces in the earth's crust.

federal lands: All lands and interests in lands owned by the U.S., which are subject to the mineral leasing laws, including mineral resources or mineral estates reserved to the U.S. in the conveyance of a surface or non-mineral estate.

feral: having reverted to the wild state; not domesticated; as in feral (or wild) horses.

field: 1) A set of rocks containing hydrocarbons. 2) An oil and gas reservoir.

flare: Process that burns and evacuates unused gases.

floodplain: That portion of a river valley, adjacent to the channel, which is built of recently deposited sediments and is covered with water when the river overflows its banks at flood stages.

fluvial: Of or pertaining to rivers.

forage: Vegetation of all forms available for animal consumption.

forb: A broad-leafed flowering herb other than grass.

formation: A rock/mineral deposit or structure covering an area with the same physical properties.

fracing (fracturing): A method of stimulating well production by increasing the permeability of the producing formation. Under extremely high hydraulic pressure, the fracturing fluid (water, oil, dilute hydrochloric acid, or other fluid) is pumped into the formation that parts or fractures it. Proppants or propping agents such as sand or glass beads are pumped into the formation as part of the fracturing job. The proppants become wedged in the open fractures, leaving channels for oil or gas to flow into the well after the hydraulic fracture pressure is released. This process is often called a “frac job.” When high concentrations of acid are used, it may be called an “acid frac job.”

fugitive dust: Airborne particles emitted from any source other than through a controllable stack or vent.

gathering pipelines: Pipelines within a field that transport gas or oil from the well to a central production facility or to the point of sale.

Global Positioning System (GPS): Computer software that records and stores coordinates for positions on earth via satellite.

gravitational acceleration constant (g): The indication of the intensity of a gravitational field. Expressed in meters per second squared (m/s^2), at the surface of the earth, 1 g is about 9.8 m/sec^2. As an example 5%g means that motion of 5% x 9.8 m/sec^2 can be expected.

groundwater: Water contained in the pore spaces of consolidated and unconsolidated material.

habitat: A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

habitat function: The arrangement of habitat features and capability of those features to sustain species, population, and diversity of wildlife over time.

Holocene: That period of time (epoch) since the last ice age; also the series of strata deposited during that epoch.

human environment: The factors that include but are not limited to biological, physical, social, economic, cultural, and aesthetic factors that interrelate to form the environment.

hydraulic conductivity: The rate of water flow in gallons per day through a cross-section of 1 square foot under a unit hydraulic gradient at the prevailing temperature of 60oF.

hydrocarbon: A compound formed from carbon and hydrogen, for example oil and gas.

hydrology: A science that deals with the properties, distribution, and circulation of surface and subsurface water.

hydrostatic testing: Testing of the integrity of a newly placed but uncovered pipeline for leaks. The pipeline is filled with water and pressurized to operating pressures, and the pipeline is visually inspected.

impacts: These include a) direct impacts, which are caused by the action and occur at the same time and place and b) indirect impacts, which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect impacts may include growth-inducing impacts and other impacts related to induced changes in the pattern of land use, population density, or growth rate and related impacts on air and water and other natural systems, including ecosystems. Impacts include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Impacts may also include those resulting from actions which may have both beneficial and detrimental impacts, even if on balance the agency believes that the impact will be beneficial (40 CFR 1508.8).

impermeable: Not permitting the passage of a fluid.

impoundment: The accumulation of any form of water in a reservoir or other storage area.

increment: Incremental standards (prevention of significant deterioration [PSD]) are the maximum amounts of pollutants allowed above the baseline in regions of clean air.

infiltration: The movement of water or some other liquid into the soil or rock through pores or other openings.

infrastructure: The basic framework or underlying foundation of a community including road networks, electric and gas distribution, water and sanitation services, and facilities.

injection well: A well that is used to inject produced water from drilling operations in order to maintain pressure or to bring a field back under pressure.

intensive managmeent. Management that includes the use of proper distance restrictions, mitigation stipulations, seasonal or timing restrictions, rehabilitation standards, reclamation measures, use of Best Management Practices, and the application of the Wyoming Mitigation Guidelines for Surface Disturbing and Disruptive Activities to adequately protect the resources for which the intensive management is applied. Intensive management actions would be applied with the goal of maintaining or enhancing sensitive resources (i.e., plant communities, wildlife habitat, soils, water, archeological or paleontological resources, etc.). Management may include attaching conditions of approval to specific projects or additional planning recognizing the unique resources for which the area is managed; typically these would be more restrictive then standard management and would be designed for specific projects and locations.

interdisciplinary team (IDT): A group of federal and cooperating agencies selected to work within the NEPA process in scoping, analysis, and document preparation. The purpose of the team is to integrate its collective knowledge of the physical, biological, economic, and social sciences and the environmental design arts into the environmental analysis process. Interaction among team members often provides insight that otherwise would not be apparent.

interim reclamation: Reclamation initiated on well pads, roads, and pipelines after drilling activity is completed and wells are in production. Interim reclamation is considered successful when reclamation performance objectives are met.

intermittent stream: A stream or reach of a stream that is below the local water table for at least some part of the year and obtains its flow from both surface runoff and groundwater discharge.

intertongue: Irregular/overlapping boundaries among rock formations.

intervisible turnout: a turnout on a local or BLM road where approaching drivers have a clear view of the section of road between the two turnouts and can pull off to the side to let the approaching driver pass

invasive species: a species that is not native (or is alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112).

irretrievable: A term that applies to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.

irreversible: A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time.

isopach: A contour that connects points of equal thickness. Commonly, the isopachs, or contours that make up an isopach map, display the stratigraphic thickness of a rock unit as opposed to the true vertical thickness. Isopachs are true stratigraphic thicknesses; i.e., perpendicular to bedding surfaces.

lacustrine: Pertaining to, produced by, or formed in a lake or lakes.

land use: The types of activities allowed (e.g., mining, agriculture, timber production, residential, industrial).

landslide: A perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow.

lease: 1) A legal document that conveys to an operator the right to drill for oil and gas. 2) The tract of land on which a lease has been obtained, where producing wells and production equipment are located.

lek: A traditional courtship display attended by male greater sage-grouse in or adjacent to sagebrush-dominated habitat. Leks are categorized as:

> ***Active:*** Any lek that has been attended by male greater sage-grouse during the strutting season.
>
> ***Inactive:*** Leks where it is known that there was no strutting activity through the course of a strutting season.
>
> ***Unknown:*** Leks that have not been documented either active or inactive during the course of a strutting season.
>
> ***Occupied:*** A lek that has been active during at least one strutting season within the last 10 years.
>
> ***Unoccupied*** (***formerly termed "historical lek":***) There are two types of unoccupied leks: (1) Destroyed -a formerly active lek site and surrounding sagebrush habitat that has been destroyed and is no longer capable of supporting greater sage-grouse breeding activity. (2) Abandoned -a lek in otherwise suitable habitat that has not been active during a consecutive 10-year period.
>
> ***Undetermined:*** Any lek that has not been documented as being active in the last 10 years but that does not have sufficient documentation to be designated unoccupied.

Life of project: Begins with the first disturbance authorized under the ROD for this project and ends when all wells are plugged and abandoned and all surface disturbance (each disturbed site) meets the reclamation performance objectives.

lithic scatter: A surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris. This is a common prehistoric site type that is contrasted to a cultural material scatter (which contains other or additional artifact types such as pottery or bone artifacts), or to a camp (which contains habitation features, such as hearths, storage features, or occupation features), or to other site types that contain different artifacts or features.

lithology: The description of the physical character of a rock as determined by eye or with a low-powered magnifier, based on color, structures, mineralogic components, and grain size.

loam: A mixture of sand, silt, and clay containing between 7 and 27 percent clay, 28 to 50 percent silt and less than 50 percent sand.

local roads: BLM roads that provide primary access to large blocks of land and connect with or are extensions of a public road system.

Loess: a geologic term that refers to deposits of silt (sediment with particles 2–64 microns in diameter) that have been laid down by wind action.

log: A systematic recording of data, as from the driller's log, mud log, electrical well log, or radioactivity log. Many different logs may be run to obtain various characteristics of down-hole formations.

long-term impacts: For the purpose of this NEPA analysis, long-term impacts last for the life of the project or beyond.

migrate: To pass periodically from one region or climate to another.

mineral rights: Reserved mineral rights are the retention of ownership of all or part of the mineral rights by a person or party conveying land to the United States. Conditions for exercising these rights have been defined in the Secretary's Rules and Regulations to Govern Exercising of Mineral Rights Reserved in Conveyances to the United States attached to and made a part of deeds reserving mineral rights.

mitigate: To lessen the severity.

mitigation: Avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree of magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or compensating for the impact by replacing or providing substitute resources or environments.

mitigation measures: Actions taken to reduce or minimize potential impacts to the environment.

modeling: A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

mollisols: Soil order that has a thick (generally 10-inch), very dark brown to black surface horizon that is rich in organic matter (grassland soils common in prairie regions).

monitor: To systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.

mud: Mud is drilling fluid that consists mainly of a mixture of water, or oil distillate, and "heavy" minerals such as bentonite or barites.

mud system: A system used to manage suspended mud in the well-drilling process.

National Ambient Air Quality Standards (NAAQS): The allowable concentrations of air pollutants in the air specified by the federal government. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

National Environmental Policy Act of 1969 (NEPA): The federal law established in 1969, which went into effect on January 1, 1970, that 1) established a national policy for the environment, 2) requires federal agencies to become aware of the environmental ramifications of their Proposed Actions, 3) requires full disclosure to the public of proposed federal actions and a mechanism for public input into the federal decision-making process, and 4) requires federal agencies to prepare an environmental impact statement for every major action that would significantly affect the quality of the human environment.

National Register of Historic Places: A list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture.

native species: Plants or animals that originated in the area in which they are found (i.e., they naturally occur in that area); with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

natural gas: Those hydrocarbons, other than oil and other than natural gasliquids separated from natural gas, that occur naturally in the gaseous phase in the reservoir and are produced and recovered at the wellhead in gaseous form.

nephelometric turbidity unit (NTU): A unit measuring the lack of clarity of water, used by water and sewage treatment plants; named for the nephelometer used to take the measurement.

No Action Alternative: The management direction, activities, outputs, and effects that are likely to exist in the future if the current plan would continue unchanged.

No Surface Occupancy (NSO): A stipulation in a lease that disallows any surface disturbance in the lease area at any time. Natural Gas or oil from an NSO area, for instance, would have to be recovered by directional drilling.

Notice of Intent (NOI): A notice published in the Federal Register to announce the intent to prepare an EIS.

noxious weeds: Officially designated (State of Wyoming-designated, Sublette County-declared) undesirable or invading weedy species generally introduced into an area due to human activity.

oil and gas field: A natural accumulation of oil and gas in the subsurface. Oil and gas may be present in two or more reservoirs at different depths.

oil and gas lease: A federal oil and gas lease is a legal document that gives the lease holder the right to explore for and develop any oil and gas that may be present under the area designated in the lease while complying with any surface use conditions which may have been stipulated when the lease was issued.

ozone (O_3): A molecule containing three oxygen atoms produced by passage of an electricalspark through air or oxygen (O2).

paleontology: The science that deals with the history and evolution of life on earth.particulate matter: A particle of soil or liquid matter (e.g., soot, dust, aerosols, fumes, andmist).

passerine: Passerines are the perching birds, and most are also songbirds.

perennial stream: A stream or reach of a stream that flows throughout the year.

perforation: Holes punched in the casing of a well at the pay zone to be produced to allow gas or oil to enter the well.

permeability: The extent that a substance is open to passage or penetration, especially by fluids.

permeable: The property or capacity of a porous rock, sediment, or soil to transmit a liquid.

permittee (grazing): A person who has livestock grazing privileges on an allotment or allotments within the resource area.

pH: Measure of acidity or alkalinity

phenology: The study of periodic plant and animal life-cycle events that occur periodically, such as blossoming or migration, and how these are influenced by seasonal and interannual variations in climate.

physiographic province: A region having a pattern of relief features or landforms that differs significantly from adjacent regions.

physiography: The genesis and evolution of landforms.

playa: The low, flat parts of a basin or other undrained area typically characterized by depressions with clay bottoms that pool water on the surface and accumulate salts (see also riparian areas).

PM_{10}: Airborne suspended particles with an aerodynamic diameter of 10 microns or less.

$PM_{2.5}$: Airborne suspended particles with an aerodynamic diameter of 2.5 microns or less.

potential: In the context of the Standards for Healthy Rangelands for the Public Lands Administered by the Bureau of Land Management in the State of Wyoming, the highest ecological status a riparian-wetland area can attain given no political, social, or economical constraints.

preferred alternative: The alternative identified in the EIS as the action favored by the agency.

prevention of significant deterioration (PSD): A classification established to preserve, protect,and enhance the air quality in National Wilderness Preservation System areas in existence prior to August 1977 and other areas of national significance, while ensuring economic growth can occurin a manner consistent with the preservation of existing clean air resources. Specific emission limitations and other measures, by class, are detailed in the Clean Air Act (42 U.S.C. 1875 etseq.).

produced water: Water brought to the surface through the borehole.

production: Phase of commercial operation of an oil field.

production casing: Steel pipe installed in the borehole to isolate formations in the borehole and to eliminate communication among hydrocarbon-bearing zones and/or water aquifers and othermineral resources.

proppants: Proppants or propping agents are substances such as sand or glass beads that are pumped into the formation as part of the fracturing job. The proppants become wedged in the open fractures, leaving channels for oil to flow into the well after the hydraulic fracture pressure is released. This process is often called a “frac job.” When high concentrations of acid are used, it may be called an “acid frac job” (see also fracing/fracturing).

PSD increments: The maximum allowable increase in pollutant concentrations permitted over baseline conditions as specified in the EPA Prevention of Significant Deterioration (PSD) regulations (40 CFR Part 52.21). The regulations apply only to areas currently attaining NAAQS/WAAQS. Most National Parks and Wilderness Areas are Class I areas, where almost no future pollution increase is permitted. Most other areas are Class II areas, where moderate increases in pollution levels are allowed.

public land: Lands or interests in lands owned by the United States and in this case administered by the Secretary of Interior through the Bureau of Land Management, without regard to how the United States acquired ownership.

quaternary: The latest period of time, from the present to 2 million years ago and represented by local accumulations of glacial and post-glacial deposits.

range: Land producing native forage for animal consumption and lands that are revegetated naturally or artificially to provide forage cover that is managed like native vegetation, that are amenable to certain range management principles or practices.

raptor: A group of carnivorous birds consisting of hawks, eagles, falcons, kites, vultures, and owls.

recharge: Replenishment of the water supply in an aquifer through the outcrop or along fracture lines.

reclamation: Rehabilitation of a disturbed area to make it acceptable for designated uses. This normally involves regrading, replacement of topsoil, revegetation, and other work necessary to restore it for use.

Record of Decision (ROD): A decision document for an EIS or Supplemental EIS that publicly and officially discloses the responsible official’s decision regarding the actions proposed in the EIS and their implementation.

reserve pit: An excavated pit that may be lined with plastic that holds drill cuttings and waste mud.

reserves/recoverable reserves: Areas of mineral-bearing rock from which the mineral can be extracted profitably with existing technology and under present economic conditions.

reservoir: The “pool” of oil or gas that is being tapped.

residuum: Unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place.

resource roads: Spur roads that provide point access, as to a well site, and connect to local or collector roads.

revegetation: The reestablishment and development of self-sustaining plant cover. On disturbed sites, human assistance will speed natural processes by seedbed preparation, reseeding, and mulching.

rig: A collective term to describe the equipment needed when drilling a well.

right-of-way: The legal right for use, occupancy, or access across land or water areas for a specified purpose or purposes.

riparian area: A transition between wetlands or water bodies and upland areas. Riparian areas exhibit vegetation or physical characteristics that reflect the influence of subsurface water in the root zone. Typical riparian areas include lands along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels. Excluded are ephemeral streams or washes that lack vegetation and depend on free water in the soil.

riparian communities. Communities of vegetation associated with either open water or wetlands. Examples are cottonwood and willow communities; meadows; aspens near water sources; and other trees, grasses, forbs, and shrubs associated with water.

road metal: the crushed rock used for road beds and surfaces, foundations, and railway embankments, among other things

roosting: To rest or sleep in a roost. A bird will typically use the same roost for an extended period of time.

runoff: That part of precipitation that appears in surface streams. Precipitation that is not retained on the site where it falls and is not absorbed by the soil.

salinity: 1) A measure of the amount of mineral substances dissolved in water; 2) salty.

scatter (archeological): Archaeological evidence of prior disturbance that is distributed about an area rather than concentrated in a single location.

scope: Extent or range of view.

scoping: An early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a Proposed Action. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and written comments in response to news releases, direct mailings, and articles about the Proposed Action and scoping meetings.

sediment: Soil or mineral transported by moving water, wind, gravity, or glaciers, and deposited in streams or other bodies of water or on land.

sediment load: The amount of sediment (sand, silt, and fine particles) carried by a stream or river.

seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

shale: A laminated sediment in which the constituent particles are predominantly of the clay grade.

short-term impacts: For the purpose of this analysis, short-term impacts are generally defined as those that would last for 5 years or less.

shrink-swell: Refers to clays or soils that alternately expand and contract in a semiarid climate where drying out is possible.

shut-in: The process of stopping production at an otherwise producing well.

significant impact: A meaningful standard to which an action may impact the environment. The impact may be beneficial, adverse, direct, indirect, or cumulative and may be short-term or long-term.

silt: Any earthy material composed of fine particles, smaller than sand but larger than clay, suspended in or deposited by water.

slope wash: Soil and rock material that is being or has been moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels.

socioeconomics: Study of an impact region on the current and projected population and relative demographic characteristics (housing, economy, government, etc.).

soil productivity: The capacity of a soil to produce a specific crop such as fiber and forage, under defined levels of management. It is generally dependent on available soil moisture, nutrients, and length of growing season.

sole source aquifer: An aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer.

spacing: The number of acres per given well in the subsurface. For instance, 160-acre spacing means that one well would be drilled in each quarter section (160 acres) or up to four wells per section (640 acres).

species of concern: Species of concern include federally listed Threatened or Endangered species, species proposed for listing, BLM Sensitive Species, WGFD priority species, and species considered rare or important by the Wyoming Natural Diversity Database.

stipulation: A legal requirement, specifically a requirement that is part of the terms of a mineral lease. Some stipulations are standard on all federal leases. Other stipulations may be applied to the lease at the discretion of the surface management agency to protect valuable surface resources. Stipulations are supported by the NEPA process; without NEPA support, a stipulation cannot be added to the lease.

strata: An identifiable layer of bedrock or sediment.

stromatolite: a laminated usually mounded sedimentary fossil formed from layers of cyanobacteria, calcium carbonate, and trapped sediment. (Merriam-Webster)

structural basin: A large depression of structural origin.

substrate: Material consisting of silts, sands, gravels, boulders, and/or woody debris found on the bottom of a stream channel.

surface-disturbing activities: Any authorized action that disturbs vegetation and surface soil, increasing erosion potential above normal site conditions. This definition typically applies to mechanized or mechanical disturbance. However, intense or extensive use of hand or motorized hand tools may fall under this definition. Examples of surface-disturbing activities include construction of well pads and roads, pits and reservoirs, pipelines and power lines, mining, and vegetation treatments.

Tank flashing: Flashing losses occur when a liquid with entrained gases goes from a higher pressure to a lower pressure. This occurs when condensate is transferred into a tank. As the pressure on the liquid drops, some of the compounds dissolved in the liquid are released, or "flashed." Increases in the temperature of the liquid can also cause flashing losses.

Taphonomy: The study of the origin and nature of accumulations of fossils, i.e., what happened to an organism between the time it died and the time it was buried in sediment that later became lithified rock.

taxon (*plural:* **taxon):** A population, or group of populations of organisms which are usually inferred to be phylogenetically related and which have characters in common which differentiate the unit (e.g. a geographic population, a genus, a family, an order) from other such units. A taxon encompasses all included taxa of lower rank and individual organisms.

taxadjunct: a soil that has properties outside the range of any recognized series. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Tertiary: The older of the two geologic periods comprising the Cenozoic Era; also the system of strata deposited during that period.

Threatened species: Any species (plant or animal) that is likely to become an Endangered species within the foreseeable future throughout all or a significant portion of its range. Threatened species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.

topography: The features of the earth, including relief, vegetation, and waters.

topsoil: The uppermost layers of naturally occurring soils suitable for use as a plant growth medium.

total dissolved solids (TDS): Total amount of dissolved material, organic or inorganic, contained in a sample of water.

transpiration: The process by which water vapor escapes from a living plant and enters the atmosphere.

tuff: A rock formed by compacted volcanic fragments, generally smaller than 4 mm in diameter.

turbidity: A measurement of the total suspended solids.

two-track: A road that has not been constructed or maintained but that has been created by repeated use.

unconformity: A break in the stratigraphic sequence.

underground source of drinking water: An aquifer that supplies any public water system or contains a sufficient quantity of groundwater to supply a public water system or currently supplies drinking water for human consumption.

understory: A layer of vegetation underlying a layer of taller vegetation, such as brush and grass under trees.

undulate: To move or cause to move with a wavelike motion.

ustic: Soils that are moist for more than half a year but have a distinct dry season.

vegetation type: A plant community with visually distinguishable characteristics, named for the apparent dominant species.

viewshed: The areas seen from any given point.

visibility: Refers to the visual quality of the view or scene in daylight, with respect to color, rendition, and contrast definition. The ability to perceive form, color, and texture.

visual resource: The composite of basic terrain, geologic features, water features, vegetation patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for viewers.

Visual Resource Management (VRM): A system of visual management used by the BLM. The program has a dual purpose—to manage the quality of the visual environment, and to reduce the visual impact of development activities while maintaining effectiveness in all BLM resource programs. VRM also identifies scenic areas that warrant protection through special management attention. The system uses four classes for categorizing visual resources.

> ***Class I*** —Natural ecological changes and limited management activity are allowed. Any contrasts created within the characteristic landscape must not attract attention. This classification is applied to wilderness areas, wild and scenic rivers, and other similar situations.

Class II —Changes in any of the basic elements (form, line, color, texture) caused by a management activity should not be evident in the characteristic landscape. Contrasts are seen but must not attract attention.

Class III—Contrasts to the basic elements caused by a management activity are evident but should remain subordinate to the existing landscape.

Class IV—Any contrast may attract attention and be a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color, and texture of the characteristic landscape.

water bar: A ridge made across an incline to divert water to one side.

water quality: Refers to a set of chemical, physical, or biological characteristics that describe the condition of a river, stream, or lake. The quality of water determines what beneficial uses it can support. Different conditions or levels of water quality are required to support different beneficial uses.

water recharge: The natural process whereby surface water enters a groundwater aquifer.

watershed: The total land area that drains to a given watercourse or body of water.

Waters of the U.S.: A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds with defined bed and bank, the use, degradation, or destruction of which could affect interstate or foreign commerce.

well or wellbore: The hole drilled from the surface to the gas-bearing formation, several of which may be developed from a single well pad.

well pad: Relatively flat work area (surface location) that is used for drilling a well or wells and producing from the well once it is completed.

wetlands: A term that varies in meaning depending on the methodology used to determine wetland characteristics. Typically wetlands must have plants associated with anaerobic soil conditions (no oxygen and saturated with water), evidence of modeling (metal deposits) or other hydric soil indicators, and the hydrology to allow for the location to be fully saturated at or near the soil surface for at least two weeks in a typical year. Wetlands can include standing water at or near the surface (typically not more than 6 feet deep) or saturated banks along flowing water such as riparian areas. (See also wetlands/riparian.)

wetlands/riparian: Areas exhibiting vegetation or physical characteristics that reflect the influence of surface or subsurface water. These areas include lands adjacent to, or contiguous with, perennially and intermittently flowing rivers, streams, springs and seeps; meadows; playas; and the shores of lakes and reservoirs with stable water levels, among others. Excluded are ephemeral streams or washes that lack typical riparian vegetation. These areas can typically be identified by the plant communities that are present. (See also definitions for wetlands and riparian communities.)

wind rose: Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period of time. Wind roses may also give information concerning distribution of wind speed, stability, or other meteorological parameters.

winter range: The place where migratory (and sometimes non-migratory) animals congregate during the winter season.

workover: Well maintenance activities that require onsite mobilization of a drill rig to repair the well bore equipment (casing, tubing, rods, or pumps) or the wellhead. In some cases, a workover may involve development activities to improve production from the target formation.

Wyoming Ambient Air Quality Standards (WAAQS): The allowable concentrations of air pollutants in the air specified by the State of Wyoming. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

zone: The area between two depths in a well containing reservoir or other characteristics.