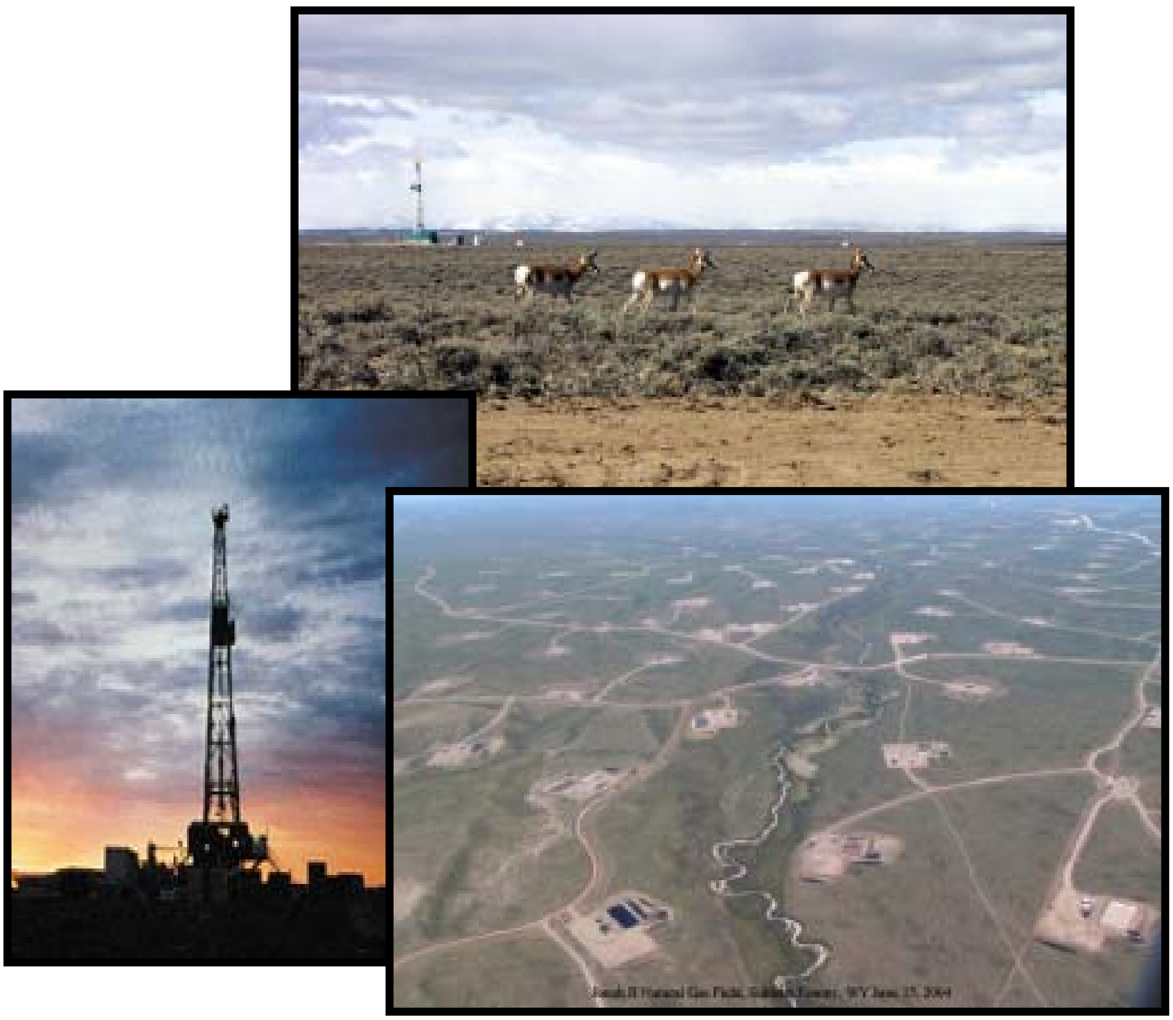
U.S. Department of the Interior

Bureau of Land Management
Pinedale and Rock Springs Field Offices

February 2005
DES-05-05

DRAFT
ENVIRONMENTAL IMPACT STATEMENT, JONAH INFILL DRILLING PROJECT, SUBLETTE COUNTY, WYOMING
(Volume 1 of 2)



MISSION STATEMENT

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

BLM/WY/PL-05/009+1310

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Wyoming State Office
P.O. Box 1828
Cheyenne, Wyoming 82003-1828

In Reply Refer To:

1310 (100)

January 31, 2005

Dear Reader:

This Draft Environmental Impact Statement (DEIS) on the proposed Jonah Infill Drilling Project is submitted for your review and comment. This DEIS has been prepared to analyze the potential impacts of the drilling and production operations of natural gas wells and associated access roads, pipelines, and production facilities proposed by several companies within the proposed project area located in Sublette County, Wyoming.

Three technical support documents have also been prepared in conjunction with the DEIS. These documents contain detailed technical information for (1) air quality modeling, (2) socio-economic modeling, and (3) development procedures including transportation plan, reclamation plan, and hazard materials management plan. A limited number of technical support documents are available upon request. They will also be available for review at the Bureau of Land Management (BLM) offices listed below. The DEIS and its technical support documents may be viewed or downloaded from the BLM State website at *www.wy.blm.gov*.

Bureau of Land Management
Wyoming State Office
5353 Yellowstone Road.
Cheyenne, Wyoming 82009

Bureau of Land Management
Pinedale Field Office
432 E. Mill St., PO Box 768
Pinedale, Wyoming 82941

The Jonah Infill Drilling Project Area (JIDPA) includes 30,500 acres with surface ownership at approximately 94 percent Federal (28,580 acres), 2 percent private (640 acres), and 4 percent State of Wyoming (1,280 acres). Currently within the JIDPA, there are 501 producing and shut-in natural gas wells and an extensive infrastructure of roads and pipelines for natural gas production in place.

Ten alternatives were analyzed. The Proposed Action proposes to develop the natural gas resource by drilling up to 3,100 new wells on up to 16,200 acres of new surface disturbance over the next 12 years. To support gas field production the Proposed Action includes development infrastructure such as roads, pipelines, water wells, and other ancillary facilities needed to link the wells with existing transportation systems.

Under the No Action Alternative, the effects of limiting development in the JIDPA to those that have been analyzed in previous environmental documents for the Jonah II Field and Modified Jonah II Project Area are considered and provide a basis for comparison of alternatives.

Alternative A proposes to develop 3,100 new wells on up to 3,100 new well pads over the same time period with the same additional infrastructure, with some lease stipulation and conditions of approval removed to facilitate recovery of natural gas. Alternative B proposes to develop up to 3,100 new wells from the currently-authorized 497 well pads at varying paces of development. Alternatives C through G each propose varying amounts of surface disturbance, well pad (surface) density restrictions, and paces of development.

The Agency Preferred Alternative proposed field development based on performance objectives and three management areas with different percentages of surface disturbance.

If you wish to submit comments on the DEIS, we request that you make them as specific as possible. Comments will be more helpful if they include suggested changes, sources, or methodologies. Comments that contain only opinions, or preferences, will not receive a formal response. However, they will be considered and included as part of the BLM decisionmaking process.

Following the publication of this DEIS the BLM will host an open house in Pinedale, Wyoming. All meetings, or hearings, and any other public involvement activities will be announced at least 15 days in advance through public notices, media news releases, and or mailings.

This DEIS was prepared pursuant to the National Environmental Policy Act and other regulations and statutes to address possible environmental and socio-economic impacts which could result from the project. This DEIS is not a decision document. Its purpose is to inform the public of the impacts associated with implementing the companies' drilling proposal, to evaluate alternatives to the proposal, and to solicit public comments. This DEIS also provides information to other regulatory agencies for use in their decisionmaking processes for other permits required for implementation of the project.

Freedom of Information Act Considerations: Public comments submitted for this DEIS, including the names and street addresses of respondents, will be made available for review after the comment period closes at the Pinedale Field Office during regular business hours (8:00 a.m. to 4:30 p.m.), Monday through Friday, except holidays. Public comments will be published as part of the Final EIS. Individual respondents may request confidentiality. If you wish to withhold your address from public review or from disclosure under the Freedom of Information Act, you must state this prominently at the beginning of your written comment. Such requests will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public inspection in their entirety.

Please retain this copy of the DEIS for future reference as the Final EIS may be published in an abbreviated format. A copy of the DEIS has been sent to affected Federal, State, and local government agencies, and to those persons who have indicated that they wished to receive a copy of the DEIS. Copies of the DEIS are available for public inspection at the BLM offices listed below.

Sincerely,

Alan L Kesterke

for Robert A. Bennett
State Director

COMMENT ADDRESSES

Please submit written comments to:	Jonah Infill Drilling Project Comments Bureau of Land Management – Pinedale Field Office PO Box 768 Pinedale, WY 82941
Please submit electronic comments to:	WYMail_Jonah_Infill@blm.gov

DRAFT ENVIRONMENTAL IMPACT STATEMENT, JONAH INFILL DRILLING PROJECT, SUBLETTE COUNTY, WYOMING

(Volume 1 of 2)

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

and

Rock Springs Field Office
Rock Springs, Wyoming

February 2005

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ABSTRACT

Environmental Impact Statement, Jonah Infill Drilling Project, Sublette County, Wyoming

(**X**) Draft ( ) Final

Lead Agency:	Bureau of Land Management Pinedale Field Office Pinedale, Wyoming
Cooperating Agency:	State of Wyoming
For Further Information, Contact:	Carol Kruse Bureau of Land Management 432 E. Mill St. Pinedale, WY 82941 307-367-5352

The Bureau of Land Management has received a proposal from oil and gas developers to more intensively develop natural gas resources in an approximately 30,500-acre portion of the Jonah Field through infill drilling among existing wells. The project area is generally located about 32 miles southeast of Pinedale and 28 miles northwest of Farson in southeastern Sublette County, Wyoming. Within the project area boundary there are currently 533 wells permitted or committed to from 497 well pads. Wells would be expected to produce for approximately 40 years; the Life of the Project (from first well drilled to last well plugged and abandoned and habitat function restored) is estimated to be up to 110 years.

Ten alternatives were considered in detail. The No Action alternative is required by the National Environmental Policy Act as a baseline against which other action alternatives can be analyzed. For this project, the No Action alternative would not authorize field-level development, though drilling could continue on State and private leases and would occur on Federal leases to prevent drainage of Federal resources.

The Proposed Action includes drilling, completing, and operating up to 3,100 additional wells on up to 16,200 acres of new disturbance, including the roads, pipelines, and other ancillary facilities needed to support the new wells; minimum well pad (surface disturbance) density of 64 well pads per 640-acre section; bottomhole well density ranging from 1 bottomhole every 5 acres to 1 bottomhole every 40 acres; and 250 wells drilled per year. Standard field development and production procedures would be followed. Above a certain level of authorized surface disturbance, the Operators have committed to establishing a fund to finance compensatory (off-site) mitigation for impacts that cannot be fully mitigated on-site. Recent communication from

the Operators indicates their willingness to consider other methods of implementing compensatory mitigation.

One action alternative removes some standard restrictions and mitigations to minimize the amount of directional drilling required, to remove some wildlife and surface protections, etc., and to facilitate additional gas recovery; another limits all drilling to the currently-authorized 497 well pads; two others vary the number of wells; three others vary well pad density; and the BLM Preferred Alternative combines several of the other alternatives and applies additional mitigation and outcome- or performance-based field management objectives.

The Wyoming State Director is the BLM's Authorized Officer responsible for preparing this Draft Environmental Impact Statement.

EXECUTIVE SUMMARY

The Department of Interior (DOI), Bureau of Land Management (BLM) Pinedale Field Office (PFO) and Rock Springs Field Office (RSFO) has received a proposal from EnCana Oil and Gas (USA), Inc., BP America Production Company, and other natural gas operators (collectively known as the Operators) to expand existing natural gas drilling and development operations in the Jonah Field in south-central Sublette County, Wyoming. Operations are proposed for that portion of the Jonah Field referred to as the Jonah Infill Drilling Project Area (JIDPA) which encompasses approximately 30,500 acres located in portions of Townships 28 and 29 North, Ranges 107 through 109 West, approximately 32 miles southeast of Pinedale and 28 miles northwest of Farson, Wyoming.

The DOI/BLM Pinedale and Rock Springs Field Offices have determined the proposed project would constitute a major federal action and therefore requires the preparation of an Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act of 1969, as amended (NEPA). This draft EIS was prepared in accordance with NEPA to assess the environmental consequences of the Operator's proposed action and alternative courses of action. It is intended to provide the public and decision-makers with a complete and objective evaluation of impacts resulting from the Proposed Action and reasonable alternatives.

Life of project (LOP) is estimated to vary from 63 to 105 years, depending on the alternative and pace of development.

Currently within the JIDPA, BLM has approved or committed to 497 well pads and 533 wells with associated access roads, pipelines, and ancillary facilities. Operation and maintenance of these facilities will continue as authorized by existing permits.

PROPOSED ACTION

The Operators propose to expand development of natural gas and condensate reserves from the Lance and other formations at depths of approximately 11,000 feet by drilling as many as 3,100 additional wells on up to 16,200 acres of new surface disturbance during the development (drilling) phase. Specific features include the following: a minimum of 64 well pads per 640-acre section, downhole well spacing from 1 bottomhole/5 acres to 1 bottomhole/40 acres; up to 465 miles of new resource roads with associated pipelines; 8 miles of new collector/local roads; 41 acres of new surface disturbance for ancillary facilities; and 100 acres of new surface disturbance for exploration of other formations. The Operators have committed to various mitigation measures which vary by alternative and propose to fund a Cumulative Impacts Mitigation Fund for offsite Compensatory Mitigation (CM) under some alternatives. This fund could mitigate adverse impacts within the JIDPA by financing substitution mitigation projects outside the JIDPA. As proposed, the fund could be based on the level of surface disturbance authorized (e.g., $850/acre over 11,000 acres). Recent communication from the Operators indicates their willingness to consider other methods of implementing compensatory mitigation.

SCOPING

Public and agency scoping was conducted to determine issues relative to the Proposed Action. A scoping notice and informational materials were mailed to potentially interested parties beginning in March 2003. All issues identified during scoping and BLM and Interdisciplinary Team reviews were evaluated to identify key issues that drove development of alternatives and the impact analyses. The nine key issues identified are: surface disturbance acreage; socioeconomics and boom/bust avoidance; regional visibility effects; greater sage-grouse/greater sage-grouse habitat protection; pronghorn antelope migration corridor protection; direct and indirect habitat fragmentation and loss for all wildlife; maximum natural gas recovery; loss of livestock forage and project hazards; and BLM monitoring and enforcement capability.

The eight alternatives meet the Purpose and Need of the proposal but vary in response to the key issues. Three separate paces of development (75, 150 and 250 wells drilled per year) are analyzed for most alternatives. Other alternatives were considered but rejected for a variety of reasons.

ALTERNATIVES

No Action Alternative: Reject Operator's Proposal

The No Action Alternative would reject the Operator's Proposed Action and all field-level development alternatives. Though this alternative rejects the field-level development as proposed, existing BLM management protocols could allow new drilling activity. However, the BLM cannot predict what level of development would be required to support existing management protocols, so for alternative analysis purposes assumed zero new development. The No Action alternative serves as a benchmark enabling decision-makers and the public to compare the magnitude of environmental consequences across action alternatives.

Alternative A: Minimize Directional Drilling

New initial (drilling phase) surface disturbance would be comparable to the Proposed Action (16,200 acres), but development activity would be exempt from some existing BLM Conditions of Approval (COAs), stipulations, and mitigation. Most notably, environmentally sensitive areas would not be avoided in order to increase the gas recovered.

Alternative B: Minimize Surface Disturbance

All new wells would be drilled from the 497 currently approved well pads. This alternative requires expansion of existing well pads but results in the least amount of new surface disturbance (3,297 acres) while still providing for a higher level of resource recovery within the JIDPA.

Alternatives C and D: Restrict Number of New Wells

Alternative C limits development to 1,250 new wells and well pads with an estimated total new initial surface disturbance of 6,705 acres. Alternative D increases the number of new wells and well pads to 2,200, resulting in new surface disturbance of 11,581 acres. Neither alternative includes well pad surface density restrictions.

Alternatives E, F and G: Restrict Well Pad Density

Alternative E stipulates a maximum of 16 well pads per section (1 well pad/40 acres) with a total new initial surface disturbance of approximately 6,386 acres. Alternative F increases well pad density to 32 wells per section (1 well pad/20 acres) and results in new surface disturbance of 10,446 acres. Alternative G increases the density to 64 wells per section (1 well pad/10 acres) with 13,898 acres of new surface disturbance. Each alternative assumes up to 3,100 new wells would be drilled.

BLM Preferred Alternative

Three different surface disturbance allowances per section would be established within different areas of the JIDPA, resulting in a total of approximately 7,804 acres of new surface disturbance. Performance-based field management objectives would address key issues and significant impacts. Monitoring and surveying would be required to determine if objectives are being met. An interagency adaptive management working group would be established to monitor the effectiveness of development guidelines, mitigation, and monitoring, and to recommend to BLM any modifications to these procedures based on monitoring results.

ENVIRONMENTAL IMPACTS

Physical Resources Impacts

Topography/Water

The JIDPA has a continental, semi-arid, cold desert climate and is located in the central Green River Basin with ephemeral drainages primarily flowing to the Green or Big Sandy Rivers. Groundwater and surface water are variable in quality, and the major use is for livestock and natural gas development operations (ground water only). Significant impacts to topography are expected but not to ground water resources. Surface water resources down-channel from the JIDPA could be significantly affected during run-off events under all alternatives.

Air Quality/Visibility

Whereas no violations of applicable federal or state air quality regulations are anticipated, significant project-specific and cumulative air quality impacts are anticipated to visibility at regional Class I airsheds (e.g., Bridger Wilderness Area) under all alternatives (including No Action). A detailed analysis of air quality effects is provided in the *Draft Air Quality Technical Support Document for the Jonah Infill Drilling Project Environmental Impact Statement*. Modeling of air quality and air quality-related value (AQRV) impacts from the BLM Preferred Alternative will be run during the draft environmental impact statement public comment period and reported in the final environmental impact statement.

Soils

Seventeen soil map units occur in the JIDPA and most have construction and reclamation limitations. Several known sand dunes and other windblown deposits occur in the area. Significant impacts to soils (loss during runoff events, loss of productivity) could occur under all alternatives but are not quantified. Modeling to quantify soil impacts across the range of alternatives will be run during the draft environmental impact statement public comment period and results will be reported in the final environmental impact statement.

Biological Resources Impacts

Wildlife

Significant impacts to various wildlife habitats in the JIPDA have already occurred as a result of past and current oil and gas development activity. Wildlife that occurs in the JIPDA which may be impacted by this project include pronghorn antelope, greater sage-grouse, raptors and up to seventeen BLM Wyoming Sensitive (BWS) species (most notably sagebrush obligates). On-site mitigation measures and monitoring would occur under most alternatives pursuant to the Wildlife Monitoring/Protection Plan (see *Jonah Infill Drilling Project Development Procedures Technical Support Document*); however, additional significant impacts to some of these species are anticipated. Only under the BLM Preferred Alternative are impacts during the LOP somewhat diminished by establishing specific objectives for wildlife attendance/productivity and faster restoration of habitat function through reclamation. On-site habitat function should be restored as reclamation vegetation nears maturity.

Threatened & Endangered Species

T&E species that may occur on or downstream from the JIDPA include the black-footed ferret, bald eagle, four Colorado/Green River fish species (Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker) and the plant Ute ladies' tresses. No impacts to these species are anticipated from proposed development under any alternative.

Plant Cover

Plant cover values vary according to the three dominant sagebrush vegetation types present on the JIDPA, with significant impacts expected in many areas. To mitigate the potential impacts, a Reclamation Plan for the project has been prepared (see *Jonah Infill Drilling Project Development Procedures Technical Support Document*, Appendix G) and would be required for all development alternatives. Performance-based management objectives in the BLM Preferred Alternative would further mitigate impacts by focusing development and reclamation on faster restoration of pre-development plant cover.

Land Use Impacts

During the LOP and beyond, the JIDPA would not be as suitable for the historic land uses of livestock grazing, wildlife use, and recreation, until on-site habitat function is restored through reclamation.

Cultural & Historic Resources Impacts

Potential impacts to cultural resources would be mitigated through data recovery and/or avoidance of significant properties. Site-specific surveys for cultural resources would be conducted prior to disturbance, and formal Wyoming State Historic Preservation Office (SHPO) consultation would occur where cultural resource properties may be impacted. If eligible cultural properties are inadvertently disturbed (unanticipated discoveries), appropriate data recovery programs would be implemented.

Socioeconomic Impacts

Communities most likely to be affected by the proposed project are Pinedale, Big Piney/Marbleton, and Boulder in Sublette County; La Barge in Lincoln County; and Eden/Farson and Rock Springs in Sweetwater County. A detailed socioeconomic impact assessment was prepared for this project (see *Draft Socioeconomic Analysis Technical Support Document for the Jonah Infill Drilling and South Piney Project Environmental Impact Statements).* Significant socioeconomic impacts have already occurred in these cities and counties, due in part to oil and gas development in the past decade. These impacts included additional work opportunities, increased salaries, and increased government revenues, along with growing populations and the inherent increase in infrastructure demands on emergency services, medical facilities and housing. This project is not likely to create additional, new significant impacts.

MITIGATION MEASURES

Numerous standard, JIDPA-specific, and site-specific mitigation measures could be applied during all phases of the project to minimize potential impacts. Site-specific measures would be applied in approved Applications for Permit to Drill and Rights-Of-Way applications for each new project feature as Conditions of Approval, mitigation or monitoring. Interim reclamation would restore any areas disturbed during initial development that are not required during the production phase for the LOP. Upon completion of the project, all wells would be plugged and abandoned, surface facilities would be removed, and the remaining disturbed areas would be reclaimed and revegetated.

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ABBREVIATIONS AND ACRONYMS

ºF	Degrees Fahrenheit
μeq/l	Microequivalents per liter
μg	Micrograms
μg/m^3	Micrograms per cubic meter
AACL	Acceptable Ambient Concentration Levels
AASHTO	American Association of State Highway and Transportation Officials
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ADT	Average daily traffic
acre-ft	Acre-foot/feet
AGA	American Gas Association
AIRFA	*American Indian Religious Freedom Act*
AJE	Annual Job Equivalents
AML	Appropriate Management Level
ANC	Acid-neutralizing capacity
APD	Application for Permit to Drill
API	American Petroleum Institute
API	Atmospheric pressure ionization
AQD	Air Quality Division
AQRV	Air Quality-Related Values
ARPA	*Archaeological Resource Protection Act of 1979*
ARS	Agricultural Research Service
ATV	All-terrain vehicle
AUM	Animal unit month
BA	Biological Assessment
BACT	Best Available Control Technology
bbls	Barrels
bcpd	Barrels of condensate per day
BLM	Bureau of Land Management
BMP	Best Management Practice
B.P.	Before present
BP America	BP America Production Company (formerly BP Amoco).
bpd	barrels per day
BTU	British Thermal Unit
BWS	Bureau of Land Management Wyoming Sensitive
BWPD	Barrels of Water Per Day
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
C.F.R.	*Code of Federal Regulations*
cfs	Cubic feet per second
CIAA	Cumulative impact assessment area
CM	Compensation Mitigation
CO	Carbon monoxide
CO_2	Carbon dioxide
COA	Condition of approval
COOP	University of Wyoming Cooperative Fish and Wildlife Research Unit
COE	U.S. Army Corps of Engineers
CPI-U	Consumer Price Index for all Urban Consumers
CRMP	Cultural Resource Management Plan
CSU	Controlled Surface Use Stipulations
DAT	Deposition Analysis Threshold
dB	Decibel
dBA	A-weighted decibel
DEIS	Draft environmental impact statement
DM	Department Manual
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DR	Decision Record
dv	Deciview
EA	Environmental assessment
ED	Economically Disadvantaged
EIS	Environmental impact statement
EnCana	EnCana Oil and Gas (USA), Inc.
EO	*Executive Order*
EPA	U.S. Environmental Protection Agency
EPCA	*Energy Policy Conservation Act*
ESA	Endangered Species Act
FAR	Functioning-at-risk
FEMA	Federal Emergency Management Agency
FLPMA	*Federal Land Policy and Management Act of 1976*
ft	Foot or feet
FONSI	Finding of No Significant Impact
g/hp-hr	Grams per horsepower-hour
gal	Gallon
GCIAA	General Cumulative Impact Assessment Area
GDRA	Great Divide Resource Area
GIS	Geographic information system
gpm	Gallons per minute
GPS	Global positioning system
GRBAC	Green River Basin Advisory Council

ABBREVIATIONS AND ACRONYMS (CONTINUED)

GRRA	Green River Resource Area
GSP	Gross State Product
H_2S	Hydrogen sulfide
HAP	Hazardous air pollutant
hp	Horsepower
hr	Hour
HS-20	Refers to the AASHTO truck type and axle load rating
HUD	Department of Housing and Urban Development
I-80	Interstate 80
IAMWG	Interagency Management Working Group
IDT	Interdisciplinary Team
IM	Instruction Memorandum
IMPROVE	Interagency Monitoring of Protected Visual Environments
IWAQM	Interagency Workgroup on Air Quality Modeling
JACRMA	Jonah-Anticline Cultural Resource Management Area
JIDPA	Jonah Infill Drilling Project area
JMHCAP	Jack Morrow Hills Coordinated Action Plan
kg/ha-yr	Kilogram per hectar per year
l	Liter
LAC	Limit of Acceptable Change
lb(s)	Pound(s)
LCHMA	Little Colorado Herd Management Area
LOP	Life-of-Project
LQD	Land Quality Division
m	Meter(s)
MBO	Million barrels of oil
mcf	Thousand cubic feet
MCIAA	Minerals Cumulative Impact Assessment Area
MEI	Maximally exposed individual
MFP	Management Framework Plan
mg	Milligram
MGD	Million gallons per day
MJ2PA	Modified Jonah II Project Area
mi	Mile(s)
MLE	Most likely exposure
mmcf	Million cubic feet
mmcfd	Million cubic feet per day
MOU	Memorandum of Understanding
mph	Miles per hour
MSDS	Material Safety Data Sheet
N_2	Nitrogen
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAGPRA	Native American Graves and Repatriation Act
NCPA	National Cultural Programmatic Agreement
n.d.	No date
NED	Not Economically Disadvantaged
NEPA	*National Environmental Policy Act of 1969*
NHPA	*National Historic Preservation Act of 1966*
NF	Nonfunctional
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
NOI	Notice of Intent
NOS	Notice of Staking
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NSO	No Surface Occupancy
NTL	Notice to Lessees
NWI	National Wetland Inventory
OHV	Off-highway vehicle
Operators	EnCana, BP America, and other oil and gas companies working in the JIDPA
OSHA	Occupational Safety and Health Administration
OVM	Organic vapor meter
PA	Programmatic Agreements
PAPA	Pinedale Anticline Project Area
PAWG	Pinedale Anticline Working Group
PFC	Proper functioning condition
PFO	Pinedale Field Office
PILT	Payment in lieu of taxes
PLS/ac	Pure live seed per acre
$PM_{2.5}$	Particulate matter less than 2.5 microns in effective diameter
PM_{10}	Particulate matter less than 10 microns in effective diameter
POD	Plan of Developement
ppm	Parts per million
PRA	Pinedale Resource Area
PSD	Prevention of Significant Deterioration
Pub. L.	Public Law
RCRA	*Resource Conservation and Recovery Act of 1976*
RDP	Road Development Plan
RFD	Reasonably Foreseeable Development
RMG	Reservoir Management Group

ABBREVIATIONS AND ACRONYMS (CONTINUED)

RMP	Resource Management Plan
ROD	Record of Decision
ROW	Right-of-way
RSFO	Rock Springs Field Office
RV	Recreational vehicle
RVD	Recreational visitor days
SARA	*Superfund Amendments and Reauthorization Act of 1986*
SCADA	Supervisory Control and Data Acquisition
SCBC	Sublette County Board of Commissioners
SCPC	Sublette County Planning Commission
SCS	U.S. Soil Conservation Service
SHPO	State Historic Preservation Office
SIL	Significant Impact Level
SMA	Surface Management Agency
SO_x	Oxides of sulfur
SO_2	Sulfur dioxide
SPCC Plan	Spill Prevention, Control, and Countermeasure Plan
SPSS	Special Status Plant Species
SRA	Sensitive resource area
SUP	Surface Use Plan
SVR	Standard visual range
SWPP Plan	Stormwater Pollution Prevention Plan
SWREE	Southwest Regional Economic Evaluation
T&E	Threatened and endangered
TCF	Trillion cubic feet
TCP	Traditional Cultural Properties
TCPU	Transportation, Communication, and Public Utilities
TDS	Total dissolved solids
TEC&SC	Threatened, endangered, candidate, and other species of concern
TEE	total energy efficiency
TEP&C	Threatened, endangered, proposed and candidate species.
THK	THK Associates, Inc.
TLS	Timing Limitation Stipulations
TMDL	Total Maximum Daily Load
TP	Transportation Plan
TPA	Transportation planning area
TPTSD	Transportation Planning Technical Support Document
TPQ	Threshold planning quantity
tpy	Tons per year
TRC Mariah	TRC Mariah Associates Inc.
TRPH	Total recoverable petroleum hydrocarbons
TSP	Total suspended particulate matter
U.S.C.	*United States Code*
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USDOC	U.S. Department of Commerce
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Fish and Wildlife Service
UW	University of Wyoming
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
VRM	Visual Resource Management
WAAQS	Wyoming Ambient Air Quality Standards
WAPA	Wyoming Association of Professional Archeologists
WAQSR	Wyoming Air Quality Standards and Regulations
WCLI	Wyoming Cost of Living Index
WDA	Wyoming Department of Agriculture
WDEQ	Wyoming Department of Environmental Quality
WDERP	Wyoming Department of Employment, Research, and Planning
WDOC	Wyoming Department of Commerce
WDOE	Wyoming Department of Employment
WDOT	Wyoming Department of Transportation
WDR	Wyoming Department of Revenue
WESTAR	Western States' Air Resource Council
WGFC	Wyoming Game and Fish Commission
WGFD	Wyoming Game and Fish Department
WHHMA	Wild Horse Herd Management Area
WNDD	Wyoming Natural Diversity Database
WOGCC	Wyoming Oil and Gas Conservation Commission
WQD	Water Quality Division
WRCC	Western Regional Climate Center
W.S.	*Wyoming Statute*
WSA	Wilderness Study Area
WSEO	Wyoming State Engineer's Office
WSGS	Wyoming State Geological Survey
WSLUC	Wyoming State Land Use Commission
WSP	Wyoming State Protocol
WUS	Waters of the U.S.
WyCAS	Wyoming Comprehensive Assessment System
WyGISC	Wyoming Geographic Information Science Center
WYNDD	Wyoming Natural Diversity Database

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CHAPTER 1 — INTRODUCTION

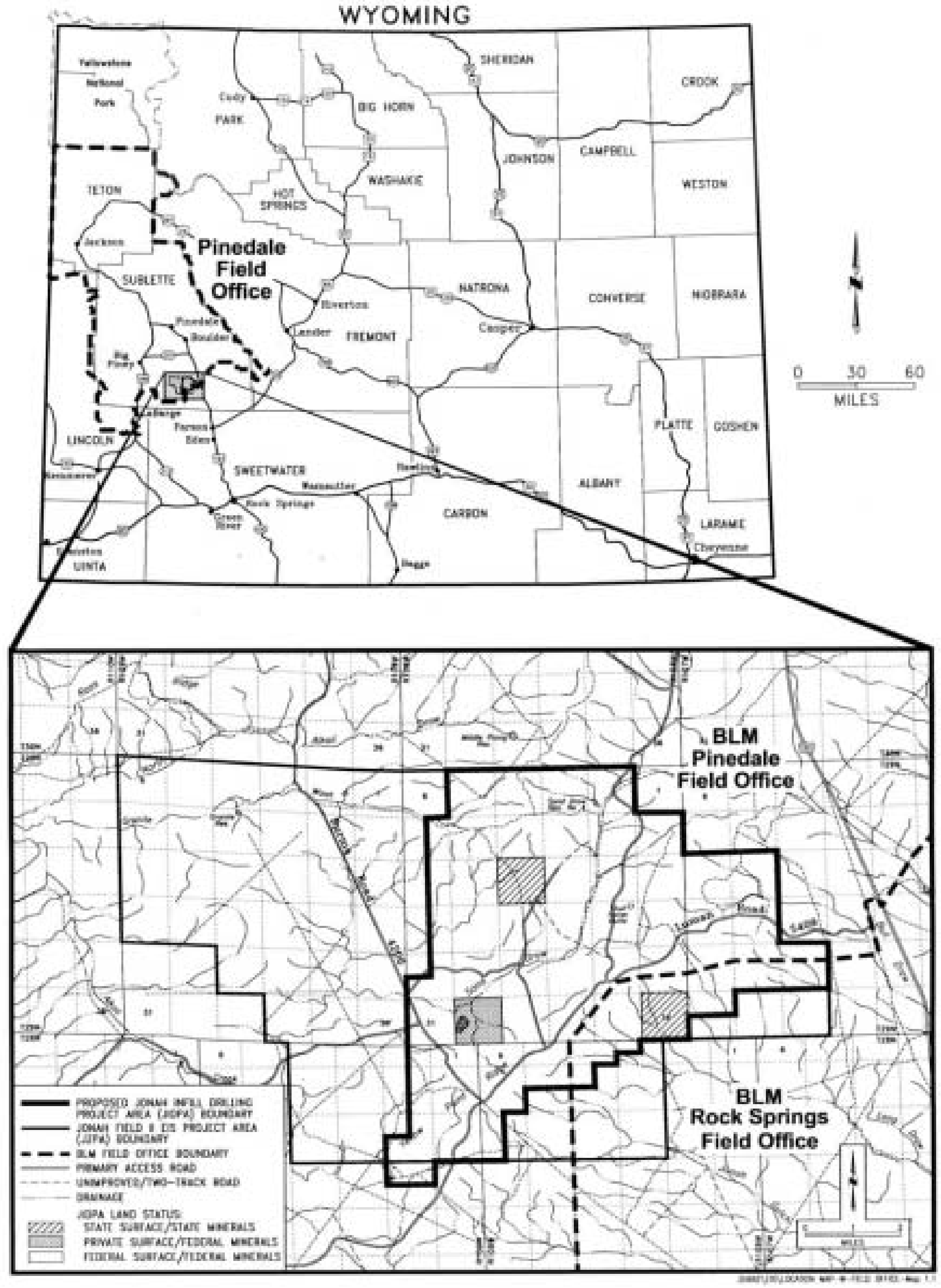
The U.S. Department of the Interior (USDI), Bureau of Land Management (BLM) Pinedale Field Office (PFO) and Rock Springs Field Office (RSFO) have received a proposal from EnCana Oil and Gas (USA), Inc. (EnCana), BP America Production Company (BP America), and other companies (referred to as "Operators") to expand the existing Jonah Field natural gas drilling and development operations in south-central Sublette County approximately 32 miles southeast of Pinedale, 28 miles northwest of Farson, and 1.5 to 11.0 miles west of U.S. Highway 191 (Map 1.1). Expanded development is proposed in portions of Townships 28 and 29 North (T28N-T29N), Range 107, 108, and 109 West.

The project is referred to as the Jonah Infill Drilling Project (the Project), and the total Jonah Infill Drilling Project area (JIDPA) includes approximately 30,500 acres. This acreage includes approximately 28,580 acres of federal surface and mineral estate managed by the BLM, 1,280 acres of State of Wyoming surface and minerals, and 640 acres of private surface/federal minerals. The JIDPA includes the entire area formerly described as the Modified Jonah Field II Project Area (MJ2PA) (BLM 2000a) but has been expanded to include the N½ of Section 23, T28N, R109W for analysis purposes, since natural gas development from the same productive formation has occurred in this area.

Based on Operator knowledge of natural gas reservoir characteristics (geology, flow from existing wells, anticipated recovery rates, and economics), the Operators anticipate field development in the JIDPA to involve infill drilling among existing wells. The Operators propose drilling and developing up to 3,100 additional new wells in the JIDPA depending on the outcome of continued exploration and reservoir characterization. Bottom-hole (subsurface) well spacing is expected to range from 16 wells/640-acre section up to as many as 128 wells/section (1 well/5 acres). The Operators propose a minimum of 64 well pads per section. The construction of various ancillary facilities such as roads, pipelines, water wells, water disposal sites, and compressor station expansions would occur in association with the expanded development. Because Operators have identified the potential for up to 3,100 new wells with associated facilities on up to 16,200 of new surface disturbance, the BLM has determined it prudent to prepare an environmental impact statement (EIS) to analyze the impacts associated with this level of development.

The proposed Project is a major expansion of existing natural gas development operations as initially proposed and authorized in the Jonah Field II Natural Gas Project EIS (BLM 1997a, 1998a) and its Record of Decision (ROD) (BLM 1998b) and subsequently revised by the Environmental Assessment (EA), Finding of No Significant Impact (FONSI), and Decision Record (DR) for the Modified Jonah Field II Project (BLM 2000a, 2000b).

The purpose of this EIS is to provide the public and decision-makers with sufficient information to understand the estimated environmental consequences of implementing the Project. This EIS assesses the estimated environmental impacts of the No Action Alternative, the Proposed Action, seven alternatives, and the BLM Preferred Alternative (see Chapter 2). The analyses in this EIS



Map 1.1 Jonah Infill Drilling Project Location, Sublette County, Wyoming, 2005.

were also used to identify and develop appropriate mitigation measures to minimize environmental impacts.

The BLM PFO is the lead agency for this EIS since the majority of development is proposed for lands under their jurisdiction. The BLM (PFO and RSFO) has provided guidance, input, participation, and independent evaluation during EIS preparation. The State of Wyoming participated in the preparation of this EIS as a cooperating agency; state agencies specifically participating include the Office of State Lands and Investments, Wyoming Department of Environmental Quality (WDEQ), Wyoming Oil and Gas Conservation Commission (WOGCC), Wyoming State Geological Survey (WSGS), Wyoming State Engineer's Office (WSEO), Wyoming Department of Agriculture (WDA), Wyoming Game and Fish Department (WGFD), Wyoming State Historic Preservation Office (SHPO), Wyoming State Parks and Historic Sites, Wyoming Business Council, and Wyoming Department of Transportation. The BLM, in accordance with 40 C.F.R. 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.

Standard operating procedures and practices currently used in gas field development throughout Wyoming and the surrounding region would be employed for this Project (see Appendix G). Construction, development, production, and abandonment would comply with all applicable federal, state, and county laws, rules, and regulations (see Section 1.3). Numerous standard, Project-specific, and site-specific mitigation measures would be employed during all phases of the Project to avoid, minimize, or mitigate potential impacts to the environment (see Appendix A: *BLM Standard Stipulation/Mitigation Requirements* and Appendix B: *Operator-Committed Practices*). Reclamation would be conducted as soon as practical on disturbed areas. Upon Project completion, all wells would be plugged and abandoned, surface facilities would be removed, and most disturbed areas would be reclaimed and revegetated.

Pursuant to the *National Environmental Policy Act of 1969* (NEPA), as amended, and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 *Code of Federal Regulations* [C.F.R.] 1500-1508), the BLM has prepared this EIS to describe and evaluate the probable impacts of the Proposed Action and other alternative actions.

This EIS incorporates key provisions of *Federal Land Policy and Management Act of 1976* (FLPMA) to manage public lands and their resource values to "best meet the present and future needs of the American people" (Section 103 [43 U.S.C. 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 [43 U.S.C. 1702]). FLPMA also says that it is appropriate that some lands be used "for less than all of the resources" (Section 103 [43 U.S.C. 1702]). The proposed Project is compliant with resource management regulations (43 C.F.R. 1610).

1.1 PURPOSE AND NEED

The proposed development meets the purpose and need of BLM Resource Management Plan (RMP) minerals development objectives. These objectives are:

- to maintain or enhance the opportunities for mineral exploration and development, while protecting other resource values;

- to provide for oil and gas leasing, exploration, and development while protecting other values;
- to consider the conservation and enhancement of natural resources with the economic benefits of resource development;
- to coordinate land use decisions with economic factors and needs;
- to plan land use consistent with the orderly development, use, and conservation of resources while preserving environmental quality; and
- to plan uses that encourage energy conservation.

The purpose of the proposed development is also to enable the commercial production by Operators of federally owned natural gas in conformance with BLM RMP oil and gas objectives, pursuant to their rights under existing oil and gas leases issued by the BLM, and to prevent drainage of federal minerals by wells located on adjacent nonfederally owned lands (i.e., State of Wyoming lands). All of the federally owned minerals in the JIDPA have been leased. National mineral leasing policies and the regulations by which they are enforced recognize the statutory right of lease holders to develop federal mineral resources to meet continuing national needs and economic demands as long as unnecessary and undue environmental degradation is not incurred.

Natural gas is an integral part of the U.S. energy future due to its availability and the presence of an existing market delivery infrastructure. By developing domestic reserves of natural gas, the U.S. reduces its dependence on foreign sources of energy while maintaining an adequate and stable supply of fuel to maintain economic well-being, industrial production, and national security. According to the American Gas Association (2003), 99% of the natural gas used in the U.S. is produced in North America (85% in the U.S. and nearly 15% in Canada), supplies are abundant, and demand is anticipated to increase 45% by 2015 and 53% by 2020; this project would assist in providing natural gas to meet anticipated demand. Demand has increased 35% in the last decade. The National Petroleum Council (2003) estimates that natural gas provides nearly one-quarter of all U.S. energy requirements, about 19% of electric power generation, and is used for heating and cooking in over 60 million U.S. households. U.S. industries get over 40% of all their primary energy from natural gas.

The true measure of energy efficiency is total energy efficiency. Total energy efficiency (TEE) takes into account all of the energy used or lost in the production, processing, and delivery steps involved in supplying energy to run factories, businesses, homes, and vehicles, plus the efficiency of the energy-using product itself (American Gas Association, 2003). Natural gas is delivered to the consumer with a TEE of about 90%, whereas electricity is delivered with a TEE of about 27%. The use of natural gas in chemical and energy production applications results in lower air pollutant emissions than does the comparable use of other fossil fuels. For instance, burning natural gas rather than coal results in a reduction of 85-96% in the pounds of emissions per million British Thermal Units (BTUs) of energy produced (American Gas Association 2003). The environmental advantages of burning natural gas are emphasized in the *Clean Air Act Amendments of 1990*.

Development of new gas resources like those proposed by the Operators in the JIDPA is consistent with the Comprehensive National Energy Strategy announced by the U.S. Department of Energy (DOE) in April 1998 (DOE 1998), and meets the purpose and need of the Energy

Policy and Conservation Act (42 *United States Code* [U.S.C.] 6201). That strategy is designed to guide national policy toward energy security, economic expansion, and greater protection of the environment. One of the goals of that strategy is to ensure against energy disruptions by increasing production of domestic sources of natural gas.

1.2 NATIONAL ENVIRONMENTAL POLICY ACT

This EIS was prepared in accordance with NEPA and is in compliance with all applicable regulations and laws subsequently passed, including regulations (40 C.F.R. 1500-1508), USDI requirements (*Department Manual* [DM] *516* [516 DM 1 through 6], *Environmental Quality* [USDI 2004]), guidelines listed in the BLM *National Environmental Policy Act Handbook, H-1790-1* (BLM 1988a), *Guidelines for Assessing and Documenting Cumulative Impacts* (BLM 1994c), and CEQ's *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997).

1.3 DECISIONS TO BE MADE

The decision the BLM will make as a result of the analysis presented in this EIS is whether to allow, and under what conditions to allow, the development, operation, maintenance, and reclamation of expanded development/surface disturbances on federal land in the JIDPA. BLM will determine what level of impacts are approved, and what Conditions of Approval (COAs), Best Management Practices (BMPs), 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 proposal. The BLM must analyze and authorize each component of the project that involves the disturbance of federal lands on a site-specific basis. The method used to evaluate and authorize each surface-disturbing activity is an Application for Permit to Drill (APD), right-of-way (ROW) grant, or Sundry Notice, with supporting Environmental Assessment (EA), which would be required before any construction can occur.

<u>Pinedale Field Office RMP Amendment Decision</u>

The Notice of Intent (NOI) for this Project (see Section 2.1) indicated the possible need for an RMP amendment. Determination of need to amend an RMP as a result of newly proposed oil and gas development projects was based on several factors including, but not limited to number of new wells, acres of new long-term surface disturbance, and conformance of the project with RMP objectives. Paramount among these factors is whether or not approving a proposed project would meet RMP objectives. An update to the PFO RMP was provided in the ROD for the Pinedale Anticline Oil and Gas Exploration and Development Project (BLM 2000c). That ROD set an oil and gas reasonably foreseeable development (RFD) projection of 1,944 new wells (above the 1,815 wells present at that time) over a 10- to 15-year period beginning in 2000, and included 6,300 acres of new long-term disturbance (above the 14,076 acres present at that time).

As of March 2004, the WOGCC website listed 2,530 wells in the PFO area; these wells are estimated to require approximately 8,572 acres of long-term disturbance. Current oil and gas development proposals in the PFO could add approximately 3,310 more wells (more than the updated RFD), 5,190 acres of new long-term disturbance (less than the updated RFD), and existing RMP objectives would still be met. Based on all criteria, BLM has determined that this proposed project would not require an amendment of the PFO RMP (as updated in BLM [2000c]) if development at the proposed level is approved.

1.4 AUTHORIZING ACTIONS AND RELATIONSHIP TO POLICIES, PLANS, AND PROGRAMS

A list of the major permits, approvals, and authorized actions necessary to construct, operate, maintain, and abandon project facilities is provided in Table 1.1.

1.4.1 Federal Permits, Authorizations, and Coordination

Drilling of federal minerals is subject to the BLM's Onshore Oil and Gas Orders (43 C.F.R. Subpart 3164 - Special Provisions). Operator drilling programs require BLM approval of each well and well pad on federal surface or federal minerals prior to commencement of drilling (see Figure 1.1). BLM reviews the drilling program through the APD process. 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 shall be held fully accountable for their contractor's compliance with the requirements of the approved permit and/or plan" (48 *Federal Register* 56226, December 20, 1983).

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

Nine Presidential *Executive Orders* (EOs) affect implementation of the project. These EOs, which are binding on all government agencies, place restrictions on government approval of construction activities and apply to wetlands (EO 11990), floodplains management (EO 11988), migratory birds (EO 13186), environmental justice (EO 12898), Native American sacred sites (EO 13007), historic trails (EO 13195), cultural resources and historic preservation (EO 11593 and EO 13287), and invasive species (EO 13112).

Policies for development and land use decisions within the JIDPA are contained in the draft and final Pinedale Resource Area (now referred to as the PFO) Resource Management Plan (RMP)/EIS (BLM 1987a, 1987b), its ROD (BLM 1988b) and the Green River Resource Area (now referred to as the RSFO) RMP/EIS (BLM 1992a, 1996a) and its ROD (1997b). These two RMPs allocate which lands and/or minerals are appropriate for leasing. These documents also provide development guidelines. Both RODs indicate federal minerals will be made available for orderly and efficient development, and all minerals actions will comply with goals, objectives, and resource restrictions (mitigations) required to protect other resource values. Both the PFO

Table 1.1 Major Federal, State, and Local Permits, Approvals, and Authorizing Actions for the Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[1]

Agency	Permit, Approval, or Action	Authority
Office of the President of the United States	Protection and enhancement of the cultural environment	Executive Order 11593
	Floodplains management	Executive Order 11988
	Protection of wetlands	Executive Order 11990
	Environmental justice	Executive Order 12898
	Indian sacred sites	Executive Order 13007
	Invasive species	Executive Order 13112
	Protection of migratory birds	Executive Order 13186
	Trails for America in the 21st century	Executive Order 13195
	Preserve America	Executive Order 13287
Bureau of Land Management (BLM)	Permit to drill, deepen, or plug back on federal onshore lands (APD/Sundry process); authorization for flaring and venting of natural gas on federal lands; plugging and abandonment of a well on federal lands	*Mineral Leasing Act of 1920* (30 *United States Code* [U.S.C.] 181 et seq.); 43 Code of Federal Regulation (C.F.R.) 3162
	Right-of-way grants and temporary use clearances on federal lands	*Mineral Leasing Act of 1920*, as amended (30 U.S.C. 185); 43 C.F.R. 3180; FLPMA (43 U.S.C. 1761 - 1771); 43 C.F.R. 2800
	Antiquities and cultural resource clearances on BLM-managed land	*Antiquities Act of 1906* (16 U.S.C. Section 431-433); *Archaeological Resources Public Protection Act of 1979* (16 U.S.C. Sections 470aa - 470*ll*); 43 C.F.R. 3
	Approval to dispose of produced water on BLM-managed land	*Mineral Leasing Act of 1920* (30 U.S.C. 181 et seq.); 43 C.F.R. 3164; *Onshore Oil and Gas Order No. 7*
U.S. Army Corps of Engineers (COE)	Section 404 permits and coordination regarding placement of dredged or fill material in area waters and adjacent wetlands	Section 404 of the *Clean Water Act of 1972* (40 C.F.R. 122 - 123, 230)
U.S. Fish and Wildlife Service (USFWS)	Coordination, consultation, and impact review on federally listed threatened and endangered (T&E) species	*Fish and Wildlife Coordination Act* (16 U.S.C. Sec. 661 et seq.); Section 7 of the *Endangered Species Act of 1973*, as amended (16 U.S.C. et seq.); *Bald Eagle Protection Act*, as amended (16 U.S.C. 668-668dd)
U.S. Environmental Protection Agency (EPA)	Spill Prevention, Control, and Countermeasure Plans (SPCCPs)	40 C.F.R. 112
	Regulation of hazardous waste treatment, storage, and/or disposal	*Resource Conservation and Recovery Act* (42 U.S.C. Section 6901)
U.S. Department of Energy (DOE)	Regulation of interstate pipeline product transportation	Various sections of the U.S.C. and C.F.R.
U.S. Department of Transportation (DOT)	Control of pipeline maintenance and operation	49 C.F.R. 191 and 192
Wyoming Board of Land Commissioners/Land and Investments Office	Approval of oil and gas leases, ROWs for long-term or permanent off-lease/off-unit roads and pipelines, temporary use permits, and developments on state lands	*Wyoming Statute* (W.S.) 37-1-101 et seq.

Table 1.1 (continued)

Agency	Permit, Approval, or Action	Authority
Wyoming Department of Environmental Quality - Water Quality Division (WDEQ/WQD)	Regulation of off-lease disposal of drilling fluids from abandoned reserve pits	*Wyoming Environmental Quality Act* (W.S. 35-11-301 through 35-11-311)
	National Pollutant Discharge Elimination System (NPDES) permits for discharging waste water and storm water runoff	WDEQ Rules and Regulations, Chapter 18, W*yoming Environmental Quality Act* (W.S. 35-11-301 through 35-11-311); Section 405 of the *Clean Water Act* (40 C.F.R. 122-124)
	Administrative approval for discharge of hydrostatic test water	*Wyoming Environmental Quality Act* (W.S. 35-11-301 through 35-11-311)
Wyoming Department of Environmental Quality - Air Quality Division (WDEQ/AQD)	Permits to construct and permits to operate	*Clean Air Act; Wyoming Environmental Quality Act* (W.S. 35-11-201 through 35-11-212)
Wyoming Department of Environmental Quality - Land Quality Division (WDEQ/LQD)	Mine permits, impoundments, and drill hole plugging on state lands	*Wyoming Environmental Quality Act,* Article 4, and Quality, as amended (W.S. 35-11-401 through 35-11-437)
Wyoming Department of Environmental Quality - Solid Waste Division	Construction fill permits and industrial waste facility permits for solid waste disposal during construction and operations	*Wyoming Environmental Quality Act* (W.S. 35-11-501 through 35-11-520)
Wyoming Department of Transportation (WDOT)	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)	Permit to use earthen pit (reserve pits) on nonfederal lands	WOGCC Regulations (Section III; Rule 305)
	Authorization for flaring or venting of gas	WOGCC Regulations (Section III; Rule 326)
	Permit for Class II underground injection wells	WOGCC Regulations (Section III; Rule 346)
	Well plugging and abandonment	40 C.F.R. 146; 40 C.F.R. 147.2551
	Permit to drill, deepen, or plug back (APD process)	WOGCC Regulations (Section III; Rule 315)
	Change in depletion plans	*Wyoming Oil and Gas Act* (W.S. 30-5-110)
	Minimum safety standards for oil and gas activities	WOGCC Regulations (Rules 320-A, 327, and 328)
Wyoming State Engineer's Office (WSEO)	Permits to appropriate ground water (use, storage, wells, dewatering)	W.S. 41-121 through 147 (Form U.W.5)
	Permits to appropriate surface water	W.S. 41-201 (Form S.W.1)
Wyoming State Historic Preservation Office (SHPO)	Cultural resource protection, programmatic agreements, consultation	Section 106 of *National Historic Preservation Act* (NHPA) and Advisory Council Regulations (36 C.F.R. 800)
Sublette County	County road crossing/access permits	Planning and Zoning Department
	Small wastewater permits	Planning and Zoning Department
	Hazardous material recordation and storage	Emergency Management Coordinator
	Zone changes	Planning and Zoning Department
	Noxious weed control	Weed and Pest Department

[1] 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.

and RSFO planning areas (excluding specific locations outside the JIDPA) are open to consideration for exploration, leasing, and development for all leaseable minerals (e.g., oil, gas, coal). Execution of the Proposed Action or alternatives presented in this EIS is consistent with the management decisions presented in the PFO and RSFO RMP/RODs (BLM 1988b, 1997b).

The BLM also has specific provisions it must adhere to regarding the draining of federal minerals from adjoining nonfederal lands. These provisions are codified in 43 C.F.R. 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 nonfederal 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).

1.4.1.1 Wyoming BLM Mitigation Guidelines and Practices for Surface Disturbing and Disruptive Activities

Consistent with *Oil and Gas Onshore Order #1* regulations regarding leasing and operations, 43 CFR Parts 3100 and 3160 respectively, oil and gas leases are issued by the BLM. Stipulations may be added as terms of the lease to reflect management guidance established in the applicable Resource Management Plan (RMP). Once the 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 Application for Permit to Drill (APD) or its associated application for right-of-way (ROW) so that a site-specific environmental assessment (EA) may be prepared. EAs prepared for APD or ROW authorizations often include site-specific conditions of approval (COAs) that add further site-specific operation requirements based on the impact analysis in the EA.

The Wyoming BLM has adopted a standard set of guidelines and post-lease COAs that apply to all surface disturbing activities on Federal lands and minerals in Wyoming (see Appendix A). These mitigation guidelines encompass all aspects of environmental protection. Upon request by the applicant, an exception to a lease stipulation or a COA may be granted by the BLM following on-site review to see if the exception is warranted.

With the exception of five specific mitigations excluded from Alternative A, the standard Wyoming BLM mitigation guidelines are applied to all alternatives analyzed in this EIS.

1.4.1.2 Conformance with BLM Pinedale and Green River Resource Management Plans

The Operators' proposal is in conformance with the fluid minerals management objectives of the PFO and RSFO RMPs, including the RFD in the PFO RMP as updated by the ROD for the Pinedale Anticline Oil and Gas Exploration and Development Project (BLM 2000c) (see Section 1.3). Post-LOP, when full reclamation has occurred (habitat function is restored to 80% of pre-project levels), management within the JIDPA boundary would conform to all RMP objectives. Resource conditions within the JIDPA boundary during infill development and production may not be in full conformance with the RMPs; however, management objectives would be met within the Field Office as a whole during JIDPA development and production.

1.4.2 State and Local Permits, Authorization, and Coordination

The proposed project development alternatives are in conformance with the *Wyoming State Land Use Plan* (Wyoming State Land Use Commission 1979) and the *Sublette County Comprehensive Plan: County Vision, Goals and Policies* (Sublette County Board of Commissioners [SCBC] and Sublette County Planning Commission [SCPC] 2003). The alternatives comply with all relevant State and county laws and regulations (see Table 1.1).

CHAPTER 2 — PUBLIC PARTICIPATION, ISSUES AND CONCERNS, AND ALTERNATIVES

2.1 PUBLIC PARTICIPATION

NEPA regulations (40 C.F.R. 1500) require the BLM to use an early scoping process to identify significant issues in preparation for impact analysis. The principle goals of scoping are to allow public participation and identify issues, concerns, and potential impacts that require detailed analysis in the EIS. Scoping was the primary mechanism used by BLM to identify public interests and concerns about proposed development actions in the JIDPA.

To encourage early and improved public participation and agency cooperation, a number of meetings/announcements involving the BLM, Operators, various agencies, and the public have been held. On March 13, 2003, the BLM's Notice of Intent (NOI) appeared in the *Federal Register* and invited the public to comment or provide research information regarding the Operators' proposal to infill drill in the Jonah natural gas field. On March 26, 2003, copies of a scoping notice describing the Proposed Action and seeking comments were mailed to appropriate government offices, elected officials, public land users, groups, newspapers, radio and television stations. A scoping meeting was held in Pinedale, Wyoming, on April 17, 2003. An additional public meeting was held on November 13, 2003, to present to the public the draft project alternatives that had been developed to address public concerns and would be analyzed in the EIS. On November 20, 2003, EnCana submitted to the BLM a revised development proposal. On December 12, 2003, the BLM issued a letter identifying Operator-proposed development plan revisions and soliciting further comment. This letter was issued to those who received the March 2003 scoping notice and other parties who had commented in response to the NOI. Additional opportunities for agency and public participation are planned during EIS review periods.

Numerous issues and concerns were identified and comments were submitted between March 2003 and August 2004. Consultation and coordination with other government agencies included: WGFD, USFWS, U.S. Department of Agriculture Forest Service (USFS), Environmental Protection Agency (EPA) and the BLM Interdisciplinary Team (IDT). The issues and concerns identified to date are summarized in Appendix C.

All comments received during the scoping process were reviewed and analyzed. The BLM identified nine key or driving issues based primarily upon the assumed quantity, intensity, or duration of a potential impact, and/or the volume of agency or public interest in the issue. The range of alternatives was developed in response to the key issues. These alternatives provide a range of potential effects to key issues because of varying levels of surface disturbance and/or by inclusion or exclusion of various development guidelines/management protocol.

The extent and distribution of surface disturbance affects all the key resources but most notably those associated with wildlife, wildlife habitat, and livestock forage. Ranges in the pace of development (75, 150, or 250 wells developed per year) were applied under Alternatives A through G, and a range of well numbers were analyzed (3,100 wells for most alternatives, 1,250 wells for Alternative C, and 2,200 wells for Alternative D). This range in pace of development and well numbers provides a range of effects to socioeconomics and air quality, BLM inspection and enforcement capability, and project duration. The application or renewal of alternative-specific on-site surface disturbance protocols and mitigation (see Section 2.3, and Appendices A and B), including Operator-committed monitoring, reporting and off-site compensatory mitigation (CM), provides a range of potential impacts to most key resources/resource issues including air quality, greater sage-grouse, pronghorn antelope, and other wildlife, livestock forage, and BLM inspection and enforcement capability.

2.1.1 Key Issues

Issue 1 The extent of proposed surface disturbance and its effects on all area resources.

Respondents identified the total volume and distribution of proposed surface disturbance associated with the Proposed Action as an issue for numerous area resources (e.g., wildlife and wildlife habitat, cultural resources, vegetation, soils). The extent and duration of surface disturbance was also identified as potentially adversely affecting appropriate management of these area resources.

Issue 2 Pace of proposed development, associated regional socioeconomic effects, and boom/bust avoidance.

Respondents expressed concern with the potential influx of transient workers who do not tend to maintain permanent residence as experienced with past energy development projects; the added burden to area infrastructures such as community support facilities including hospitals and medical clinics, emergency services, housing, and roads and; inadequate capacity of governments to address infrastructure shortfalls.

Employees also identified as a concern the desire to maintain permanent residence in the area, but held the belief that if BLM does not approve continued development in the JIDPA, they would be forced to relocate. Furthermore, project proponents and local government agencies identified that the potential revenues from tax dollars, royalties, and jobs associated with the proposed project would benefit the State, county, and local communities.

Issue 3 Potential project impacts on regional visibility, particularly at area residences and in Class I airsheds and other air quality impacts including those associated with emission volumes, atmospheric deposition, and regulatory authority.

Many respondents indicated that regional haze and smoke plumes have increased locally in association with ongoing natural gas development projects in the region, and that maintenance and improvement of visibility is a requirement of the *Clean Air Act* within nearby wilderness areas (Class I airsheds). Other respondents had concerns about project emission effects on worker and area resident health; others were concerned about excessive acid deposition. Nighttime star gazing was also identified as having been locally affected. Additionally, agencies and the public expressed concerns regarding the authority for air quality mitigation requirements.

Issue 4 Project effects to greater sage-grouse, greater sage-grouse habitats, and habitat function.

Respondents identified effects to this species and its habitats as an issue because of the historic population levels of greater sage-grouse in the JIDPA and the apparent decline in greater sage-grouse populations across their range. Potential project effects to breeding, nesting, brood-rearing, and wintering habitat and habitat function were identified as potentially contributing to continued population declines. It was also noted that existing greater sage-grouse protection measures appear to be inadequate within the JIDPA and that with the proposed increase in development, existing protection measures would be even less effective.

Issue 5 Project effects on pronghorn antelope migration corridors leading to and from crucial winter ranges north of the JIDPA.

Current developments in the region were identified as already having adversely affected the historic migrations of the Sublette antelope herd. Continued development within the JIDPA and at other locations within the Sublette herd unit area were identified as potentially cumulatively affecting pronghorn antelope seasonal migrations. Hunters, wildlife enthusiasts, and wildlife management agencies all consider the maintenance of existing migratory corridors extremely important to pronghorn population maintenance.

Issue 6 Proposed surface disturbance, human presence, and noise effects to overall habitat loss (direct and indirect) for numerous wildlife species and associated fragmentation of wildlife habitats.

Respondents indicated that, with implementation of the proposed project, the JIDPA would no longer be suitable habitat for many wildlife species (e.g., threatened and endangered species, BLM-sensitive species, and raptors). Habitat loss was attributed to direct loss through surface disturbance, indirect loss through animal avoidance of areas proximal to developments, and habitat fragmentation (habitat is no longer suitable for species requiring intact habitat patches larger than what would be available if the project were constructed).

Issue 7 Maximize natural gas recovery from the field.

Respondents indicated that one of BLM's mandates under the *Mineral Leasing Act* is to maximize recovery of available resources. It was pointed out that many of the existing and proposed development restrictions (e.g., lease stipulations, RMP requirements, Operator-committed practices) limit the economic feasibility of maximizing recovery of the JIDPA's natural gas resources.

Issue 8 Loss of livestock forage and project-associated hazardous conditions to area livestock/livestock operations.

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

Issue 9 BLM monitoring and enforcement capability.

Respondents indicated that processing permits for current and proposed levels of natural gas development in the area is limiting BLM staff from adequately fulfilling their concurrent responsibilities for area management (e.g., site inspections, reclamation monitoring, wildlife monitoring, cultural resource clearance actions). It was suggested that this may lead to unidentified violations of numerous laws, rules, and regulations (e.g., *Endangered Species Act*, *Clean Water Act*, lease stipulations, RMP requirements, Operator-committed practices required under past project authorizations).

For more detail on these key issues and the variability in scoping respondent concerns see Appendix C.

2.2 DEVELOPMENT OF ALTERNATIVES

The BLM IDT used the nine key issues (see Section 2.1) to build the project alternatives. The Proposed Action and other action alternatives meet the purpose and need for the project, are technically and economically reasonable and provide a reasonable range of management and mitigation opportunities. Operators committed to various mitigations depending on the alternative (see Appendix B, Exhibit B-1); the IDT developed additional mitigation measures that would avoid, minimize, rectify, reduce, eliminate, or compensate for adverse impacts (see Sections 2.14 and 5.2). Some of these mitigation measures are common to all action alternatives including the Proposed Action, whereas others are applied only to one or a few action alternatives. Some Operator-committed practices are outside the jurisdiction of the BLM (see Appendix B).

The variable well numbers and development paces analyzed result from unknowns in the natural gas market and in potential future development technologies. Experience in Wyoming reveals that well number and development pace predictions are often incorrect; therefore, ranges in these development parameters are appropriate. Furthermore, as new technologies become available and resource demand changes, development protocol also will likely change. For example, in the past well development operations for wells similar to those in the JIDPA could take months to drill, require pads of >5.0 acres, lacked adequate surface casing to protect freshwater aquifers, and did not consider such practices as flareless completions or directional drilling. All alternatives analyzed in this EIS consider these new technological advances, and allow for the inclusion of new technologies as they become available.

Alternatives considered to be technically or economically unfeasible, and/or unrealistic, were eliminated from detailed impact analysis. The rationale for eliminating these alternatives is provided in Section 2.15.

2.3 FEATURES COMMON TO ALL ALTERNATIVES

Development requirements and procedures common to all alternatives are provided in Appendix G, and in general these procedures would be applied under all alternatives.

All applicable federal, state, and local laws, rules, and regulations would be applied under any approved alternative, and all requirements listed in Appendix A would be implemented under all alternatives except Alternative A. For the purpose of analyses designed to minimize directional drilling under Alternative A, requirements for avoiding selected resources such as steep slopes, greater sage-grouse leks, and raptor nests, were not applied.

Appendix B provides a list of Operator-committed measures, and Exhibit B-1 lists which of these measures the operators committed to by alternative, except the BLM Preferred Alternative. All Operator-committed practices that can be required by the BLM would be applied under the Preferred Alternative.

Absent specific revisions in the ROD for this project, Operators would comply with the management objectives, COAs, standard stipulations, and mitigation measures identified in the BLM PFO RMP ROD (BLM 1988b), and BLM RSFO RMP ROD (BLM 1997b).

Operators would comply with all appropriate federal, state, and local laws and regulations, and all appropriate permits from the appropriate regulatory agency would be obtained before proceeding.

Operators would continue to encourage limiting the speed of all vehicles operated by the leaseholder, Operator, or Operator agents in the JIDPA.

Operators would install remote telemetry or equivalent technology at all wells to minimize well monitoring trips.

A ground water monitoring program for all water wells in or affected by activities in the JIDPA would be implemented, with annual reports to BLM, Jonah Infill Working Group (JIWG), WSEO, and WDEQ. Water wells would be tested annually for drawdown, general chemical constituents, and total petroleum hydrocarbons, using WDEQ-approved methods.

Operators would submit to BLM for approval a reclamation plan (interim and long-term) for the JIDPA within one year of the ROD for this project. A reclamation quality assurance/quality control monitoring program would be implemented until development and interim (production phase) reclamation is completed to BLM standards.

Operators would monitor raptor, including ferruginous hawk and burrowing owl, nesting activity, greater sage-grouse lek attendance, and occurrence of other sagebrush-obligate species in the JIDPA.

Traffic would be confined to the running surface of roads and well pads as approved in APDs and ROWs. Operators would continue to cooperate with the BLM to identify and prohibit use of two-tracks where ROWs have not been obtained.

2.4 ALTERNATIVES ANALYZED IN DETAIL

The No Action, the Proposed Action, and eight alternative development actions are evaluated in this EIS. A brief comparison of alternatives is provided in Table 2.1.

The types and locations of existing surface disturbance in the JIDPA are presented in Map 2.1. The LOP for all alternatives is shown in Table 2.2.

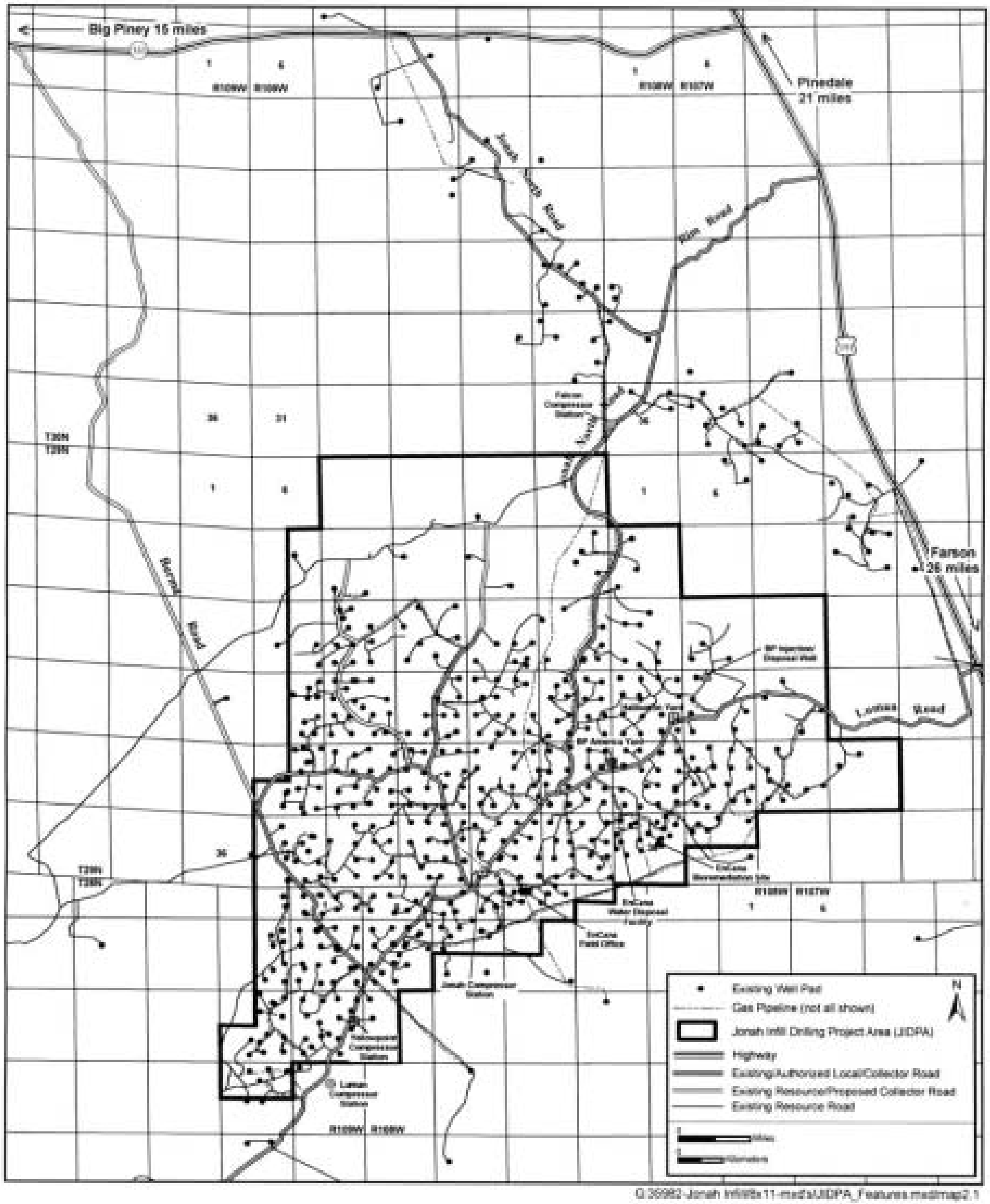
2.5 NO ACTION ALTERNATIVE – REJECT OPERATORS' PROPOSAL

Under the No Action Alternative, the BLM would reject the Operators' proposal for additional field-level natural gas development on federal lands within the JIDPA. Authorizations for and impacts from previously approved or committed to development (533 wells) and surface

Table 2.1 Comparison of Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

	Alternative									
Project Parameter	No Action[1]	Proposed Action[2]	A[2]	[3]	[4]	[5]	[6]	[7]	[8]	BLM Preferred Alternative[9]
Development Features										
			B	C	D	E	F	G		
Total Acres Surface Disturbance	4,209	20,409	20,409	7,506	10,914	15,790	10,595	14,655	18,198	12,525
LOP Acres Surface Disturbance	1,409	6,040	6,040	2,622	3,399	4,755	3,597	3,997	5,408	3,847
Total Miles of Resource Roads/Gathering Pipelines	199	664	664	199	387	529	239	353	582	473
Total Miles of Collector/Local Roads	38	46	46	46	46	46	46	46	46	46
Total Number of Natural Gas Well Pads[10]	497	3,597	3,597	497	1,747	2,697	763	1,705	3,050	3,597
These development features directly or indirectly affect habitat loss and fragmentation for all species, pronghorn migration, visibility, livestock hazards and available forage, socioeconomics, and gas recovery.										
Pace of Development										
Wells Developed per year	0	250	75-250	75-250	75-250	75-250	75-250	75-250	75-250	250
Life-of-Project (years)	63	76	76-105	76-105	68-80	72-73	76-105	76-105	76-105	76
Pace of development directly or indirectly affects duration of habitat and forage loss, visibility, socioeconomics, gas recovery, and BLM enforcement and monitoring capability.										

1 See Table 2.3 for further detail.
2 See Table 2.4 for further detail.
3 See Table 2.5 for further detail.
4 See Table 2.6 for further detail.
5 See Table 2.7 for further detail.
6 See Table 2.8 for further detail.
7 See Table 2.9 for further detail.
8 See Table 2.10 for further detail.
9 See Table 2.11 for further detail.
10 Although pad numbers may not vary under some alternatives, the types and spatial distribution of pads would vary across all alternatives.



Map 2.1 Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.

Table 2.2 Estimated Life-of-Project (LOP) (in Years), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Phase	No New Wells	1,250 Wells	2,200 Wells	3,100 Wells
Development				
75 wells drilled/year	0	17	30	42
150 wells drilled/year	0	9	15	21
250 wells drilled/year	0	5	9	13
Total Development	0	5-17	9-30	13-42
Production	40	40	40	40
Reclamation	23	23	23	23
Life-of-Project (LOP)	63 [1]	68-80	72-93	76 [2]-105

[1] No Action LOP.
[2] Proposed Action and Preferred Alternative LOP.

disturbance (497 well pads with associated roads, pipelines, and ancillary facilities) would continue (BLM 1998b, 2000b). The approved surface disturbance under the No Action Alternative is 4,209 acres initial and 1,409 acres LOP (see Table 2.3).

However, rejection of the Operators' proposal would not preclude all additional natural gas development in the JIDPA. The No Action Alternative assumes the JIDPA would be managed as approved by existing management plans (BLM 1988b, 1997b) and as previously authorized by APDs and ROWs issued under existing decisions (BLM 1998b, 2000b). Site-specific NEPA analyses would be conducted for each additional natural gas development activity authorized in the project area. Because the location and/or extent of individual well development under this scenario cannot be predicted, the impact analysis for the No Action Alternative assumes no new development.

2.6 PROPOSED ACTION

If selected, the Operators would infill drill and develop up to 3,100 new wells on a minimum of 64 well pads/section (at least 1 pad every 10 acres) with related roads, pipelines, and ancillary facilities on up to 16,200 acres of new disturbance. Operators have committed to various mitigation measures depending upon alternative (see Appendix B), and propose to establish a Cumulative Impacts Mitigation Fund to mitigate potential adverse impacts in the JIDPA. While details are emerging, one form of financing the fund could be to deposit a particular dollar amount for every acre of new initial surface disturbance in the JIDPA above a certain acreage threshold. For example, Operators have suggested a hypothetical amount of $850.00 for every acre of new initial surface disturbance authorized in the JIDPA, above a threshold of 11,000 acres. The Fund could be managed by an independent Advisory Board.

On January 13, 2005, BLM received a letter from EnCana modifying their Proposed Action relative to compensatory mitigation. In part, the letter states "…EnCana is committed to

Table 2.3 Surface Disturbance Required for the No Action Alternative, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

	Disturbance (acres)	
Project Parameter[2]	Short-term	LOP
Well Pads[3]	1,889	447
Resource Roads/Gathering Pipelines[4]	1,766	699
Collector/Local Roads[5]	239	119
Burma Road[6]	35	35
Ancillary Facilities[7]	87	80
Water Wells[8]	0	11
Sales Pipeline[9]	133	0
Exploration Activities[10]	60	18
Total[11]	4,209	1,409

1 Generally as described in the EA for the Modified Jonah Field II Natural Gas Project (BLM 2000a).
2 Includes all project parameters identified in BLM (2000a) as well as those proposed for the current project.
3 Assumes approximately 533 wells from 497 pads at 3.8 acres of initial and 0.9 acre of LOP disturbance per pad.
4 Assumes a 0.4-mile road with adjacent gathering pipeline for each well pad with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (approximately 199 linear miles of road at 8.9 acres/mile initial disturbance and 3.5 acres/mile LOP disturbance).
5 Assumes 26 miles of collector roads with average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively (approximately 9.2 acres of disturbance/mile initially and 4.6 acres/mile LOP).
6 Includes the approximately 12-mile road length outside the JIDPA and assumes an existing width of 24 ft.
7 Includes disturbances from four compressor stations, water disposal facilities, field offices, ware yards, a sand pit, and other facilities required for the existing projects and occurring both within and outside the JIDPA. Approximately 7 acres of this disturbance would be reclaimed after completion of currently approved or committed to drilling activities.
8 Includes disturbance from approximately 25 existing water wells that have been developed on existing natural gas well pads; water wells require no new disturbance and less than 0.5 acre of disturbance each for the LOP.
9 Includes an approximately 22-mile pipeline corridor with 50-ft disturbance width for sales pipelines outside the JIDPA; no new sales pipelines are proposed to carry gas from the JIDPA under this alternative.
10 All exploration activities are included in the disturbance area estimates listed above. Disturbance estimate includes areas occupied by existing natural gas developments (pads [five], roads, pipelines) in the N$^1/_2$ Section 23, T28N, R109W.
11 Includes disturbance on 4,001 acres (short-term) and 1,348 acres (LOP) in the JIDPA; the additional 208 acres (short-term) and 61 acres (LOP) disturbance listed occur at location outside the JIDPA (e.g., Burma Road, compressor stations).

achieving a net positive impact on the environment and resources affected by development in the Jonah Field. EnCana is willing to consider other approaches to mitigation including the funding of any compensatory mitigation measures identified by the Bureau of Land Management in the Draft Environmental Impact Statement for the Jonah Infill Drilling Project ("Jonah Infill DEIS"). EnCana intends to discuss its willingness to fund specific compensatory mitigation proposals or projects, in relation to the various alternatives presented in the Jonah Infill DEIS, in its formal comments on the Jonah Infill DEIS."

Drilling would begin in 2005 and continue until the total number of proposed wells have been drilled, the natural gas resources in the field have been fully developed, or economic conditions are such that it is no longer profitable to drill additional wells.

Operator reservoir modeling shows that 3,100 new wells would be necessary to adequately recover the natural gas resource present in the area. Their experience indicates that the use of directional drilling is in some cases not economically feasible and in other cases results in inadequate resource recovery.

The Proposed Action assumes that 250 wells would be developed annually (20 rigs operating year-round). LOP would be approximately 76 years (see Table 2.2).

If selected, the Proposed Action would approve:

- up to 3,100 new wells on up to 11,780 acres new initial surface disturbance and 2,790 acres LOP surface disturbance (assumes all 3,100 wells would be drilled from single-well pads with an estimated surface disturbance of 3.8 acres initial and 0.9 acre LOP per single well pad);

- 465 miles of new resource roads with gathering pipelines--4,131 acres of new initial and 1,635 acres of LOP disturbance;

- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP disturbance;

- an upgrade of approximately 12 miles of the Burma Road--75 acres of new and 20 acres LOP disturbance;

- ancillary facilities--41 acres of new initial and LOP disturbance (water disposal, storage, and compressor station facilities); and

- exploration activities--100 acres of new initial and LOP disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.4).

Following successful interim (post-drilling during production phase) reclamation, LOP surface disturbance under the Proposed Action would be 6,040 acres, which includes 1,409 acres of existing disturbance (Table 2.4). Interim reclamation success is estimated to require 5 to 10 years at any site because it generally takes that long to restore sagebrush. Restoration of habitat function could take twice that long.

Operators have identified a number of mitigation/development practices that they would apply during development of the Proposed Action (see Appendix B), including CM.

2.7 ALTERNATIVE A – MINIMIZE DIRECTIONAL DRILLING

Alternative A is similar to the Proposed Action in its estimated surface disturbance requirements (see Section 2.6 and Table 2.4), but differs from the Proposed Action in that known areas with sensitive resources in the JIDPA would not be avoided (e.g., Sand Draw, raptor nest and sage grouse lek buffers). Development of natural gas resources beneath these areas would therefore not require the use of directional drilling. Three rates of development (75, 150, and 250 wells per year) are considered under Alternative A. This alternative would not necessarily provide for required balance between gas recovery and other resource protection.

Under this alternative, well pads, access roads, and other above-ground facilities could be located within 825 ft of active raptor nests.

Under this alternative, surface disturbance and occupancy would not be prohibited within 0.25 mile of the perimeter of greater sage-grouse leks.

Under this alternative, prairie dog towns would not be avoided.

Under this alternative, the Sand Draw NSO and other drainage and steep slope avoidance areas would not be maintained.

Under this alternative, well pads, pipelines, and associated roads would not be located and designed to avoid disturbance to known raptor nest sites.

Operators have identified a number of mitigation/development practices that they would apply during development of Alternative A (see Appendix B), including CM.

2.8 ALTERNATIVE B – MINIMIZE SURFACE DISTURBANCE

Surface disturbance would be reduced by requiring that all new wells be drilled from existing well pads. Existing well pads would need to be enlarged and new pipelines built within existing pipeline corridors. If selected, Alternative B would approve:

- expansion of existing well pads--3,081 acres of initial and 1,044 acres of LOP disturbance (6.2 acres new initial and 3.0 acres of LOP disturbance per well pad expansion);
- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP disturbance;
- ancillary facilities--41 acres of new initial and of LOP disturbance (water disposal, storage, and compressor station facilities); and
- exploration activities--100 acres of new initial and of LOP disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.5).

Table 2.4 Surface Disturbance Required for the Proposed Action and Alternative A, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres)	
	New	LOP
Well Pads [1]	11,780	2,790
Resource Roads/ Gathering Pipelines [2]	4,131	1,635
Collector/Local Roads [3]	73	37
Burma Road [4]	75	20
Ancillary Facilities [5]	41	41
Water Wells [6]	0	8
Sales Pipeline [7]	0	0
Exploration Activities [8]	100	100
Subtotal	16,200	4,631
Existing Disturbance [9]	4,209	1,409
Total [10]	20,409	6,040

1 Conservatively assumes all well pads are single-well pads and require 3.8 acres of initial disturbance and 0.9 acre of LOP disturbance per pad.
2 Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (approximately 465 linear miles of road).
3 Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads), and roads would have average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.
4 Assumes an approximate 12-mile road length outside the JIDPA with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing), respectively.
5 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.
6 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.
7 No new sales pipelines are proposed.
8 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.
9 See Table 2.3.
10 Estimates include 20,126 acres and 5,959 acres of initial and LOP disturbance in the JIDPA, respectively; the additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Table 2.5 Surface Disturbance Required for Alternative B, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres)	
	New	LOP
Well Pads [1]	3,081	1,044
Resource Roads/ Gathering Pipelines [2]	0	0
Collector/Local Roads [3]	0	0
Burma Road [4]	75	20
Ancillary Facilities [5]	41	41
Water Wells [6]	0	8
Sales Pipeline [7]	0	0
Exploration Activities [8]	100	100
Subtotal	3,297	1,213
Existing Disturbance [9]	4,209	1,409
Total [10]	7,506	2,622

1 Assumes expansion of existing well pads to accommodate 3,100 new wells (no new pads). Assumes all 497 existing pads would be expanded by an average of 6.2 acres initially (10.0 acres per multi-well pad less 3.8 acres existing disturbance) and 2.1 acres for the LOP (3.0 acres per multi-well pad less 0.9 acre of existing disturbance).
2 No new resource roads would be constructed, and while new gathering pipelines may be built, they would be constructed in existing pipeline corridor disturbance areas.
3 No new collector/local roads would be constructed.
4 Assumes an approximate 12-mile road length outside the JIDPA, with initial and LOP surface disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing), respectively.
5 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.
6 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.
7 No new sales pipelines would be constructed.
8 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.
9 See Table 2.3.
10 Includes approximately 7,223 acres and 2,541 acres new and LOP disturbance in the JIDPA, respectively; the additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Following successful interim reclamation, LOP surface disturbance under Alternative B would total 2,622 acres, which includes 1,409 acres of existing disturbance (Table 2.5).

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative B, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative B.

2.9 ALTERNATIVE C – 1,250 NEW WELLS

Alternative C limits drilling and development to an assumed 1,250 new wells on up to 1,250 new single-well pads with associated roads, pipelines, and ancillary facilities. If selected, Alternative C would approve:

- 1,250 new well pads--4,750 acres of new initial surface disturbance and 1,125 acres of LOP surface disturbance;
- 188 miles of new road construction with gathering pipelines--1,666 acres of new initial and 659 acres of LOP surface disturbance;
- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP surface disturbance;
- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP surface disturbance;
- ancillary facilities--41 acres of new initial and of LOP surface (water disposal, storage, and compressor station facilities) disturbance; and
- exploration activities--100 acres of new initial and LOP surface disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.6).

Following successful interim reclamation, LOP surface disturbance under Alternative C would total 3,399 acres, which includes 1,409 acres of existing disturbance (Table 2.6).

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative C, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative C.

2.10 ALTERNATIVE D – 2,200 NEW WELLS

Alternative D limits drilling and development up to an assumed 2,200 new wells on up to 2,200 new single-well pads with associated roads, pipelines, and ancillary facilities. If selected, Alternative D would approve:

- 2,200 new well pads--8,360 acres of new initial surface disturbance and 1,980 acres of LOP surface disturbance;
- 330 miles of new road construction with gathering pipelines--2,932 acres of new initial and 1,160 acres of LOP surface disturbance;

Table 2.6 Surface Disturbance Required for Alternative C, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres)	
	New	LOP
Well Pads [1]	4,750	1,125
Resource Roads/ Gathering Pipelines [2]	1,666	659
Collector/Local Roads [3]	73	37
Burma Road [4]	75	20
Ancillary Facilities [5]	41	41
Water Wells [6]	0	8
Sales Pipeline [7]	0	0
Exploration Activities [8]	100	100
Subtotal	6,705	1,990
Existing Disturbance [9]	4,209	1,409
Total [10]	10,914	3,399

1 Assumes all wells are developed from single-well pads with 3.8 acres of initial disturbance and 0.9 acre of LOP disturbance per pad.

2 Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad, with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (approximately 188 linear miles of road).

3 Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads), and roads would have average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.

4 Assumes an approximate 12-mile road length outside the JIDPA boundary with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing), respectively.

5 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.

6 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.

7 No new sales pipelines would be constructed.

8 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.

9 See Table 2.3.

10 Includes approximately 10,631 acres and 3,318 acres new initial and LOP disturbance in the JIDPA, respectively. The additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP surface disturbance;

- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP surface disturbance;

- ancillary facilities--41 acres of new initial and of LOP surface disturbance (water disposal, storage and compressor station facilities); and

- exploration activities--100 acres of new initial and of LOP surface disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.7).

Following successful interim reclamation, LOP surface disturbance under Alternative D would total 4,755 acres, which includes 1,409 acres of existing disturbance (Table 2.7).

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative D, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative D.

2.11 ALTERNATIVE E – 16 WELL PADS/SECTION

Under Alternative E no more than 16 well pads per 640-acre section (1 well pad/40 acres) would be developed, but there would be no restriction on the number of new wells (assumes 3,100 new wells). All new wells would be drilled from the 497 existing and 266 new well pads. Necessary roads, pipelines, and ancillary facilities would also be developed. If selected, Alternative E would approve:

- 266 new well pads--5,742 acres of new initial surface disturbance and 1,842 acres of LOP surface disturbance;

- 40 miles of new road construction with gathering pipelines--355 acres of new initial and 140 acres of LOP disturbance;

- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP surface disturbance;

- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP surface disturbance;

- ancillary facilities--41 acres of new initial and of LOP surface disturbance (water disposal, storage and compressor station facilities); and

- exploration activities--100 acres of new initial and of LOP surface disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.8).

Following successful interim reclamation, LOP surface disturbance under Alternative E would total 3,597 acres, which includes 1,409 acres of existing disturbance (Table 2.8).

Table 2.7 Surface Disturbance Required for Alternative D, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres) New	Disturbance (acres) LOP
Well Pads [1]	8,360	1,980
Resource Roads/ Gathering Pipelines [2]	2,932	1,160
Collector/Local Roads [3]	73	37
Burma Road [4]	75	20
Ancillary Facilities [5]	41	41
Water Wells [6]	0	8
Sales Pipeline [7]	0	0
Exploration Activities [8]	100	100
Subtotal	11,581	3,346
Existing Disturbance [9]	4,209	1,409
Total [10]	15,790	4,755

1 Assumes all wells are developed from single-well pads with 3.8 acres of initial disturbance and 0.9 acre of LOP disturbance per pad.

2 Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (approximately 330 linear miles of road).

3 Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads), and roads would have average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.

4 Assumes an approximate 12-mile road length outside the JIDPA boundary with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing), respectively.

5 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.

6 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.

7 No new sales pipelines would be constructed.

8 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.

9 See Table 2.3.

10 Includes approximately 15,507 acres and 4,674 acres new initial and LOP disturbance in the JIDPA, respectively. The additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Table 2.8 Surface Disturbance Required for Alternative E, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres) [1]	
	New	LOP
Well Pads [2]	5,742	1,842
Resource Roads/Gathering Pipelines [3]	355	140
Collector/Local Roads [4]	73	37
Burma Road [5]	75	20
Ancillary Facilities [6]	41	41
Water Wells [7]	0	8
Sales Pipeline [8]	0	0
Exploration Activities [9]	100	100
Subtotal	6,386	2,188
Existing Disturbance [10]	4,209	1,409
Total [11]	10,595	3,597

[1] Assumes 16 well pads per 640-acre section throughout the entire 30,500-acre JIDPA. Disturbance from the currently approved 497 well pads is included in the "Existing Disturbance" of this table.

[2] Assumes all new pads would have multiple wells requiring an average of 10 acres of new disturbance and 3.0 acres of LOP disturbance per pad and that all existing pads (497) would require expansion from 3.8 acres to an average of 10.0 acres of initial disturbance (6.2 acres new disturbance per pad) and from 0.9 acre to 3.0 acres of LOP disturbance (2.1 acres new disturbance per pad).

[3] Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad, with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (approximately 40 linear miles of road). While new gathering pipelines may be constructed from existing pads, they would be built within existing pipeline corridor disturbance areas.

[4] Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads). Collector/local road average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.

[5] Assumes an approximate 12-miles road length outside the JIDPA boundary, with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing).

[6] Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.

[7] Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.

[8] No new sales pipelines would be constructed.

[9] An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.

[10] See Table 2.3.

[11] Estimates include 10,312 acres and 3,516 acres of new initial and LOP disturbance in the JIDPA, respectively. The additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative E, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative E.

2.12 ALTERNATIVE F – 32 WELL PADS/SECTION

Under Alternative F no more than 32 pads per 640-acre section (1 well pad/20 acres) would be developed but there would be no restriction on the number of new wells (assumes 3,100 new wells). All wells would be drilled from the 497 existing and 1,028 new pads. Necessary roads, pipelines, and ancillary facilities would also be developed. If selected, Alternative F would approve:

- 1,028 new well pads--8,787 acres of new initial surface disturbance and 1,840 acres of LOP surface disturbance;
- 154 miles of new road construction with gathering pipelines--1,370 acres of new initial and 1,370 acres of LOP disturbance;
- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP surface disturbance;
- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP surface disturbance;
- ancillary facilities--41 acres of new initial and of LOP surface disturbance (water disposal, storage, and compressor station facilities); and
- exploration activities--100 acres of new initial and of LOP surface disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.9).

Following successful interim reclamation, LOP surface disturbance under Alternative F would total 3,997 acres, which includes 1,409 acres of existing disturbance (Table 2.9).

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative F, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative F.

2.13 ALTERNATIVE G – 64 WELL PADS/SECTION

Under Alternative G no more than 64 pads per 640-acre section (1 well pad/10 acres) would be developed, but there would be no restriction on the number of new wells (assumes 3,100 new wells). All wells would be drilled from the 497 existing and 2,553 new pads. Necessary roads, pipelines, and ancillary facilities would also be developed. If selected, Alternative G would approve:

- 2,553 new well pads--10,298 acres of new initial disturbance and 2,247 acres of LOP surface disturbance;

Table 2.9 Surface Disturbance Required for Alternative F, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres)[1]	
	New	LOP
Well Pads[2]	8,787	1,840
Resource Roads/Gathering Pipelines[3]	1,370	542
Collector/Local Roads[4]	73	37
Burma Road[5]	75	20
Ancillary Facilities[6]	41	41
Water Wells[7]	0	8
Sales Pipeline[8]	0	0
Exploration Activities[9]	100	100
Subtotal	10,446	2,588
Existing Disturbance[10]	4,209	1,409
Total[11]	14,655	3,997

1 Assumes 32 well pads per 640-acre section throughout the entire 30,500-acre JIDPA. Disturbance from the currently approved 497 well pads is included in the "Existing Disturbance" row of this table.

2 Assumes all new pads would have multiple wells requiring an average of 7.0 acres new initial disturbance and 1.5 acres of LOP disturbance per pad and that all existing pads would require expansion from 3.8 acres to an average of 7.0 acres of initial disturbance (3.2 acres new disturbance per pad) and from 0.9 acre to 1.5 acres LOP disturbance (0.6 acre new disturbance per pad).

3 Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (154 linear miles of road). While new gathering pipelines may be constructed from existing pads, they would be built within existing pipeline corridor disturbance areas.

4 Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads). Collector/local roads average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.

5 Assumes an approximate 12-miles road length outside the JIDPA boundary with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing).

6 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.

7 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.

8 No new sales pipelines would be constructed.

9 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.

10 See Table 2.3.

11 Estimates include 14,372 acres and 3,916 acres of new initial and LOP disturbance in the JIDPA, respectively. The additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Table 2.10 Surface Disturbance Required for Alternative G, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres) [1]	
	New	LOP
Well Pads [2]	10,298	2,447
Resource Roads/Gathering Pipelines [3]	3,402	1,346
Collector/Local Roads [4]	73	37
Burma Road [5]	75	20
Ancillary Facilities [6]	41	41
Water Wells [7]	0	8
Sales Pipeline [8]	0	0
Exploration Activities [9]	100	100
Subtotal	13,989	3,999
Existing Disturbance [10]	4,209	1,409
Total [11]	18,198	5,408

1 Assumes 64 well pads per 640-acre section throughout the entire 30,500-acre JIDPA. Disturbance from the currently approved 497 well pads is included in the "Existing Disturbance" row of this table.
2 Assumes all new pads would have a single well requiring an average of 3.8 acres of new disturbance and 0.9 acre of LOP disturbance per pad and that all existing pads (497) would require expansion from 3.8 acres to an average of 5.0 acres initial disturbance (1.2 acres new disturbance per pad) and from 0.9 acre to 1.2 acres LOP disturbance (0.3 acre new disturbance per pad).
3 Assumes an average well pad access road/gathering pipeline length of 0.15 mile for each pad with average initial and LOP disturbance widths of 73.3 ft and 29.0 ft, respectively (383 linear miles of road). While new gathering pipelines may be constructed from existing pads, they would be built within existing pipeline corridor disturbance areas.
4 Assumes approximately 8 miles of new collector/local roads would be required (existing resource roads may be expanded in some areas to serve as collector/local roads). Collector/local road average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.
5 Assumes an approximate 12-miles road length outside the JIDPA boundary with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing).
6 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.
7 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new surface disturbance; assumes 0.5 acre of LOP disturbance per water well.
8 No new sales pipelines would be constructed.
9 An estimated 100 acres of new and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.
10 See Table 2.3.
11 Estimates include 17,915 acres and 5,327 acres of new initial and LOP disturbance in the JIDPA, respectively. The additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

- 383 miles of new road construction with gathering pipelines--3,402 acres of new initial and 1,346 acres of LOP disturbance;

- 8 miles of new collector/local roads--73 acres of new initial and 37 acres of LOP surface disturbance;

- an upgrade of approximately 12 miles of the Burma Road--75 acres of new initial and 20 acres of LOP surface disturbance;

- ancillary facilities--41 acres of new initial and of LOP surface disturbance (water disposal, storage and compressor station facilities); and

- exploration activities--100 acres of new initial and of LOP surface disturbance to develop well pads and other infrastructures necessary to explore for natural gas resources in formations other than the Lance Pool (Table 2.10).

Following successful interim reclamation, LOP surface disturbance under Alternative G would total 5,408 acres, which includes 1,409 acres of existing disturbance (Table 2.10).

Appendix B, Exhibit B-1 lists the Operator-committed practices that would be applied under Alternative G, and additional BLM protection requirements are provided in Appendix A. Three rates of development (75, 150, and 250 wells/year) are considered under Alternative G.

2.14 BLM PREFERRED ALTERNATIVE

The BLM Preferred Alternative optimizes natural gas recovery while minimizing impacts related to the key issues (see Section 2.1) with outcome-based performance objectives, mitigation and Best Management Practices (BMPs). If selected, the Preferred Alternative would approve:

- Up to approximately 34% (214 acres) new surface disturbance per 640-acre section within a 14,390-acre area (Map 2.2), based on 16 parent well pads and 48 satellite well pads per section (as many as 128 well bores per section)

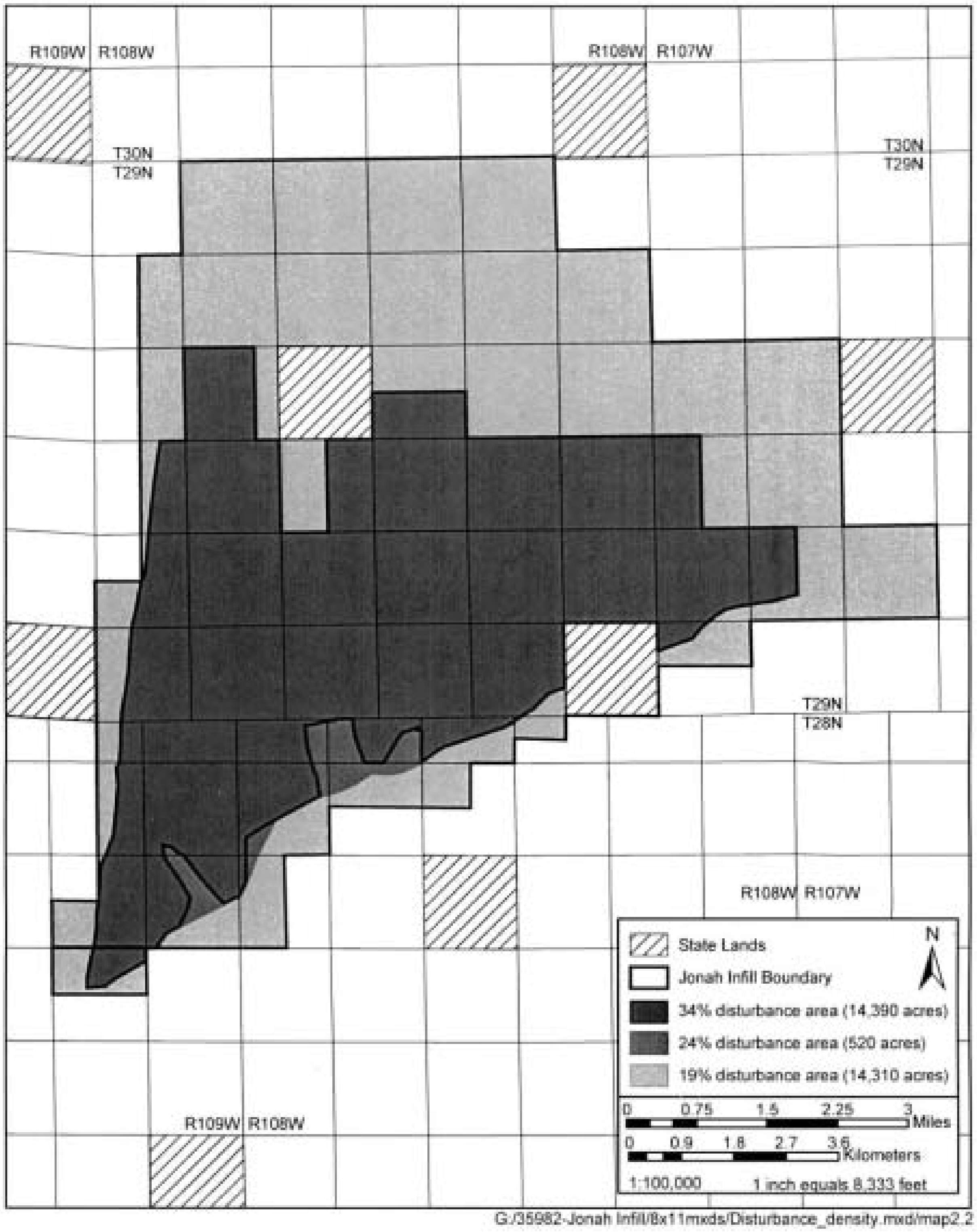
  - 4,667 acres of new initial surface disturbance and 1,300 acres LOP surface disturbance within the 14,390-acre area

  - a parent well pad is a multi-well pad and/or a pad with centralized facilities (assumes 7.0 acres of surface disturbance, including resource road and gathering pipeline)

  - a satellite well pad is a well head with no on-site storage or processing facilities (assumes 2.0 acres of surface disturbance, including resource road and gathering pipeline);

- up to approximately 24% (150 acres) new surface disturbance per 640-acre section within a 520-acre area (Map 2.2), based on 16 parent well pads and 16 satellite well pads per section (as many as 128 well bores per section)

  - 117 acres of new initial disturbance and 33 acres LOP surface disturbance.



Map 2.2 Preferred Action Surface Disturbance Limitation Areas, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

  - well pad density limitation would be applicable until monitoring data, with up to 10-year trends, conclusively show that denser than 40-acre surface spacing can meet performance-based field development and production objectives;

- up to approximately 19% (118 acres) new surface disturbance per 640-acre section within a 14,310-acre area (Map 2.2), based on 16 parent well pads per section (as many as 128 well bores per section)

  - 2,576 acres of new initial disturbance and 716 acres of LOP surface disturbance

  - well pad density limitation would be applicable until monitoring data, with up to 10-yr trends, conclusively show that denser than 40-acre surface spacing can meet performance-based field development and production objectives;

- 8 miles of new collector/local roads -- 73 acres of new initial and 37 acres of LOP surface disturbance;

- an upgrade of approximately 12 miles of the Burma Road -- 75 acres of new initial and 20 acres of LOP surface disturbance;

- ancillary facilities -- 41 acres of new initial and LOP surface disturbance (water disposal, storage, compressor station facilities);

- exploration activities -- 100 acres of new initial and LOP surface disturbance to develop well pads and other infrastructure necessary to explore for natural gas resources in formations other then the Lance Pool (Table 2.11);

- the *Wildlife Monitoring/Protection Plan* (Appendix D, *Record of Decision for the Jonah Field II Natural Gas Development Project Environmental Impact Statement, Sublette County, Wyoming* [BLM 1998b] as most recently adapted) would be modified to include activities within the JIDPA and would include a habitat mitigation plan;

- establish/implement the JIWG, an interagency adaptive management working group, at the ROD for this project (see Appendix D);

  - BLM would consider annual JIWG recommendations to adjust conditions of approval (COAs), monitoring, mitigation, and best management practices (BMPs) to meet field development and production objectives throughout the LOP

  - If the Pinedale Anticline Working Group (PAWG) is functioning effectively in 2006, the PAWG charter would be revised to include the Jonah Field in the PAWG's responsibilities during charter renewal in 2006; otherwise the JIWG would continue to function and

- recommend implementation of Operator-committed CM at the ROD as appropriate and consistent with BLM policy.

Following successful interim reclamation, LOP surface disturbance under the BLM Preferred Alternative would total 3,847 acres, which includes 1,409 acres of existing disturbance (Table 2.11).

Table 2.11 Surface Disturbance Required for the BLM Preferred Alternative, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Project Parameter	Disturbance (acres)	
	New	LOP
Well Pads/ Resource Roads/ Gathering Pipelines (34% Disturbance Area)[1]	4,677	1,300
Well Pads/ Resource Roads/ Gathering Pipelines (24% Disturbance Area)[2]	117	33
Well Pads/ Resource Roads/ Gathering Pipelines (19% Disturbance Area)[3]	2,576	716
Well Pads/ Resource Roads/ Gathering Pipelines (State of Wyoming Lands)[4]	657	183
Collector/ Local Roads[5]	73	37
Burma Road[6]	75	20
Ancillary Facilities[7]	41	41
Water Wells[8]	0	8
Sales Pipeline[9]	0	0
Exploration Activities[10]	100	100
Subtotal	8,316	2,438
Existing Disturbance[11]	4,209	1,409
Total[12]	12,525	3,847

1 Assumes no more than 34% (approximately 214 acres) of new initial project-specific disturbance per 640-acre section, 33% of which would be associated with well pads, resource roads, and gathering pipelines (i.e., 16 7.0-acre pads and associated roads and pipeline disturbance areas and 48 2.0-acre satellite pads and associated roads and pipeline disturbance areas). The remaining 1% of the disturbance acreage would encompass other project facilities (i.e., collector/ local roads, Burma Road upgrade, ancillary facilities, and exploration activities). Approximately 27.8% of new initial disturbance would be retained for the LOP. See Map 2.2.

2 Assumes no more than 24% (150 acres) of new initial project-specific disturbance per 640-acre section, 23% of which would be associated with well pads, resource roads, and gathering pipelines (i.e., 16 7.0-acre pads and associated roads and pipeline disturbance areas and 16 2.0-acre satellite pads and associated roads and pipeline disturbance areas). The remaining 1% of the disturbance acreage would encompass other project facilities (i.e., collector/ local roads, Burma Road upgrade, ancillary facilities, and exploration activities). Approximately 27.8% of the new initial disturbance would be retained for the LOP. See Map 2.2.

3 Assumes no more than 19% (118 acres) of new initial project-specific disturbance per 640-acre section, 18% of which would be associated with well pads, resource roads, and gathering pipelines (i.e., 16 7.0-acre pads and associated roads and pipeline disturbance areas). The remaining 1% of the disturbance acreage would encompass other project facilities (i.e., collector/ local roads, Burma Road upgrade, ancillary facilities, and exploration activities). Approximately 27.8% of new initial disturbance would be retained for the LOP. See Map 2.2.

4 Assumes approximately 52% (333 acres) of new initial project-specific disturbance per 640-acre section, approximately 51% of which would be associated with well pads, resource roads, and gathering pipelines. The remaining 1% of the disturbance acreage would encompass other project facilities (i.e., collector/ local roads, Burma Road upgrade, ancillary facilities, and exploration activities). Approximately 27.8% of new initial disturbance would be retained for the LOP. See Map 2.2.

5 Conservatively assumes approximately 8 miles of new collector/ local roads would be required (existing resource roads may be expanded in some areas to serve as collector/ local roads), and roads would have average initial and LOP disturbance widths of 75.7 ft and 37.8 ft, respectively.

6 Assumes an approximate 12-mile road length outside the JIDPA with initial and LOP disturbance widths of 51.7 ft (75.7 ft required less 24.0 ft existing) and 13.8 ft (37.8 ft required less 24.0 ft existing), respectively.

7 Accommodates areas potentially required for new water disposal facilities, storage yards, and increased pipeline compression capacity.

8 Approximately 16 new water wells would be developed on natural gas well pads. Water wells would require no new initial surface disturbance; assumes 0.5 acre of LOP disturbance per water well.

9 No new sales pipelines are proposed.

10 An estimated 100 acres of new initial and LOP disturbance is included to allow for exploration of geologic formations other than the Lance Pool and Mesa Verde.

11 See Table 2.3.

12 Estimates include 12,242 acres and 3,766 acres of initial and LOP disturbance in the JIDPA, respectively; the additional 283 acres (new initial) and 81 acres (LOP) of disturbance would occur outside the JIDPA.

Analysis of this alternative assumes that up to an estimated 52% (333 acres) of new surface disturbance/640-acre section would occur on State of Wyoming lands (1,280 acres) (see Map 2.2). Assumes 657 acres of new initial disturbance and 183 acres of LOP surface disturbance for well pads, resource roads, and pipelines on State of Wyoming lands.

BLM would not regulate the number of wells or the pace of development under this alternative. For the purpose of this analysis, up to 3,100 wells at a pace of 250 wells drilled per year is considered.

2.14.1 Outcome-Based Performance Objectives

The BLM Preferred Alternative field development and production would be based on meeting performance objectives to allow maximum flexibility for Operators to utilize innovation to maximize gas recovery while providing long-term protection for other resources in the JIDPA. Objectives of the BLM Preferred Alternative are as follows:

- Maintain airborne emissions at or below levels sufficient to avoid:
    - near-field or far-field concentrations exceeding Wyoming Ambient Air Quality Standards (WAAQS) or National Ambient Air Quality Standards (NAAQS);
    - cumulative near-field concentrations greater than applicable Prevention of Significant Deterioration (PSD) Class II increments;
    - cumulative far-field concentrations in regional Class I wilderness areas and parks and sensitive Class II areas greater than applicable PSD increments;
    - decreases in visibility in regional Class I and sensitive Class II areas greater than Federal Land Managers' Air Quality Related Values Workgroup (FLAG), USFS, and/or National Park Service (NPS) thresholds;
    - decreases in Acid Neutralizing Capacity (ANC) in sensitive regional lakes greater than USFS levels of acceptable change (LAC);
    - increases in total acid deposition in sensitive areas greater than deposition analysis thresholds (DAT); and
    - cumulative deposition total loadings greater than USFS levels of concern (LOC).
- Maximize centralization of development and production facilities.
- Maintain sediment erosion (salt and silt discharge rates) at WDEQ- and BLM-acceptable levels.
- Reclaim sites to establish indigenous vegetation cover and species composition to maintain soil stability and provide nutritional value, palatability, and vegetative structure (i.e., habitat function).

- Plan development activities and interim and final reclamation to maximize and increase habitat patch sizes and reduce habitat fragmentation for sagebrush-obligate species.

- Limit any increase in production activity noise levels to 10-decibel or less increase above background noise levels, as measured at noise-sensitive resource locations (e.g., greater sage-grouse leks, occupied raptor nests).

- Minimize or reduce impacts to sagebrush and other habitats to maintain or minimize losses in the number of male greater sage-grouse on leks, numbers of sagebrush-obligate listed and sensitive species, and other wildlife.

- Maintain or improve currently active big game migration routes.

- Reduce human activity per well pad in the JIDPA below current levels during both the development and production phases.

- Prevent contamination of all surface and ground water.

- Utilize state-of-the-art technologies to avoid, minimize, or mitigate impacts.

- Encourage Operators to participate in and support peer-reviewed research that evaluates impacts from development and effectiveness of applied mitigation.

2.14.2 General Conditions of Approval, Mitigation, Monitoring, Surveying, and Best Management Practices

The BLM would impose the following general COAs, mitigation and BMPs on all project authorizations and would consider annual JIWG recommendations to adjust these requirements to meet field development and production objectives throughout the LOP.

- Tracking surface disturbance area would be implemented by Operators, and Operators would provide BLM with federal geographic data committee (FGDC) –compliant metadata and geographic information system (GIS)/global positioning system (GPS) location data for all newly developed facilities and reclaimed areas within 30 days of completion of disturbance and reclamation activities. BLM would randomly verify these data.

- Well pad surface disturbance would be limited to a maximum of 7.0 acres for parent and multi- well pads, 4.0 acres for single-well well pads, and 2.0 acres for satellite well pads. These acreages include well pad, access road, pipeline, and topsoil and spoil piles.

- Hard-line fracturing processes would be required for all well pads when surface density is 1 well pad/40 acres, and recommended when well pad surface density is < 1 pad/40 acres.

- Operators would utilize flareless completions for all wells within the JIDPA unless proven on a case-by-case basis that flareless completions would be unsafe.

- Operators would begin piping produced water and condensate from all wells in the JIDPA to appropriate treatment or disposal facilities beginning no later than January 1, 2008; this would supersede previous decisions related to method of condensate disposal.

- To eliminate or minimize surface sediment discharge, all well pad and road construction shall comport WDEQ storm water discharge specifications, standards, and permitting requirements. Existing well pads and roads shall be retro-fitted to meet this requirement as directed by the Authorized Officer. Based on site-specific analysis, BLM may require more stringent sediment control measures be implemented.

- Operators would utilize remote telemetry or equivalent technology at all wells to minimize well monitoring trips.

- Centralization of development and production facilities would be maximized in the JIDPA.

- All hydraulic structures would be engineered and designed by a certified civil engineer, utilizing hydraulic runoff modeling software, to ensure the structures are stable and erosion is minimized throughout the LOP.

- All engineering for construction would be designed to minimize or mitigate cumulative impacts and minimize sedimentation at the JIDPA boundary.

- Operators would utilize closed drilling systems (no reserve pits) for all wells unless proven on a case-by-case basis that to do so would be technologically or economically infeasible. If reserve pits are approved, Operators would remove/vacuum fluids from reserve pits within 60 days of all wells on a pad being placed into production, to accelerate pit closure and reclamation.

- New compressor sites would be located away from noise-sensitive resources or muffled appropriately to minimum noise standards.

- Topsoil stockpiles would be designed to maintain soil microbial and nutrient vitality and to minimize the surface area occupied. Should stockpiles exceed 3 feet in height and/or be stored for two years or longer, Operators would consult with BLM for acceptable site-specific mitigation to maintain microbial and nutrient viability.

- Well pads, access roads, and other above-ground facilities would not be located within 825 feet of any raptor nest, within 1,000 feet of ferruginous hawk nests, and within 2,640 feet of bald eagle nests.

- The following seasonal restrictions for activities near active raptor nests/roosting sites/foraging areas would be imposed:

- February 1 through July 31, within 0.5 mile of all active raptor nests;

- February 1 through July 31, within 1.0 mile of all active ferruginous hawk nests;

- February 1 through August 15, within 1.0 mile of all active bald eagle nests;

- November 1 through April 1, within 1.0 mile of active bald eagle communal winter roosts; and

- November 15 through April 1, within 2.5 miles of all bald eagle winter foraging areas.

- Surface-disturbing and disruptive activities in greater sage-grouse winter concentration areas would be avoided from November 15 through March 14.

- Surface-disturbing and disruptive activities in greater sage-grouse nesting and early brood-rearing habitat within 2.0 miles of an occupied lek, or in identified greater sage-grouse nesting and early brood-rearing habitat outside the 2.0-mile buffer, would be prohibited from March 15 through July 15.

- Surface disturbance and occupancy would be prohibited within 0.25 mile of the perimeter of greater sage-grouse leks, and human activity would be avoided between 8 p.m. and 8 a.m. from March 1 through May 15.

- Operators would inventory greater sage-grouse seasonal habitats within the JIDPA not already inventoried by BLM or WGFD within one year of the ROD for this project; GIS data would be provided to BLM, WGFD, and the JIWG with FGDC-compliant metadata.

- Operators would map prairie dog towns and provide all map data to BLM, WGFD, and the JIWG with FGDC-compliant metadata.

- Three active and productive ferruginous hawk nesting territories, two burrowing owl nesting territories, and other raptor nesting territories would be maintained on and adjacent to the JIDPA; to the extent any of these may not be feasible, compensatory mitigation may be appropriate.

- Operator-related vehicle and OHV traffic in the JIDPA would be limited to BLM-approved roads/trails and travel on non-all-weather roads would be avoided during saturated soil conditions to avoid impacts from rutting.

- Operators would inventory all roads/trails in the JIDPA not already inventoried by BLM within one year of the date of the ROD for this project; GIS data would be provided to BLM, WGFD, and the JIWG with FGDC-compliant metadata.

- The Sand Draw No Surface Occupancy (NSO) restriction would be maintained.

- Operators would be responsible for establishing viable site-stabilizing plant growth, as determined by the Authorized Officer, within 2 years of initiation of reclamation. Site-stabilizing plant growth would consist of indigenous species and/or ecologically-comparable species as approved by the Authorized Officer. Within 5 years of initiation of reclamation, Operators must establish at least 50%, and within 8 years of initiation of reclamation establish at least 80%, of indigenous vegetative cover and species composition to maintain soil stability and provide nutritional value, palatability, and vegetative structure (i.e., habitat function). The initiation of reclamation would commence within 1 year of drilling and completion of the last well scheduled on a pad.

In the event that more than one year would lapse between the drilling of wells on a pad, the Authorized Officer may require temporary site stabilization measures.

- Operators would maximize interim (production phase) well pad reclamation (reclaim up to the wellhead, or up to the wellhead and dehydrators and separators on those pads with central production facilities).
- Field-wide interim and long-term reclamation plans would be submitted to BLM for approval no later than one year from the date of this ROD. Site-specific reclamation plans would be incorporated into all Surface Use Plans for APDs and Plans of Development for ROWs. A reclamation quality assurance/quality control monitoring program would be implemented by the Operators until development and interim (production phase) reclamation is completed to BLM standards.

Some of the aforementioned seasonal and surface use restrictions may not match those listed in Appendix A. Those provided for this BLM Preferred Alternative incorporate recent changes in agency guidance regarding wildlife restrictions.

2.14.2.1 Resource Monitoring and Surveying

The following monitoring and surveying activities would be required to monitor the effectiveness of COAs, BMPs, and mitigation, and BLM would consider JIWG recommendations to adjust monitoring and surveying requirements which determine if field development and production objectives are being met.

- Operators would continue supporting existing wildlife studies and monitoring efforts.
- Operators would implement a ground water monitoring program for all water wells in or affected by activities in the JIDPA, with annual reports to BLM, JIWG, WSEO and WDEQ. Wells would be tested annually for general chemical constituents and total petroleum hydrocarbons, using WDEQ-approved methodology.
- Operators would be required to conduct surveys of soils and vegetation types throughout the JIDPA in coordination with the BLM, and provide survey results to BLM within one year of the ROD for this project.
- Operators would be required to conduct sixth-level watershed modeling throughout the JIDPA (including identification of current sediment discharge rates), and provide the results to BLM and WDEQ, contingent on availability of data.
- Operators would prepare and implement a Sensitive Species Survey and Monitoring Plan for BLM and WGFD approval that would determine the presence, distribution, and population trends of all federally-listed, proposed, candidate, BWS, and other species including amphibians, reptiles, passerine birds, and small mammals, throughout the JIDPA. Monitoring would be conducted annually for the LOP or until BLM determines that additional monitoring is not required. Operators would prepare an annual report for BLM, WGFD, and the JIWG. Survey results would be provided annually to the WyNDD with FGDC-compliant metadata.
- Operators would monitor first flush total suspended solids in coordination with WDEQ, BLM, and other agencies.

- Operators would be required to assist BLM and WGFD in monitoring greater sage-grouse movements to determine if populations are migratory.

- In coordination with BLM, Operators would monitor forage utilization on reclaimed areas throughout project development and into the full production phase.

- Operators would monitor traffic volume on collector roads and provide an annual report to BLM.

- Operators would monitor the number of visits to well pads and provide an annual report to BLM.

- Operators would monitor noise near noise-sensitive resources and provide an annual report to BLM.

- In coordination with BLM and WGFD, Operators would monitor pronghorn antelope numbers on crucial winter ranges north and south of the JIDPA.

- Operators would monitor nesting of raptors, including ferruginous hawk, bald eagle, and burrowing owl; greater sage-grouse lek attendance; and occurrence of other sagebrush-obligate species.

2.14.3 Site-Specific Conditions of Approval, Mitigation Monitoring, Surveying, and Best Management Practices

On a site-specific basis, the BLM would impose the following COAs, mitigations and BMPs and would consider annual JIWG recommendations to adjust these requirements to meet field development and production objectives throughout the LOP.

- Convert resource roads to 2-tracks during interim reclamation.

- Provide nighttime lighting/glare restrictions (e.g., light shades/hoods, directional lighting, colored lights, wattage limits, motion detectors, elimination during non-working hours) to minimize light within and from the field.

- Monitor night lighting mitigation effectiveness in coordination with BLM.

- Spoil piles would be contoured to blend with surrounding topography and be contemporaneously reclaimed.

- Avoid prairie dog towns where practical to provide burrowing owl habitat.

2.14.4 Compensatory Mitigation

In lieu of the proposed Cumulative Impacts Mitigation Fund, the BLM Preferred Alternative recommends that, where appropriate and consistent with BLM policy, Operators voluntarily seek BLM-approved CM projects aimed at alleviating on-site mitigation concerns.

2.15 ALTERNATIVES CONSIDERED AND ELIMINATED FROM DETAILED STUDY

Many suggestions for alternatives were proposed by the public. Most of the suggested alternatives involved addressing varying well numbers, varying the rate at which the field is developed, and varying surface disturbance. While not all suggested well number, development rate, or surface disturbance suggestions were analyzed, the BLM used these suggestions when developing the alternatives analyzed in this EIS to provide a range in well numbers, development paces, and surface disturbance.

An alternative rejecting any new development was also suggested. While additional development in the area would likely occur under any no development alternative (e.g., State of Wyoming land development), for analytic purposes, the No Action Alternative sufficiently considers no new development-type impacts (see Section 2.5).

Action alternatives with fewer than 1,250 wells were rejected from consideration based upon known natural gas reservoir properties indicating that at least this many wells would be necessary for adequate resource recovery. Operators believe up to 3,100 wells would be necessary for maximum recovery.

Action alternatives with a development pace slower than 75 wells per year were rejected from consideration because the reduced development pace would result in operational and safety issues associated with drilling through depressurized zones (i.e., stuck pipe, mud weight variability problems, blow-out potential). It was determined that 75, 150, and 250 wells developed per year provides an adequate range of development paces to assess potential effects associated with the rate of development (e.g., socioeconomics, duration of habitat loss).

Two alternatives requiring all new wells to be directionally drilled and requiring no new roads were not specifically analyzed in detail because Alternative B has a similar potential effect (i.e., no new well pads, few new roads needed).

An alternative rejecting all further development in the JIDPA until all existing disturbance in the area is adequately reclaimed was not considered since this action would likely lead to considerable unrecovered resource and would unnecessarily prolong the LOP.

Numerous alternatives requiring the inclusion/exclusion of multiple resource protection, mitigation, and monitoring measures were suggested for analysis, including the application of best management practices (BMPs), the use of adaptive management procedures, and consideration of off-site CM. Additional measures (see Chapter 5) may be included as project requirements in the ROD. Many if not all of these suggested requirements are considered under one or more of the alternatives analyzed in detail (see also Appendix A and B for BLM standard mitigations, Operator-committed measures and CM ideas).

2.16 SUMMARY OF ENVIRONMENTAL IMPACTS

Table 2.12 provides a brief comparison of potential impacts to key project issues (see Section 2.1) across alternatives. Additional detail is provided in the summary of impacts table in Appendix E, and in the detailed impact assessments provided in Chapter 4.

Table 2.12 Brief Comparison of Impacts to Key Issues Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

Key Issue	No Action	Proposed Action	Other Alternatives A	B	C	D	E	F	G	Preferred[2]
Disturbance Volume										
Total Acres Surface Disturbance	4,209	20,409	20,409	7,506	10,914	15,790	10,595	14,655	18,198	12,525
LOP Acres Surface Disturbance	1,409	6,040	6,040	2,622	3,399	4,755	3,597	3,997	5,408	3,847
Project Duration/Pace/Economics										
LOP (years)	63	76	76-105	76-105	68-80	72-93	76-105	76-105	76-105	76
Wells Developed Per Year	0	250	75-250	75-250	75-250	75-250	75-250	75-250	75-250	250
New Worker Years (development and production)	0	16,863	16,863	16,863	7,011	12,106	16,863	16,863	16,863	16,863
Total Taxes and Royalties (millions)	2,335	6,072	6,235	4,876	4,846	5,646	4,993	5,588	6,030	6,030
Sublette County Share (millions)	742	1,839	1,892	1,446	1,503	1,728	1,484	1,677	1,824	1,824
Air Quality/Visibility per year										
Additional Days of Impairment per year at Bridger Wilderness	0	10	10	11	8	8-10	11	11	10-11	10-11
Additional Days of Impairment per year at Pinedale	0	3	3	5	2	2-3	3-5	3	3	3
Habitat Loss All Species										
Direct habitat loss for greater sage-grouse, pronghorn antelope, and other wildlife would be related to surface disturbance and project duration as listed above. Most wildlife species would likely avoid development areas under all alternatives.										
Indirect habitat loss for greater sage-grouse, pronghorn antelope, and other wildlife would be related to total surface disturbance (and its location), volume of human presence (worker-years), and project duration as listed above.										
Total Well Pads	497	3,597	3,597	497	1,747	2,697	763	1,705	3,050	3,597
New Roads (miles)	237	710	710	245	433	575	285	399	628	519
Average Daily Traffic Volume[3] (round trips to and from the JIDPA per day)	45-88	312-610	312-610	312-610	145-284	231-452	312-610	312-610	312-610	312-610
Mineral Resource Recovery										
Natural Gas (billion cubic feet)	3,366	7,947	8,191	6,124	6,657	7,554	6,302	7,186	7,876	7,876
Condensate (million barrels)	32	76	78	58	63	72	60	68	75	75
Livestock										
Livestock forage loss and hazard conditions would be related to the total volume of surface disturbance, the types of surface disturbance, and traffic as listed above.										
LOP Forage Loss (AUMs)	116	509	509	218	284	400	300	335	455	310
Short-term Forage Loss (AUMs)	342	1,720	1,720	618	909	1,325	881	1,277	1,531	1,002
BLM Inspection and Enforcement										
BLM inspection and enforcement capability would be dependent upon management requirements and annual budgets and priorities.										
Compensatory Mitigation										
Hypothetical Value (thousand $)	0	4,420	4,420	0	0	494	0	0	2,541	0

1 Further summary detail is provided in Appendix E, Summary of Impacts; complete detail for all resources is provided in Chapter 4.0.
2 Application of alternative-specific COAs, BMPs, and other mitigation and monitoring may reduce impact levels from those shown in this table.
3 Traffic volumes would be highest during development.

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CHAPTER 3 — AFFECTED ENVIRONMENT

This chapter describes existing conditions of the physical, biological, cultural, socioeconomic, and visual resources in the JIDPA and identifies associated resource-specific cumulative impact assessment areas (CIAAs). The resources and their respective CIAAs addressed in this EIS were identified during past Jonah project NEPA analyses, scoping for this project, and/or IDT reviews.

Critical elements of the human environment (BLM 1988a, 1999a), their status in the JIDPA, and their potential to be affected by the proposed project are listed in Table 3.1. Three critical elements (areas of critical environmental concern [ACECs], prime and unique farmlands, and wild and scenic rivers) are not present and would not be affected so are not addressed further. Other critical elements of the human environment may potentially be affected and are addressed. In addition to the critical elements, this EIS discusses existing conditions and potential project effects (see Chapter 4) on topography; mineral resources; geologic hazards; paleontological resources; soils; noise and odor; biological resources; socioeconomics; land use including status, livestock/grazing management, recreation, and transportation; and visual resources.

Table 3.2 lists the CIAAs for each resource, and CIAA maps are presented in specific resource sections of this EIS chapter. Existing disturbance in the JIDPA and CIAAs was estimated using existing digital geographic information system (GIS) data for roads, oil and gas wells, land cover, residential areas, surface water resources, wetlands, and watershed boundaries. Oil and gas well

Table 3.1 Critical Elements of the Human Environment, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Element[1]	Status on JIDPA	Addressed in This EIS
Air quality	Potentially affected	Yes
Areas of critical environmental concern	Not present	No
Cultural resources	Potentially affected	Yes
Environmental justice	Not affected	Yes
Farmlands (prime or unique)	Not present	No
Floodplains	Potentially affected	Yes
Native American religious concerns	Potentially affected	Yes
Noxious weeds	Potentially affected	Yes
Threatened and endangered species	Potentially affected	Yes
Wastes, hazardous or solid	Potentially affected	Yes
Water quality (surface and ground water)	Potentially affected	Yes
Wetlands/riparian zones	Potentially affected	Yes
Wild and scenic rivers	Not present	No
Wilderness	Not present	Yes

[1] Adapted from BLM (1988a, 1999a).

Table 3.2 Cumulative Impact Assessment Areas, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Resource	CIAA[1]
Air quality	Project area and nearby Class I and sensitive Class II airsheds[2]
Topography	Project-affected sixth-level watersheds
Geology	
Mineral resources	Combined Jonah, Jonah II and Jonah Infill Project areas
Geologic hazards	Combined Jonah, Jonah II and Jonah Infill Project areas
Paleontological resources	Paleontological/cultural resource CIAA
Soils	Project-affected sixth-level watersheds
Water resources	
Surface water	Project-affected sixth-level watersheds
Ground water	Project area and associated draw-down area
Odor	Project area and 2-mile buffer
Noise	Project area and 20-mile buffer
Vegetation	
General	Project-affected sixth-level watersheds
Wetlands/Riparian areas	Project-affected sixth-level watersheds
Wildlife and fisheries	
Big game	Project-affected ranges and migration corridors for the Sublette Pronghorn Antelope Herd
Greater sage-grouse	Northern portion of Upland Game Bird Management Area 7
Raptors	Raptor CIAA
Fisheries	Project-affected sixth-level watersheds
Other species	Jonah Wildlife Study Area
Wild horses	Little Colorado Herd Management Area
Threatened, endangered, candidate, proposed, and BLM-sensitive species	Entire ranges for affected species
Cultural resources	Paleontological/cultural resource CIAA
Socioeconomics	Counties (Lincoln, Sublette, and Sweetwater) and communities (LaBarge, Pinedale, Big Piney, Marbleton, Boulder, Eden, Farson, and Rock Springs) most likely to be impacted by the proposed Project
Land use	
Agricultural/rangeland	Project-affected grazing allotments
Minerals extraction	Combined Jonah, Jonah II, and Jonah Infill Project areas
Recreation	Recreation CIAA
Land status and prior rights	Project area and leases that extend beyond Project area
Visual resources	Visual resource CIAA

1 CIAA = cumulative impact assessment area; see resource-specific sections of EIS Chapter 3 for mapped locations.

2 Air quality emissions sources from a larger area; see Map 3.1.

and associated access road locational information was obtained from the WOGCC and BLM databases, as well as Operator-provided data. Existing development information for the JIDPA and surrounding areas was obtained from annual Jonah and Pinedale Anticline wildlife monitoring reports (TRC Mariah Associates Inc. [TRC Mariah] 2004a, 2004b) and aerial photographs of the JIDPA and surrounding areas. Big game ranges and migration routes, raptor nest and greater sage-grouse lek information, potential TEP&C and BWS species habitat information, soils, vegetation types, general wildlife observation information, wild horse management areas, and grazing allotments information were obtained from WGFD, BLM, and Wyoming Natural Diversity Database (WYNDD) digital shapefiles and associated data files and were used to assist in describing the affected environment for these resources.

3.1 PHYSICAL RESOURCES

3.1.1 Climate

The JIDPA 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 long-term meteorological measurement station is at LaBarge, Wyoming (1958-2003), approximately 20 miles southwest of the JIDPA at an elevation of 6,858 ft (Western Regional Climate Center [WRCC] 2004). Variations in elevation and topography across the region result in variations in site-specific climatic conditions; therefore, site-specific conditions in the JIDPA likely vary somewhat from those reported herein.

The total annual average precipitation at LaBarge is 8.0 inches, ranging from 17.8 inches (1995) to 3.4 inches (1975). Precipitation is greatest from mid-spring to early fall, tapering off during the winter months. An average of 30.5 inches of snow falls during the year (annual high 43.6 inches in 1987). Table 3.3 shows the average monthly temperature ranges and precipitation.

Table 3.3 Mean Monthly Temperature Ranges and Total Precipitation at LaBarge.[1]

Month	Average Monthly Low and High Temperatures (°F)	Average Precipitation (inches)
January	-1.7 - 30.9	0.31
February	1.0 - 34.6	0.34
March	13.7 - 43.1	0.38
April	23.4 - 54.0	0.81
May	32.0 - 64.8	1.31
June	38.9 - 73.6	1.03
July	43.9 - 83.4	0.67
August	42.3 - 81.6	0.88
September	33.2 -70.8	0.77
October	22.4 - 59.2	0.57
November	10.5 - 41.4	0.47
December	-0.9 - 31.0	0.46
Annual Average	21.6 - 55.7	8.0

[1] Source: (WRCC 2004).

The region has cool temperatures, with average daily temperature (in degrees Fahrenheit [ºF]) ranging between -1.7ºF and 30.9ºF in January to between 43.9ºF and 83.4ºF in July. Extreme temperatures have ranged from -52ºF (1990) to 96ºF (2002). The frost-free period generally occurs from mid-May to mid-September.

The region is subject to strong and gusty winds, reflecting channeling and mountain valley flows due to complex terrain. During the winter months, strong winds are often accompanied by snow, producing blizzard conditions. The closest comprehensive wind measurements are collected in the JIDPA at a meteorological station operated by BP America from 1999 through 2003. A wind rose for the JIDPA for years 1999 through 2002 is provided in Figure 3.1 and shows the frequency distribution of wind speed and direction. Table 3.4 provides the wind direction distribution in a tabular format. From this information, it is evident that winds in the JIDPA originate from the west to northwest approximately 40% of the time. The annual mean wind speed is 11.3 mph.

Table 3.5 shows the frequency distribution of wind speeds in the JIDPA, and Table 3.6 shows the atmospheric stability class. The atmospheric stability class is the measure of atmospheric turbulence, which directly affects pollutant dispersion. The stability classes are divided into six categories designated "A" (unstable) through "F" (very stable). The "D" (neutral) stability class occurs more than half of the time.

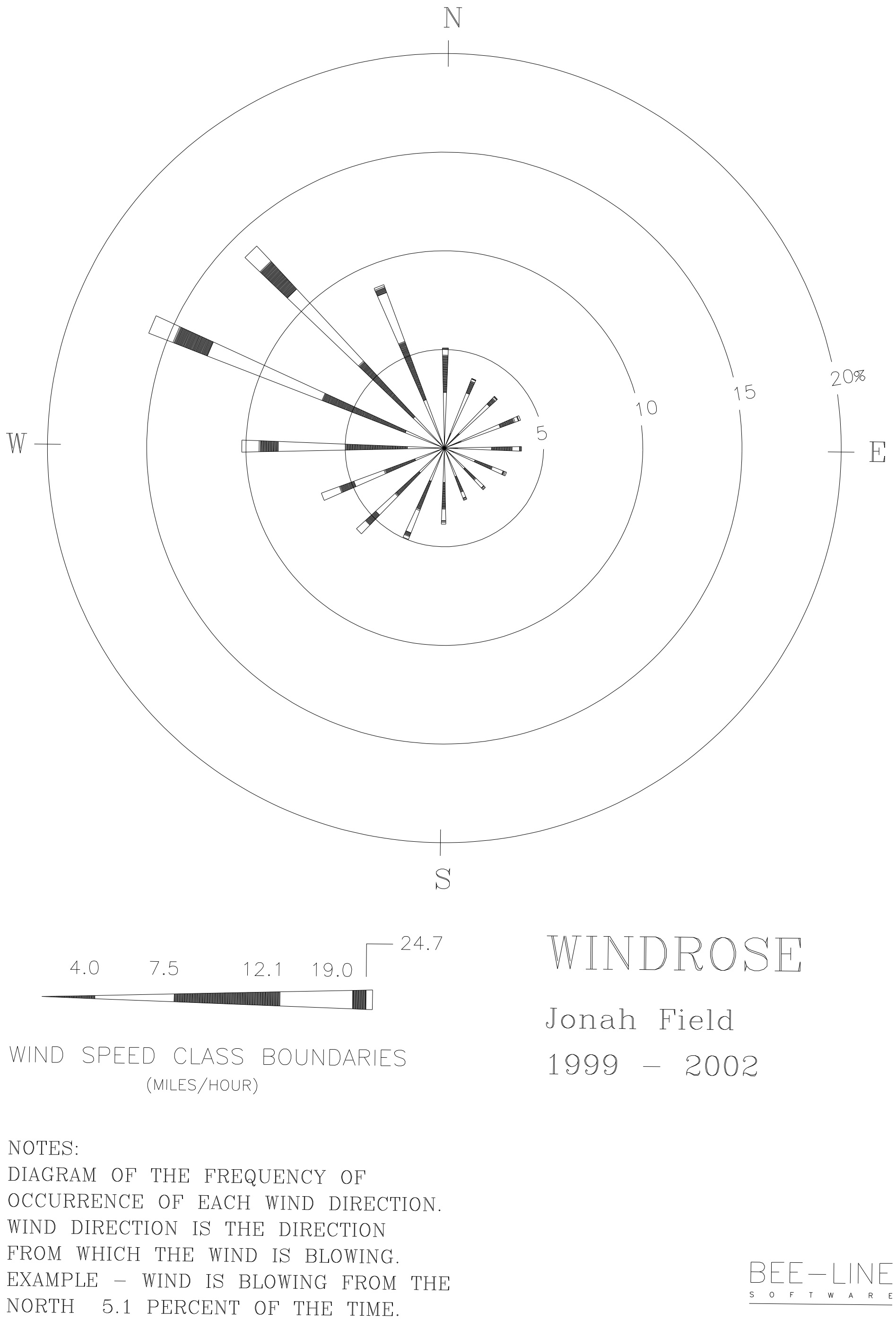
The frequency and strength of winds greatly affect the dispersion and transport of air pollutants. Because of the strong winds in the region, the potential for atmospheric dispersion is relatively high (although nighttime cooling enhances stable air, inhibiting air pollutant mixing and transport).

An assessment of project impacts to climate is beyond the scope of this analysis and is therefore not discussed further in this EIS.

3.1.2 Air Quality

The Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) are health-based criteria for the maximum acceptable concentrations of specific air pollutants at locations to which the public has access. Although specific air quality monitoring has not been conducted within the JIDPA, air quality monitoring for the most relevant pollutants has been conducted and determined to be representative of the CIAA (Map 3.1). Air pollutants measured for which ambient air quality standards exist include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). Background concentrations for these pollutants are compared to the WAAQS and NAAQS and PSD Class I and II Increments in Table 3.7.

As shown in Table 3.7, regional background values are below established standards, and all areas within the CIAA are designated as attainment for all criteria pollutants. Background air quality concentrations can be combined with modeled Project-related emissions for the same averaging time periods so that total predicted pollutant concentrations can be compared to applicable air quality standards.



Source: BP America (2004).

Figure 3.1 Wind Rose, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.

Table 3.4 Wind Direction Frequency Distribution, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.[1]

Wind Direction	Occurrence (%)
N	5.1
NNE	3.8
NE	3.6
ENE	4.1
E	3.9
ESE	3.4
SE	2.9
SSE	2.8
S	3.9
SSW	5.0
SW	6.0
WSW	6.6
W	10.2
WNW	16.0
NW	13.9
NNW	8.8

[1] Source: BP America (2004).

Table 3.5 Wind Speed Distribution, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.[1]

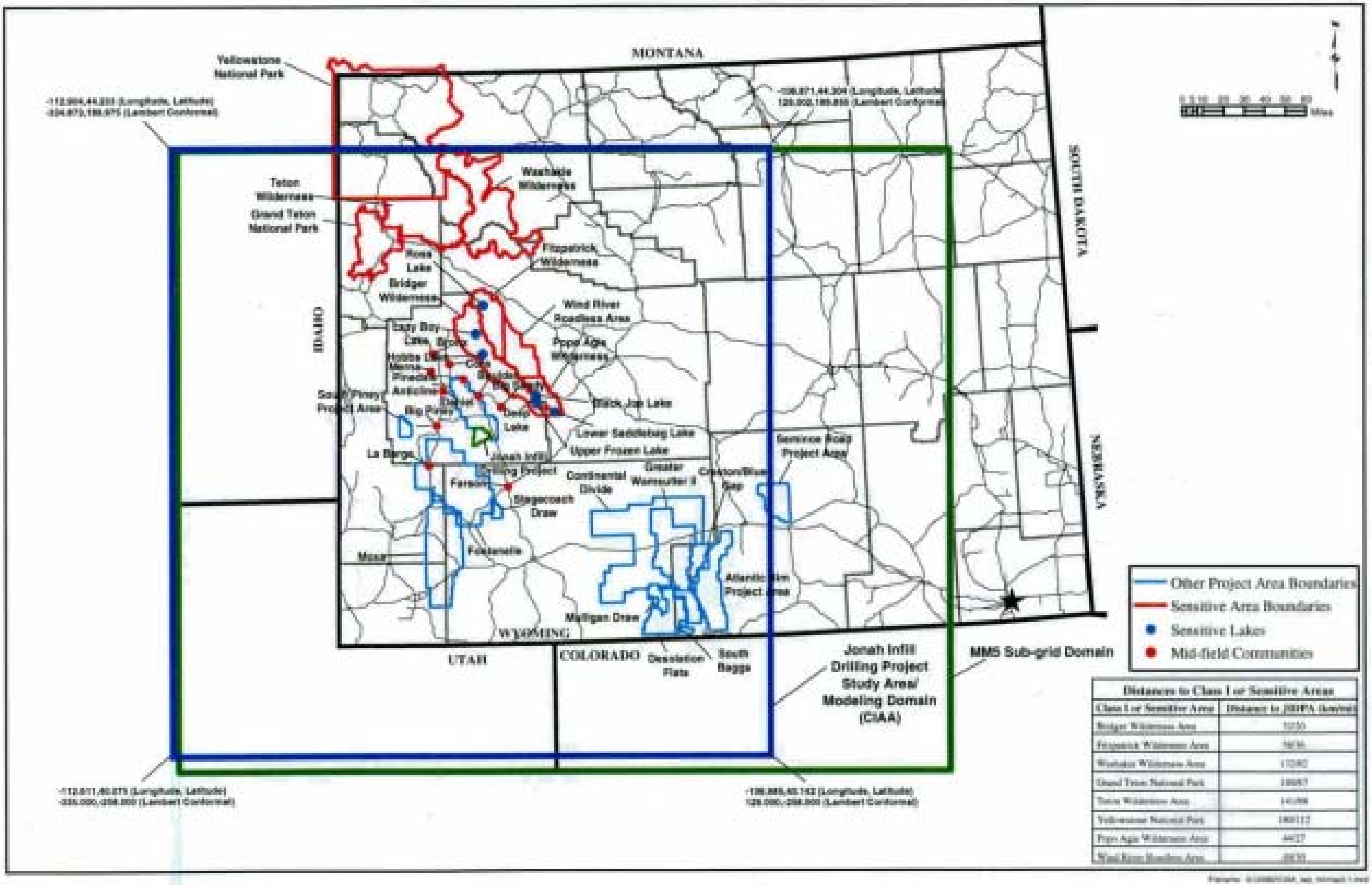
Wind Speed (mph)	Occurrence (%)
0 – 4.0	8.9
4.0 – 7.5	25.8
7.5 – 12.1	28.1
12.1 – 19.0	24.4
19.0 – 24.7	7.4
Greater than 24.7	5.4

[1] Source: BP America (2004).

Table 3.6 Atmospheric Stability Class Distribution, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.[1]

Class[2]	Frequency (%)
A	2.3
B	5.9
C	12.0
D	60.8
E	15.2
F	3.7

[1] Source: BP America (2004).
[2] A = unstable; B = neutral; F = very stable.



Map 3.1 Air Quality Modeling Domain (Cumulative Impact Assessment Area) Depicting Class I and Other Sensitive Areas and Lakes, Jonah Infill Drilling Project, 2005

Table 3.7 Air Pollutant Background Concentrations, Wyoming and National Ambient Air Quality Standards, and Prevention of Significant Deterioration (PSD) Increments ($\mu g/m^3$).

Pollutant/ Averaging Time	Measured Background Concentration	Wyoming and National Ambient Air Quality Standards	Incremental Increase Above Legal Baseline[1]	
			PSD Class I	PSD Class II
Carbon monoxide (CO)[2]				
1-hour	3,336	40,000	n/a	n/a
8-hour	1,381	10,000	n/a	n/a
Nitrogen dioxide (NO_2)[3]				
Annual	3.4	100	2.5	25
Ozone[4]				
1-hour	169	235	n/a	n/a
8-hour	147	157		
Particulate matter				
(PM_{10})[5]	33	150	8	30
24-hour	16	50	4	17
Annual				
Particulate matter				
($PM_{2.5}$)[5]	13	65	n/a	n/a
24-hour	5	15	n/a	n/a
Annual				
Sulfur dioxide (SO_2)[6]				
3-hour (National)	132	1,300	25	512
24-hour (National)	43	365	5	91
24-hour (Wyoming)	43	260	5	91
Annual (National)	9	80	2	20
Annual (Wyoming)	9	60	2	20

[1] n/a = not applicable.

[2] Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized for the Riley Ridge project (BLM 1983).

[3] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (Air Resource Specialists [ARS] 2002).

[4] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).

[5] Background data collected by WDEQ/AQD at the Emerson Building, Cheyenne, Wyoming, in 2001. These data have been determined by WDEQ/AQD to be the most representative co-located PM_{10} and $PM_{2.5}$ data available.

[6] Background data collected at the LaBarge Study Area/Northwest Pipeline Craven Creek site in 1982-1983.

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 PSD Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. The incremental increase depends upon an area's classification. Six PSD Class I areas are identified as sensitive areas within the CIAA: the Bridger, Fitzpatrick, Teton, and Washakie Wilderness Areas and Grand Teton and Yellowstone National Parks (see Map 3.1). Strict limitations on the additional amount of air pollution allowed from major emitting facilities in PSD Class I areas are applied. For Class I areas, potential cumulative concentrations are compared to applicable PSD increments, and potential Project concentrations are compared to proposed PSD significance levels. The remainder of the CIAA is classified PSD Class II, where similar but less-stringent incremental air quality limits apply. The Popo Agie Wilderness Area and the Wind River Roadless Area are PSD Class II areas that have been identified as additional sensitive areas occurring within the CIAA for air quality. PSD Class I and Class II areas are shown in Map 3.1. Regional background pollutant concentrations, NAAQS, and WAAQS, as well as PSD Class II increments are presented in Table 3.7.

The 1977 *Clean Air Act* amendments established visibility as an Air Quality-Related Value (AQRV) which federal land managers must consider. The 1990 *Clean Air Act* amendments contain a goal of improving visibility within PSD Class I areas. Residents of the Pinedale area consider visibility impairment to be a major concern.

There are two types of visible impairment caused by emission sources--plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background such as a landscape feature. Short-duration (usually less than 1-2 days) visual plumes occasionally occur from the JIDPA as a result of upset conditions occurring during flaring operations. Regional haze occurs when pollutants from more diffuse emission sources become well mixed in the atmosphere, causing a general alteration in the appearance of landscape features, changing the color or contrast between landscape features, or causing features of a view to disappear.

Visibility impairment is measured in terms of change in light extinction or change in deciview (dv). A dv change of 1 to 2 (equivalent to a 10% to 20% change in extinction) represents a small but perceptible change in visibility. Visual range, referred to as standard visual range (SVR), is 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 within the JIDPA air quality CIAA is considered very good, with an average SVR of over 93.2 miles (150.0 km) (Malm 2000).

Visibility impacts within Class II areas such as the Sublette County towns of Merna, Pinedale, and Boulder are categorized in this analysis as the mid-field area of study. Visibility or other AQRV impacts within these Class II areas are neither monitored nor regulated by state or federal agencies. Visibility and acid deposition monitoring is conducted within Class I areas. In 1985, the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring program was initiated to establish current visibility conditions, to track visibility changes, to establish long-term trends, and to determine the causal mechanisms of visibility impairment in Class I areas.

The Bridger Wilderness Area, North Absaroka Wilderness Area, and Yellowstone National Park IMPROVE sites are the closest such sites to the JIDPA. Data have been collected near the Bridger Wilderness Area and Yellowstone National Park sites since 1989, and at the North

Absaroka Wilderness Area since 2000. Figures 3.2, 3.3, and 3.4 present summaries of visibility conditions at the IMPROVE sites for the cleanest days (20th percentile best visibility days), for average conditions; and for the haziest days (20th percentile haziest visibility days), respectively (Cooperative Institute for Research in the Atmosphere [CIRA] 2003). These data are presented in SVR and were reconstructed from monitored aerosol (suspended liquid or solid particles) data.

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). Background wet and dry atmospheric acid deposition impacts have been monitored at the National Acid Deposition Program (NADP) National Trends Network (NTN) (wet deposition) and Clean Air Status and Trends Network (CASTNET) (dry deposition) station near Pinedale, Wyoming. Total annual deposition (wet and dry) reported as total nitrogen and total sulfur deposition for this site for the monitoring period of record are provided in Figure 3.5 and 3.6, respectively.

Total deposition levels of concern (LOC) have been estimated for several areas, including the Bridger Wilderness Area (USFS 1989). The "red line" LOC represents an estimate of the total pollutant loadings that each wilderness can tolerate. Total loadings above these values suggest that the land manager recommend a reduction of emissions from new sources unless data are available to indicate that no AQRVs in the Class I area are unlikely to be adversely affected. The "green line" LOC represents the total pollution loadings (current plus proposed new source contribution) below which a land manager can recommend a permit be issued for a new source, unless data are available that indicate otherwise. The USFS has indicated that the current green line values are set too high (personal communication, December 2004, with Susan Caplan, BLM Air Quality Specialist). Cumulative impacts plus background are compared to these LOCs. The Bridger Wilderness nitrogen deposition red line LOC is 10 kg/ha-yr and nitrogen deposition green line LOC is 3-5 kg/ha-yr. The Bridger Wilderness sulfur deposition red line LOC is 20 kg/ha-yr and sulfur deposition green line is 5 kg/ha-yr. For comparison with reported deposition values, these LOCs are shown on Figures 3.5 and 3.6.

The Wyoming Air Resources Monitoring System (WARMS) has measured concentrations of nitric acid, particulate nitrate, total nitrate, particulate ammonium, sulfur dioxide, and sulfate at a station near Pinedale, Wyoming since 1999. Figures 3.7 and 3.8 present the weekly concentrations of nitrogen compounds (nitrate and ammonium) and Figures 3.9 and 3.10 present concentrations of sulfur compounds (sulfur dioxide and sulfate) near Pinedale. These data are provided as an additional measure of the nitrogen and sulfur levels near the Bridger Wilderness. WARMS data from the network start-up period from 1999 and 2000 may be unreliable, however, they are provided for comparison purposes.

Site-specific lake chemistry background data (pH, acid-neutralizing capacity [ANC], elemental concentrations, etc.) have been collected by the USFS in several high mountain lakes in the nearby Wilderness Areas. Lakes for which background data were collected are shown on Map 3.1. Lake acidification is measured in terms of change in ANC, which is the lake's buffering capacity to resist acidification from atmospheric deposition of acid compounds such as sulfates and nitrates. Measured baseline ANC data for sensitive lakes within the cumulative study domain are provided in Table 3.8.

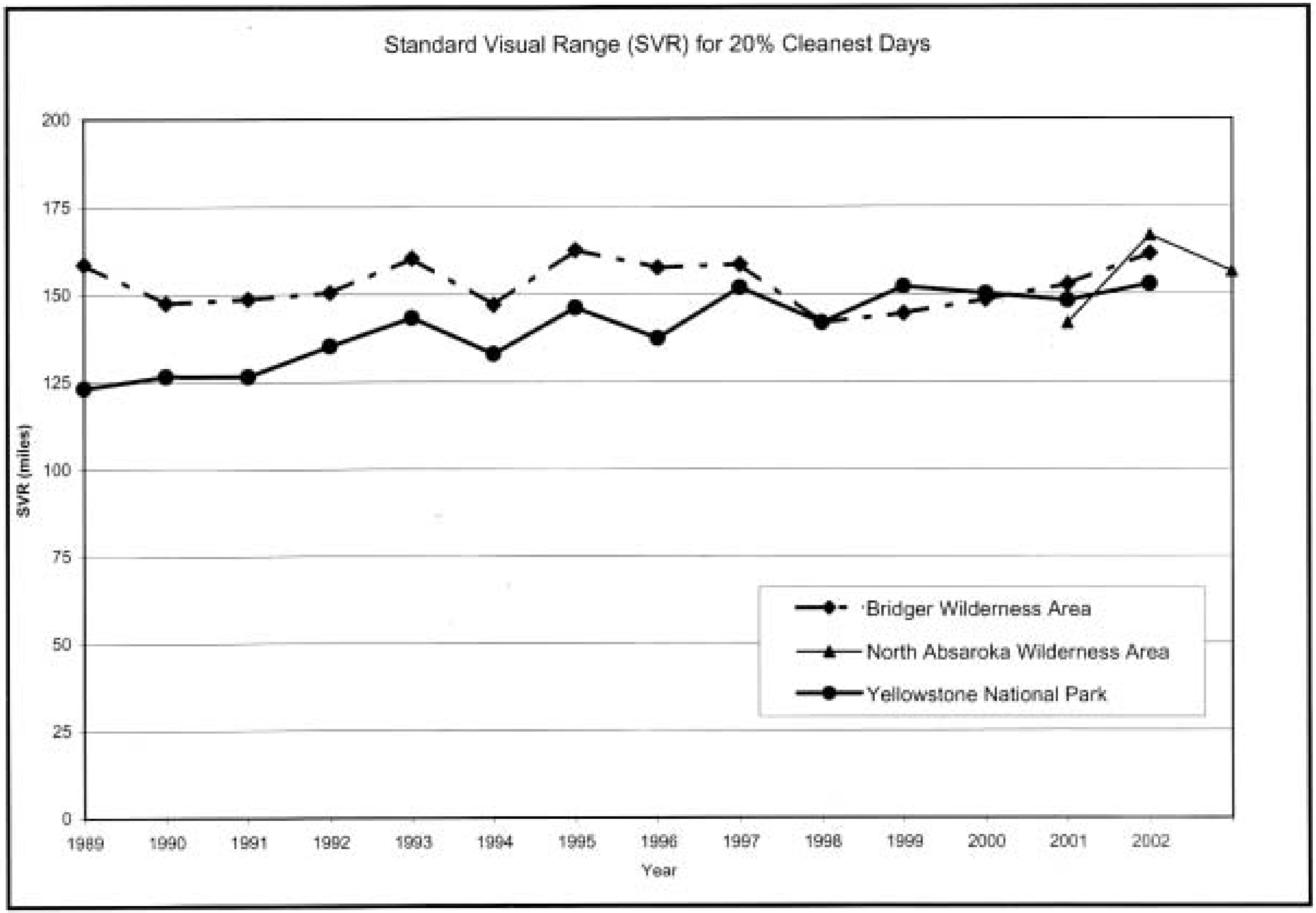


Figure 3.2 Standard Visual Range for 20th% Cleanest Days, Jonah Infill Drilling Project Area, Sublette County, Wyoming (CIRA 2003).

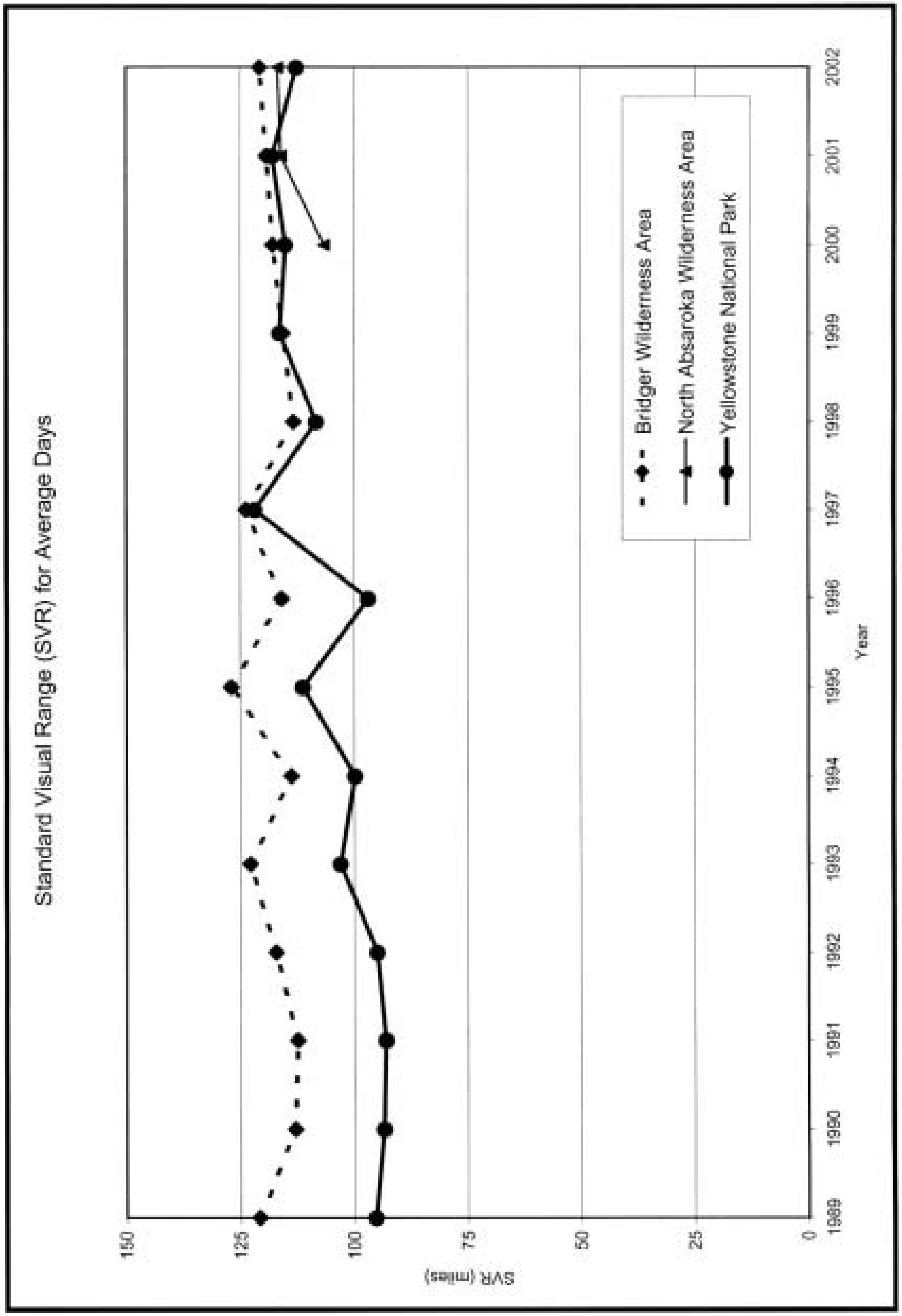


Figure 3.3 Standard Visual Range for Average Days, Jonah Infill Drilling Project Area, Sublette County, Wyoming (CIRA 2003).

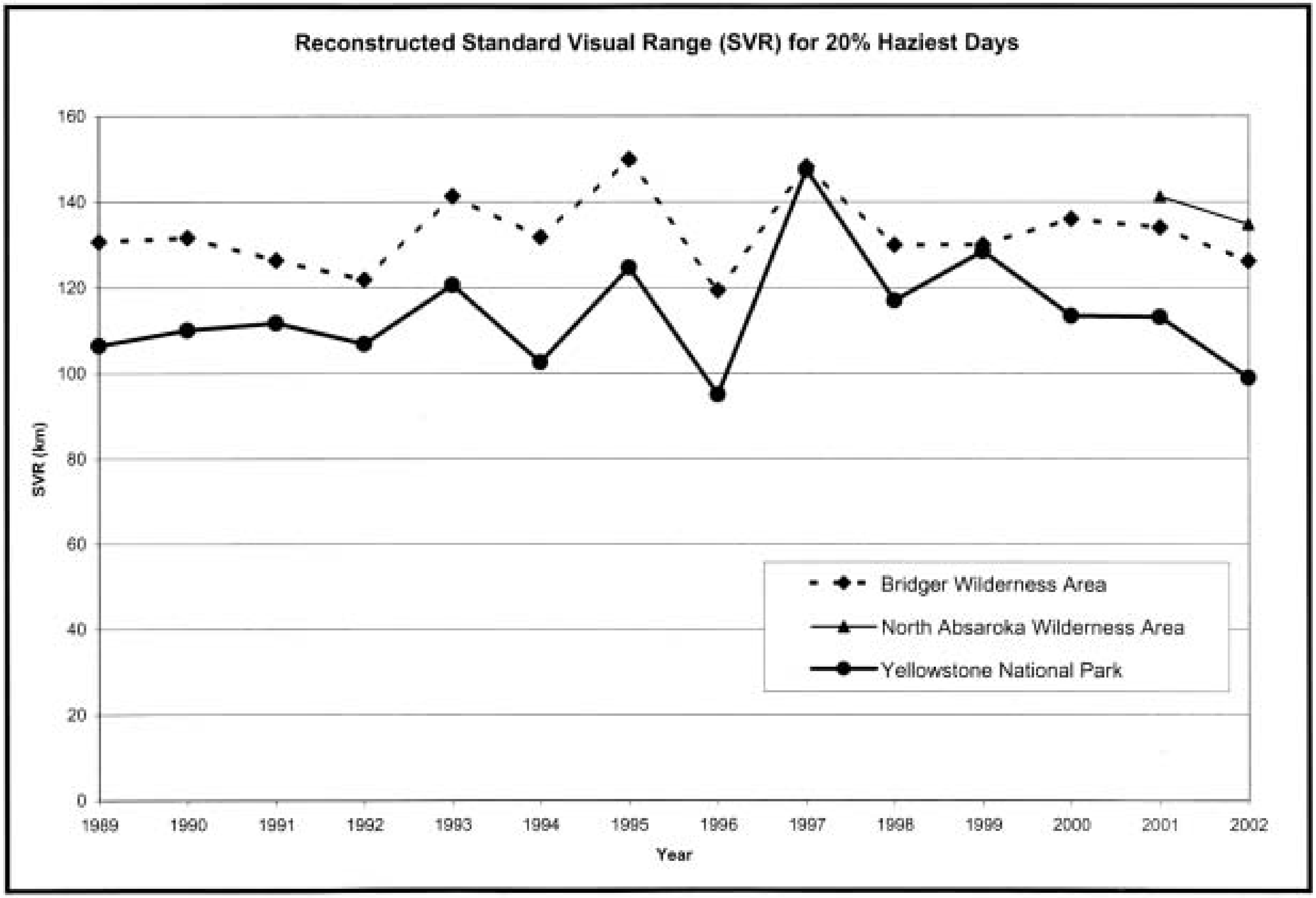


Figure 3.4 Standard Visual Range for 20th% Haziest Days, Jonah Infill Drilling Project Area, Sublette County, Wyoming (CIRA (2003).

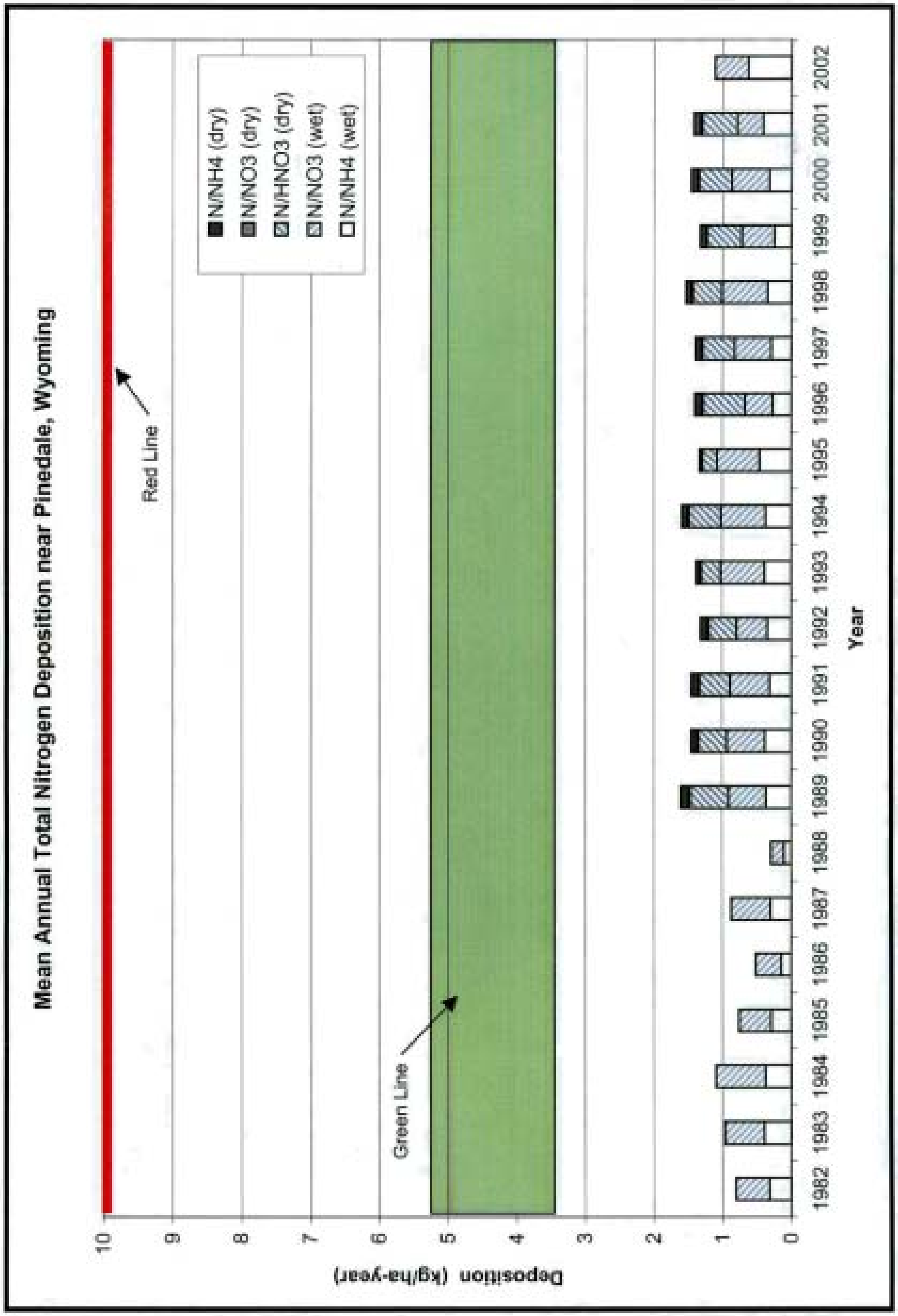


Figure 3.5 Mean Annual Total Nitrogen Deposition Near Pinedale, Wyoming (NADP [WY06] and CASTNET [PND165]).

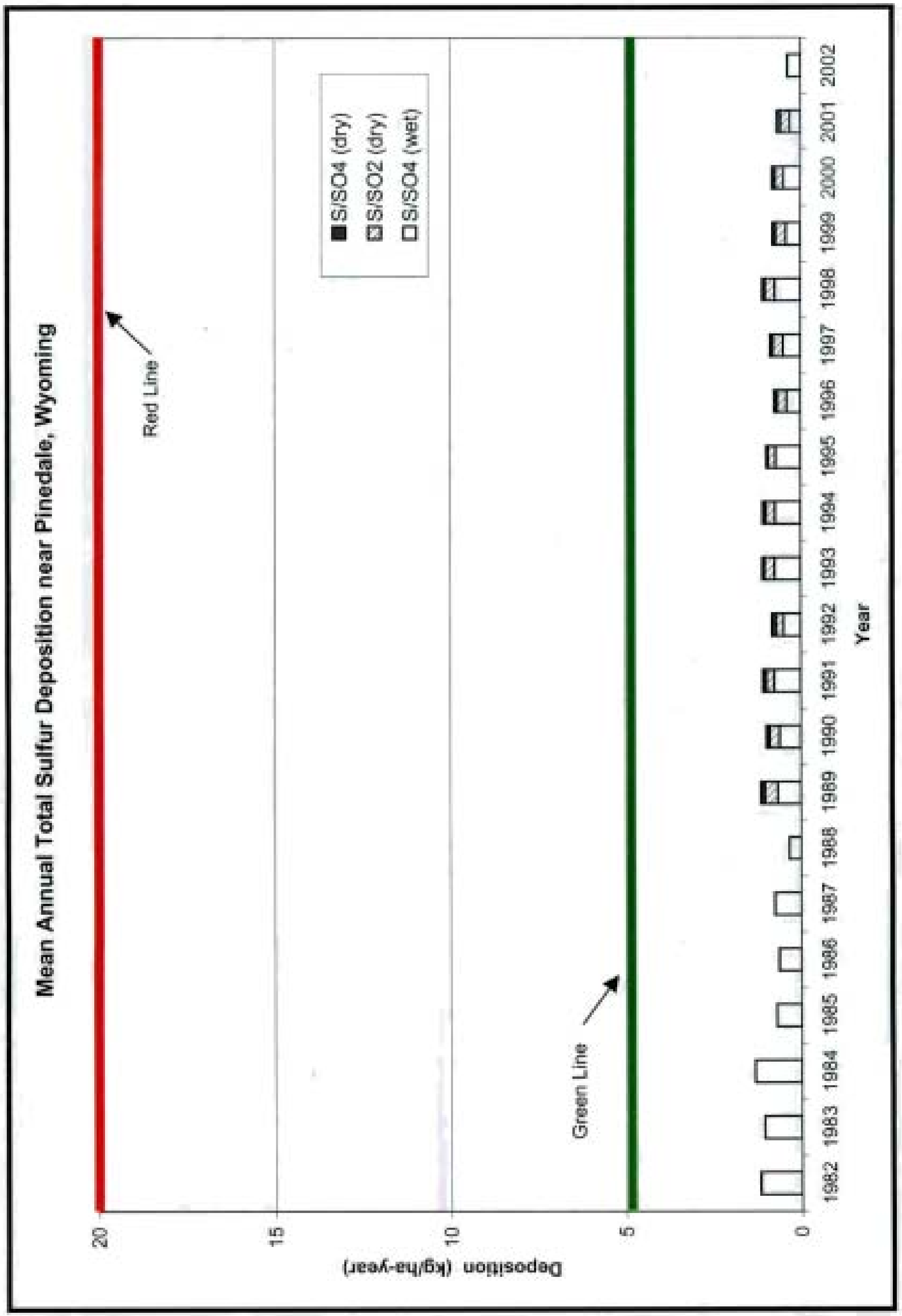


Figure 3.6 Mean Annual Total Sulfur Deposition Near Pinedale, Wyoming (NADP [WY06] and CASTNET [PND165]).

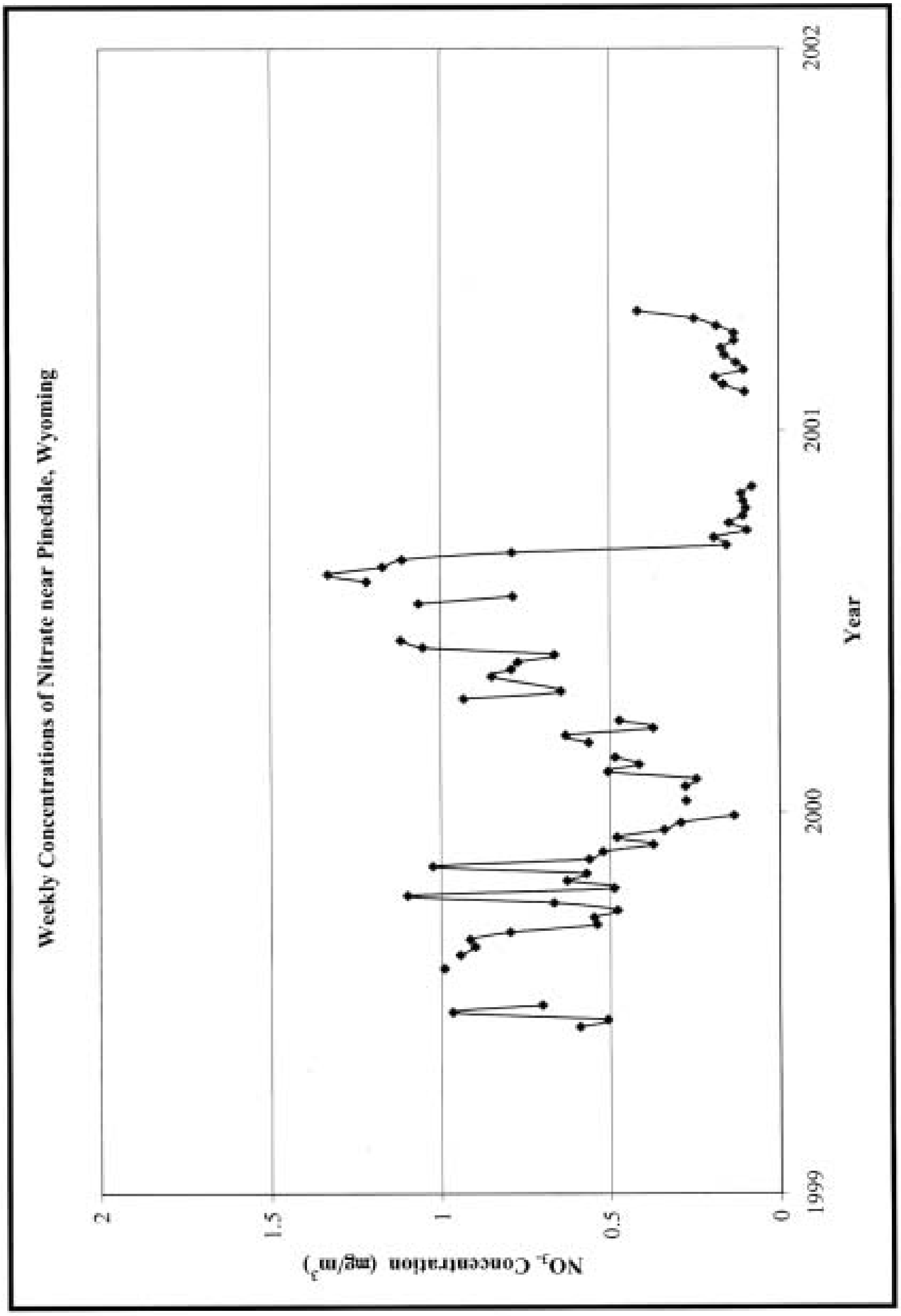


Figure 3.7 Weekly Concentrations of Nitrate Near Pinedale, Wyoming (WARMS, Pinedale).

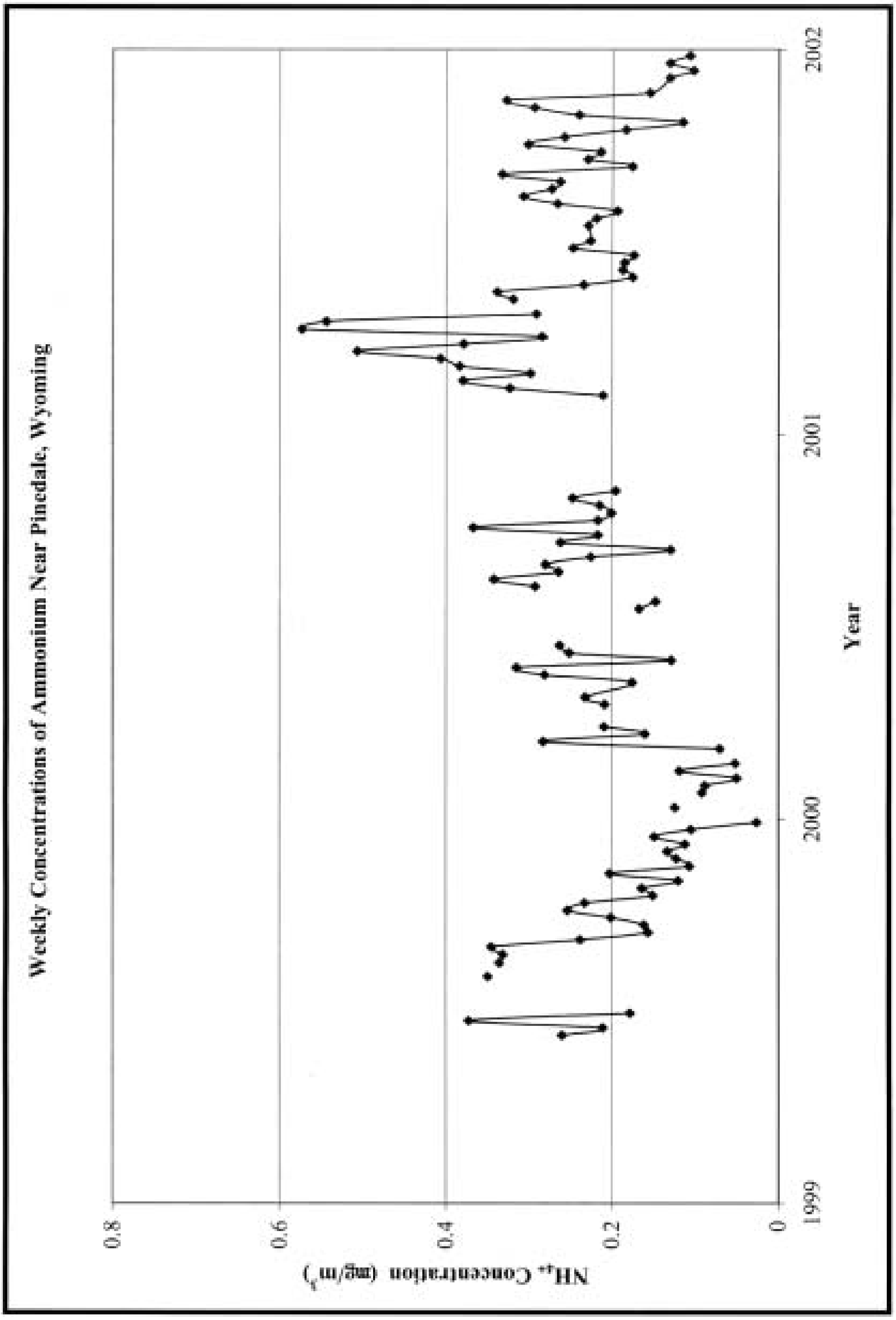


Figure 3.8 Weekly Concentrations of Ammonium Near Pinedale, Wyoming (WARMS, Pinedale).

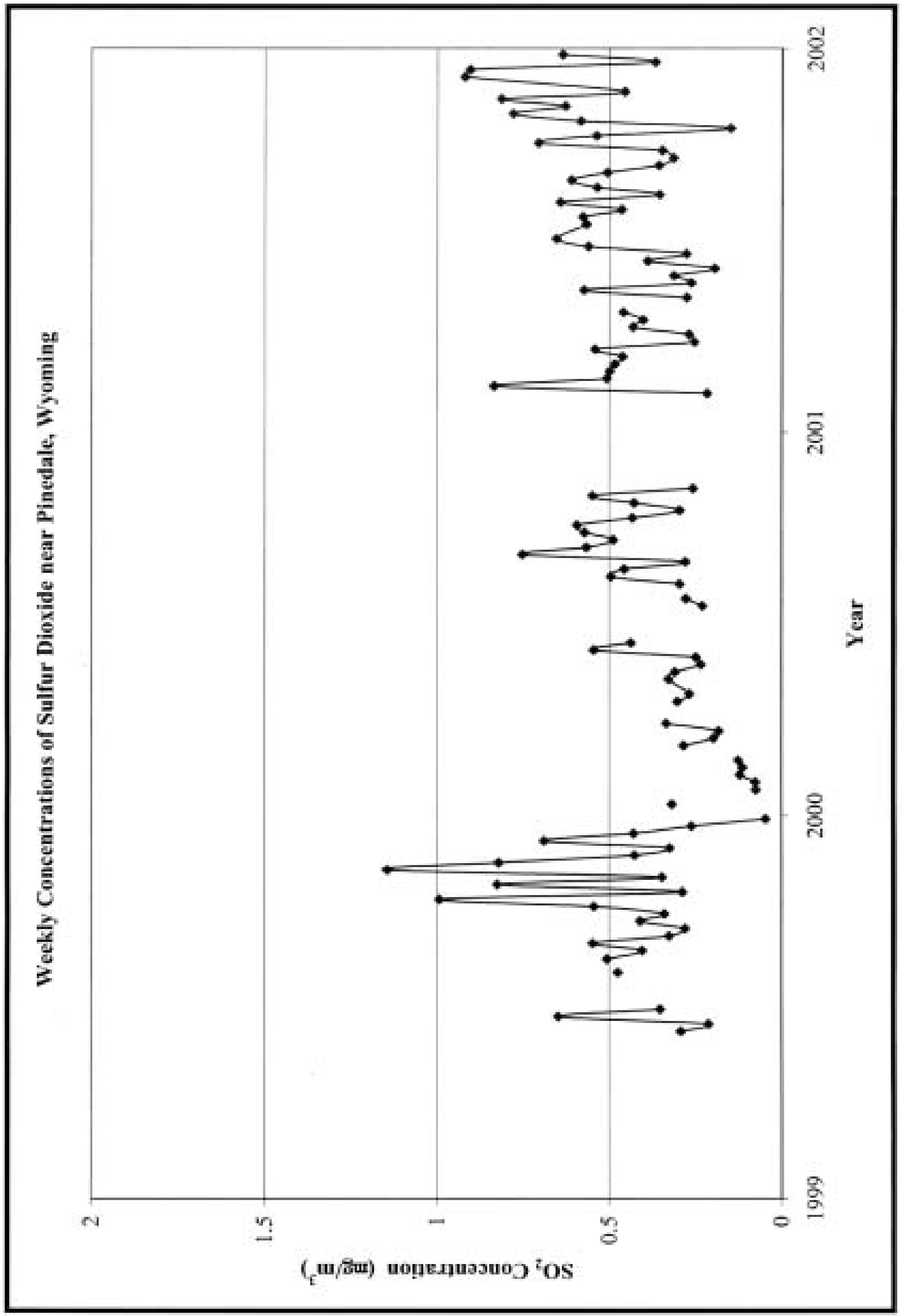


Figure 3.9 Weekly Concentrations of Sulfur Dioxide Near Pinedale, Wyoming (WARMS, Pinedale).

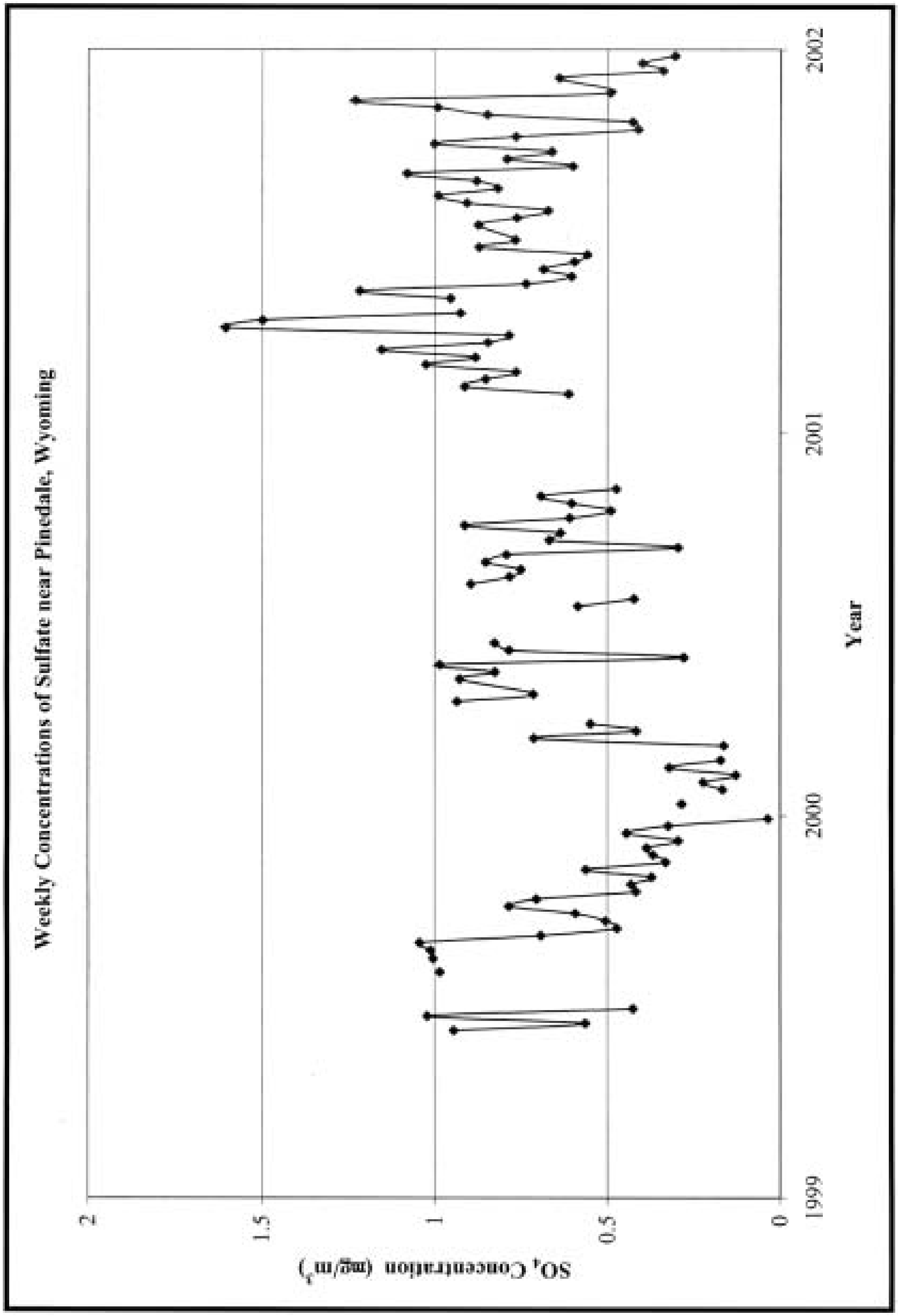


Figure 3.10 Weekly Concentrations of Sulfate Near Pinedale, Wyoming (WARMS, Pinedale).

Table 3.8 Monitored Background Conditions at Sensitive Lakes.[1]

Sensitive Lake	Lake Location	Background ANC (µeq/l)[2]	Number of Samples	Period of Monitoring
Black Joe Lake	Bridger Wilderness Area	67.0	61	1984-2003
Deep Lake	Popo Agie Wilderness Area	59.9	58	1984-2003
Hobbs Lake	Bridger Wilderness Area	69.9	65	1984-2003
Lazy Boy Lake	Bridger Wilderness Area	18.8	1	1997
Upper Frozen Lake	Bridger Wilderness Area	5.0	6	1997-2003
Ross Lake	Fitzpatrick Wilderness Area	53.5	44	1988-2003
Lower Saddlebag Lake	Popo Agie Wilderness Area	55.5	43	1989-2003

1 From USFS (2003).
2 10th Percentile Lowest ANC Values reported.

Lakes with ANC values ranging from 25 to 100 microequivalents per liter (µeq/l) are considered to be sensitive to atmospheric deposition, lakes with ANC values ranging from 10 to 25 µeq/l are considered very sensitive, and lakes with ANC values less than 10 µeq/l are considered extremely sensitive (personal communication, January 2005, with Terry Svalberg, USFS).

The USFS has identified specific AQRV "Level of Acceptable Change" (LAC) values which are used to evaluate potential air quality impacts from deposition within their wilderness areas (USFS 2000). The USFS has identified a LAC of no greater than 1 µeq/l change in ANC (from human causes) for lakes with existing ANC levels less than 25 µeq/l. A limit of 10 percent change in ANC reduction was adopted for lakes with existing ANC greater than 25 µeq/l.

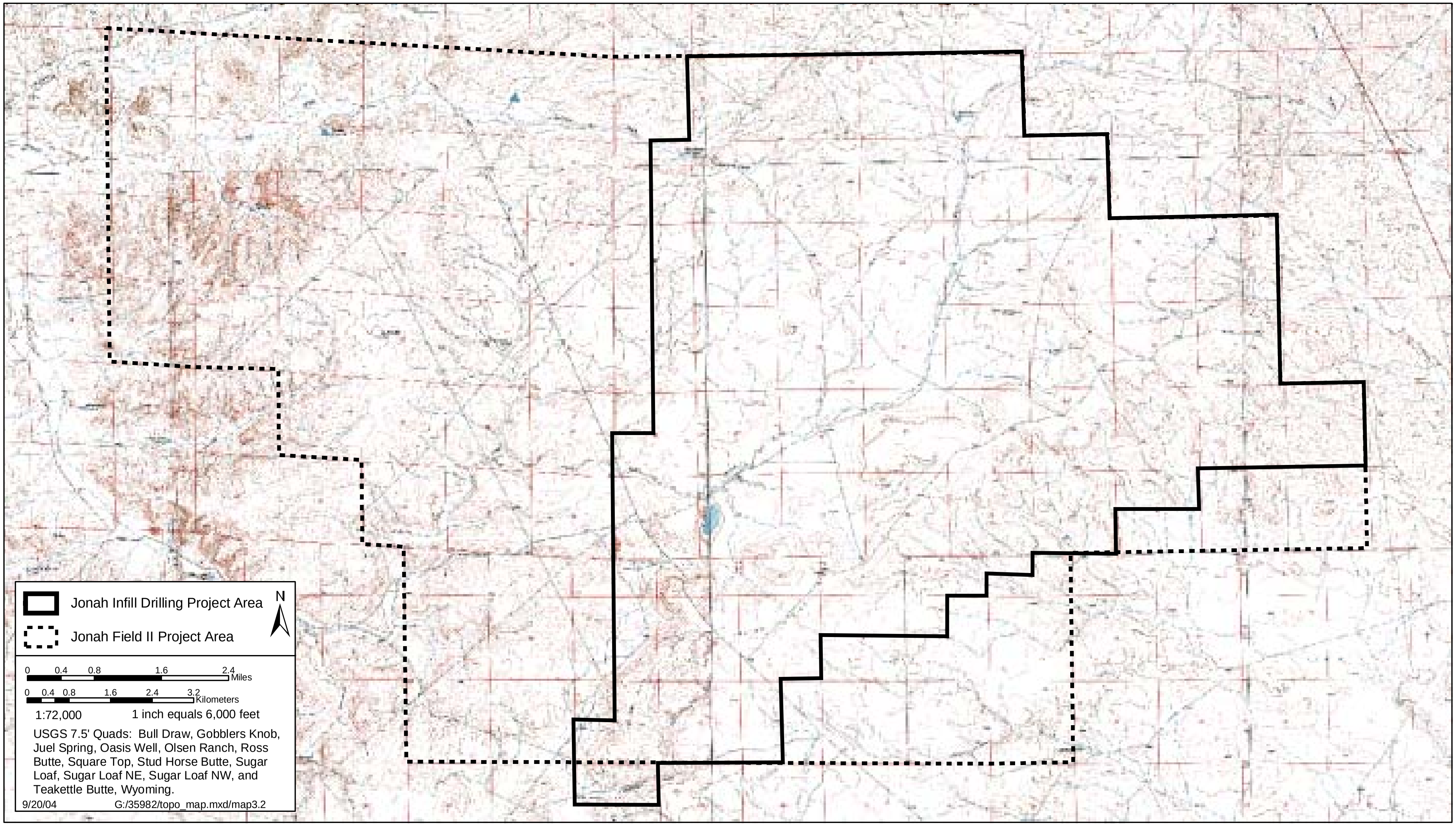
3.1.3 Topography

The JIDPA is located in the northern portion of the Green River Basin. Topography is generally gently rolling, with elevations ranging from approximately 7,400 ft on top of area buttes to about 7,000 ft on the JIDPA's southern boundary (Map 3.2). Topographic relief areas (butte slopes) typically range in height from 50 to 150 ft. Sand Draw, the major drainage in the JIDPA, bisects the area, flowing northeast to southwest into Alkali Creek (a tributary to the Green River). All drainages in the JIDPA are ephemeral, flowing only in response to snowmelt and rain storms. Drainage is predominantly to the southwest in Sand Draw and to Alkali Creek, to the west into Granite Draw, and to the southeast into Jonah Gulch (to a closed basin) and Long Draw and Bull Draw (to the Big Sandy River).

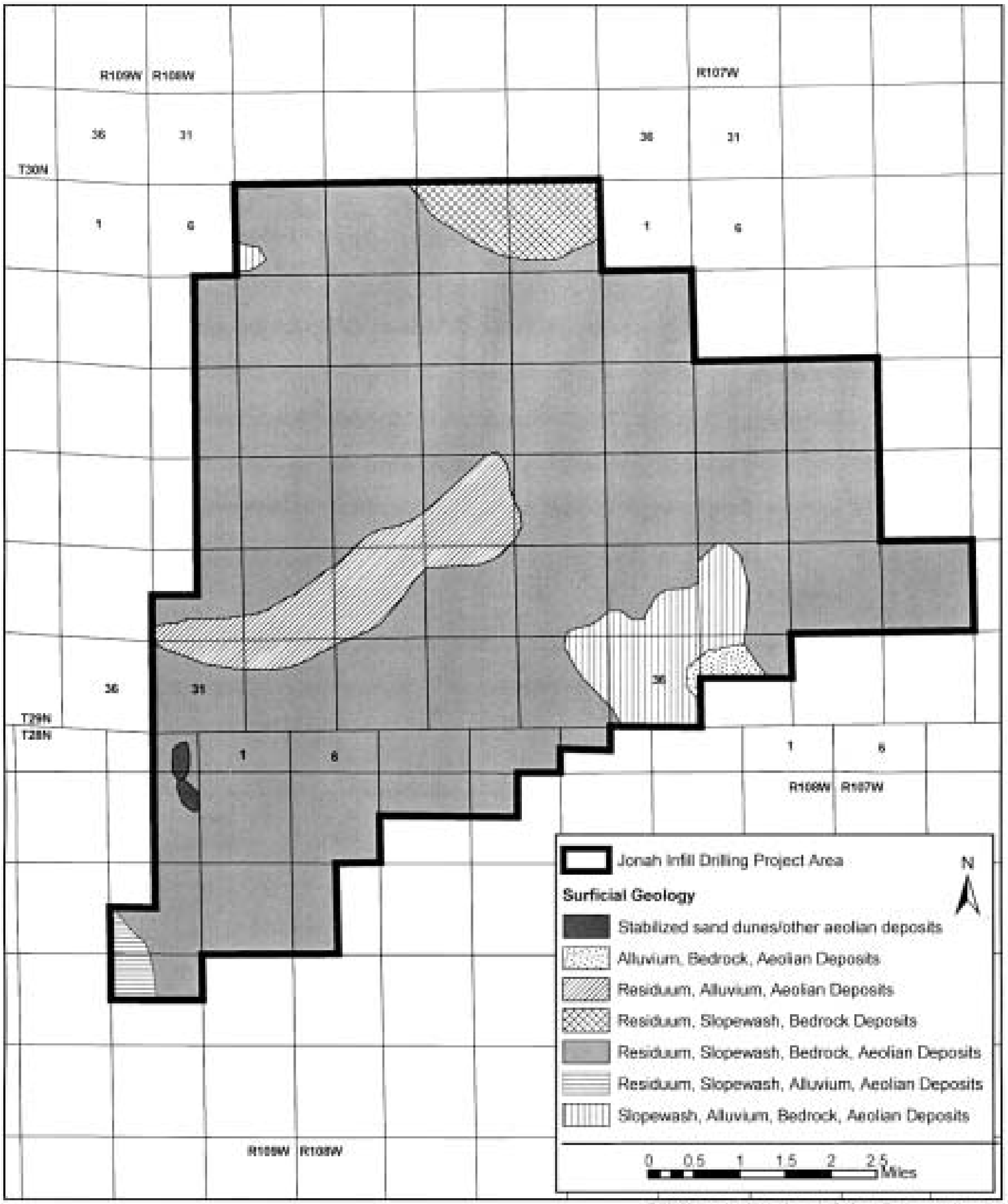
Natural gas development in the JIDPA now dominates the landscape, with over 500 wells and associated roads and pipelines. The CIAA for topography is the Project-affected JIDPA watershed areas described in detail in Sections 3.1.5 (Soils) and 3.2.1 (Vegetation).

3.1.4 Geology

The JIDPA is located on the northeastern flank of the northern Green River Basin--a structural and topographical basin located between the Overthrust Belt to the west and the Wind River Mountains to the east. The Pinedale Anticline, a large structural feature, is located immediately north and east of the JIDPA.



Map 3.2 Area Topography, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.



Map 3.3 Surface Geology, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.

Surface geology in the JIDPA is composed primarily of residuum mixed with alluvium, aeolian material, slopewash, grus, and/or bedrock outcrops. Also present are areas of slopewash and colluvium mixed with scattered deposits of residuum, grus, glacial and periglacial alluvium, aeolian deposits, and/or bedrock outcrops; shallow alluvium mixed with scattered bedrock outcrops; and an area with stabilized sand dunes (Wyoming Geographic Information Science Center [WyGISC] 2003a) (Map 3.3).

Bedrock geology in the JIDPA is dominated by the Laney Member of the Green River Formation (Tgl) and the New Fork Tongue of the Wasatch Formation (Twg) (WyGISC 2003a) (Map 3.4). An area of the Wilkins Peak Member of the Green River Formation (Tgw) occurs in the west-central portion of the area. The Laney Member is composed of oil shale and marlstone; the New Fork Tongue consists of mudstone, sandstone, and thin limestone beds; and the Wilkins Peak Member is composed of tuffaceous sandstone.

The JIDPA is underlain, in descending order, by the Green River, the Wasatch Formation, the Fort Union Formation, an unnamed Tertiary bed, the Lance Formation, the Mesaverde Group (i.e., the Almond Formation, Ericson Sandstone, Rock Springs Formation, and the Blair Formation), the Baxter/Hilliard Shale, and Lower Cretaceous (Frontier Formation), Jurassic, Triassic, Upper Paleozoic, Lower Paleozoic (Madison Formation), and Precambrian rocks. (Figure 3.11). The Lance and the upper portions of the Mesa Verde Group (together referred to as the Lance Pool) is the primary target for gas production for the Project.

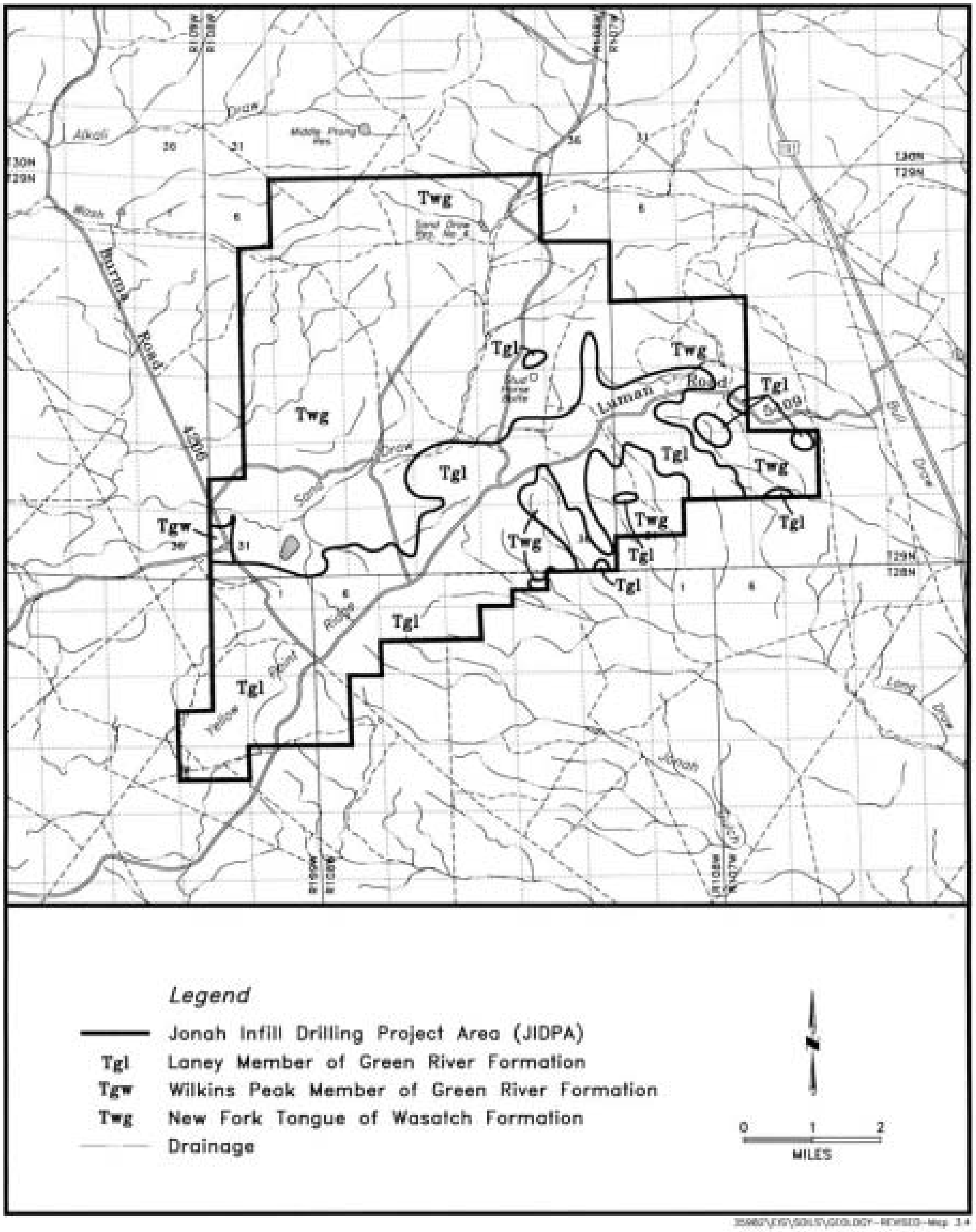
Other than the Green River and Wasatch Formations, which occur at the surface, the geological formations underlying the JIDPA would not be adversely affected by the proposed Project and, therefore, are not discussed further in this EIS. Surface geology is considered under Topography (see Section 3.1.3).

3.1.4.1 Mineral Resources

The mineral resources CIAA covers approximately 66,400 acres (103.8 square miles) on and surrounding the JIDPA and is defined as the combined Jonah EA, Jonah Field II EIS, and JIDPA areas (Map 3.5). Mineral resources within this area are generally as described below for the JIDPA; however, recovery of the natural gas resources in the CIAA area outside the JIDPA is currently considered uneconomic. Additional information on minerals industry earnings, labor, and revenues is provided in Section 3.4.

The Jonah Field is a highly productive natural gas field that produces both natural gas and condensate (oil contained in the natural gas stream). The estimated volume of natural gas in place in the field is 10,500 billion cubic ft (BCF), with recoverable volumes estimated to range between 3,400 and 8,200 BCF; 1 BCF of natural gas is the average annual amount used by 13,700 Wyoming households (2002 use rates) (Energy Information Administration 2004). Through August 2004, approximately 1,121 BCF of gas and 11 million barrels of oil (MBO) had been produced from the field from over 500 wells (WOGCC 2004).

The Lance Formation (from which natural gas would be obtained) is a sedimentary formation, formed by fluvial processes, whereby sediments were deposited in complex, discontinuous bodies by braided flowing streams. Figure 3.12 provides a photograph of a typical braided stream. The gas-bearing sediments of the Lance Formation occur in numerous discontinuous lenses (see Appendix G).



Map 3.4 Bedrock Geology, Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.

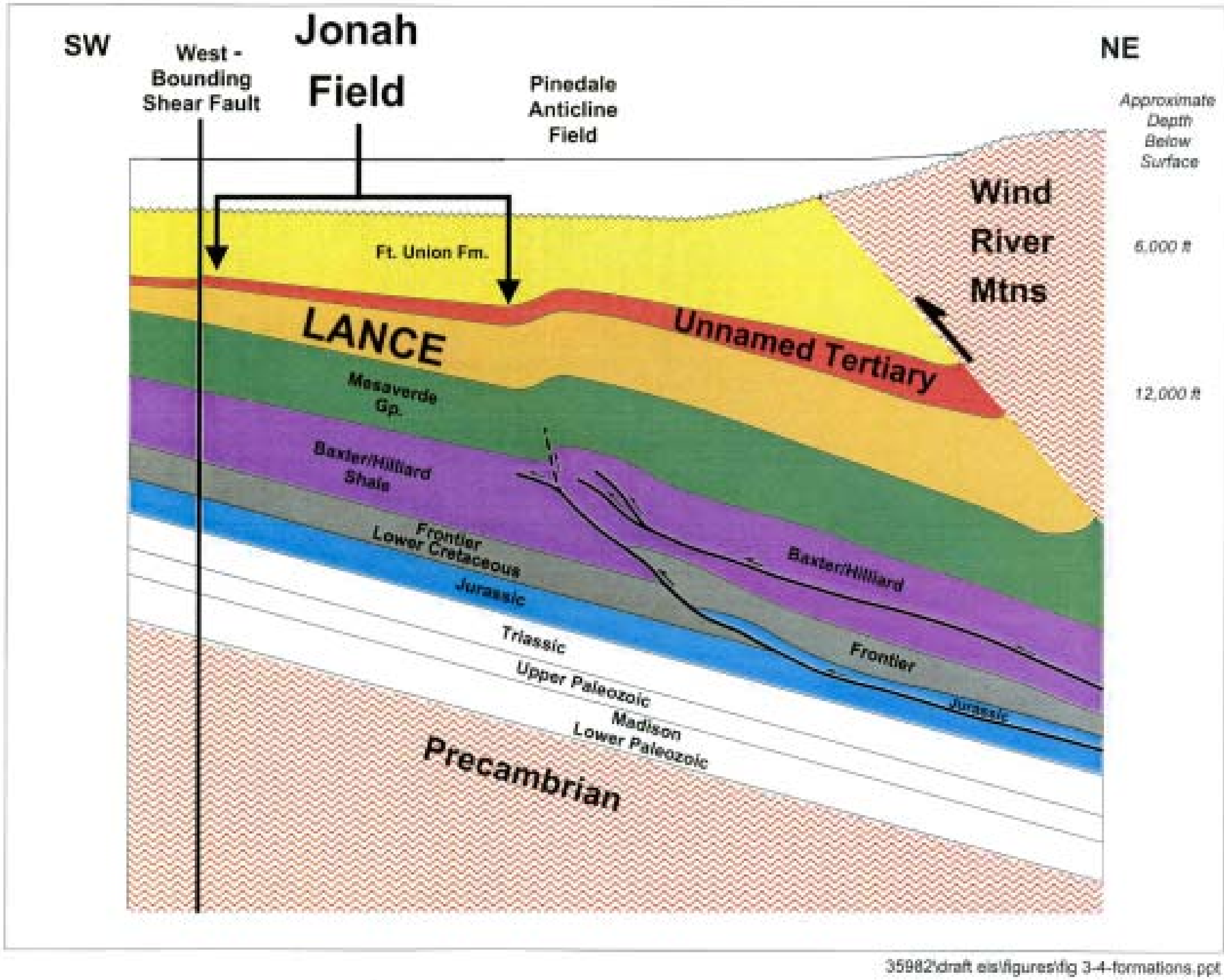
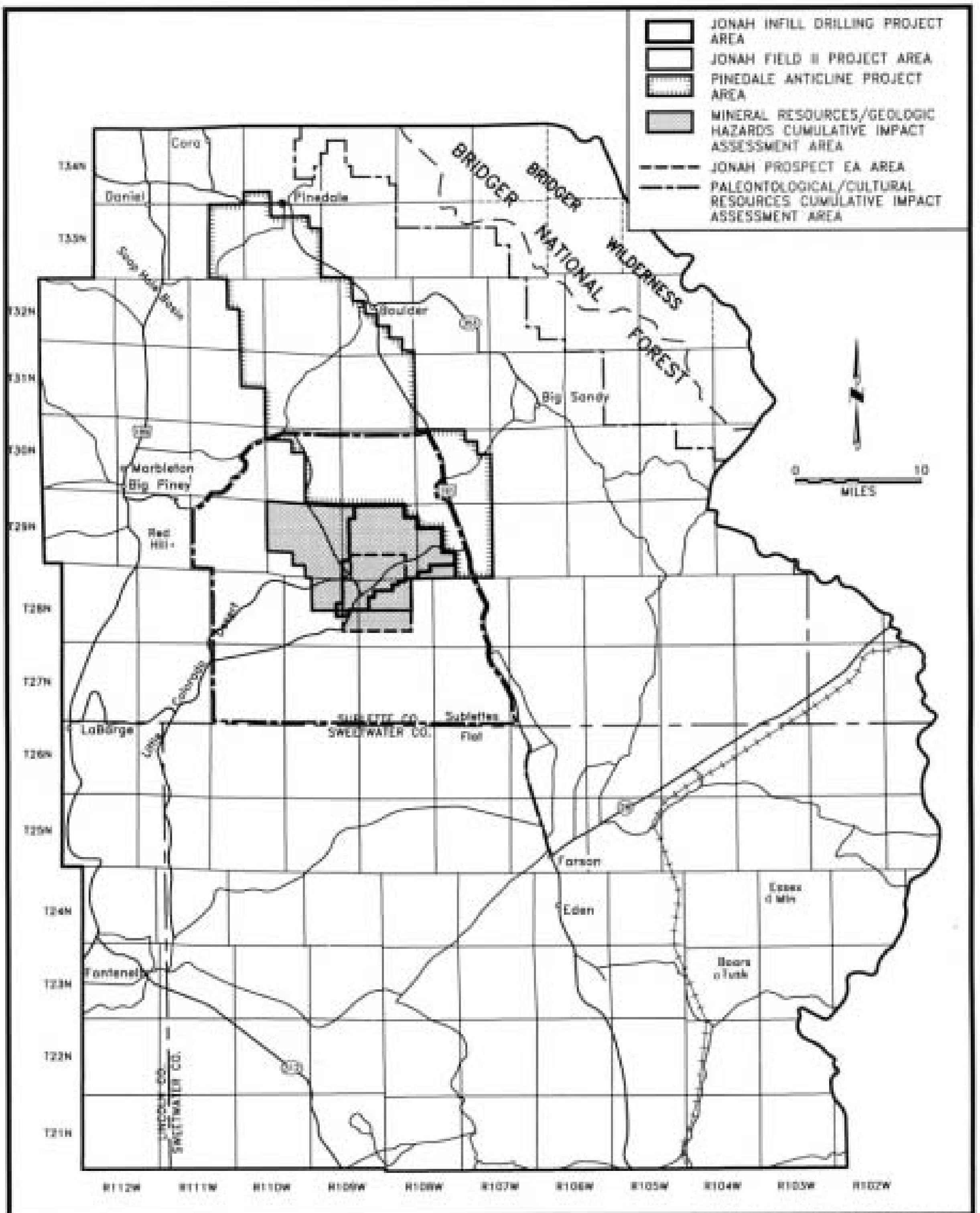
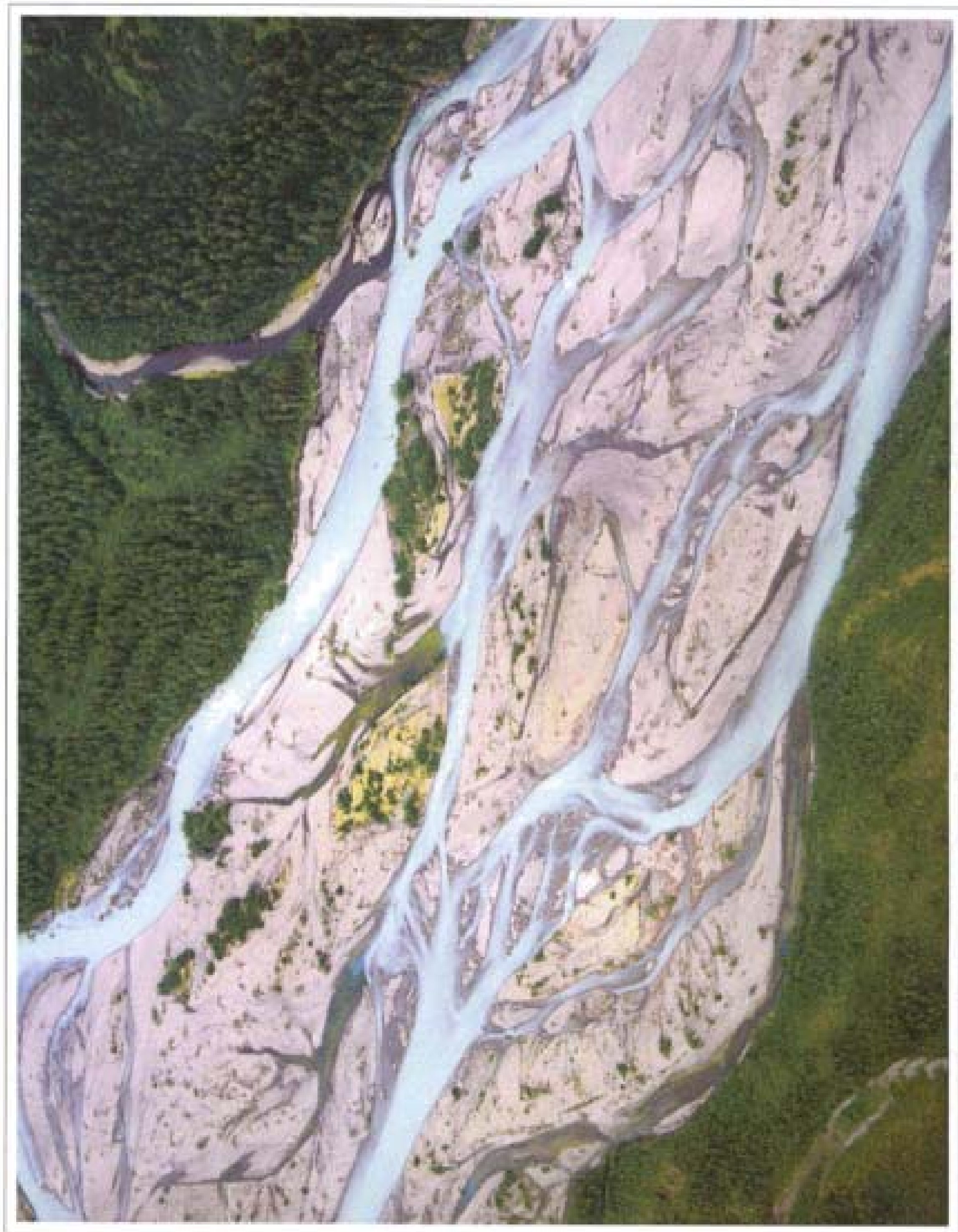


Figure 3.11 Formations Underlying the Jonah Infill Drilling Project Area, Sublette Country, Wyoming, 2005.



Map 3.5 Mineral Resources/Geologic Hazards and Paleontological/Cultural Resources Cumulative Impact Assessment Areas, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.



35983\eis\deis\figures\fig 3-5-typical braided stream.ppt

Figure 3.12 Typical Braided Stream.

Other mineral resources in the area include coal and sand and gravel. The JIDPA is located within the Green River Basin Coal Field (Jones 1991) and is underlain by coal-bearing rocks. However, the potential for coal development is low because coal beds are thin and too deep to be economically mined. Limited sand and gravel resources occur in the JIDPA, and these resources have been used for existing area developments (e.g., roads). No other minerals are known to occur in the JIDPA (Harris 1996, 1997; Hausel 1997).

3.1.4.2 Geologic Hazards

The geologic hazards CIAA covers the same 66,400 acres (103.8 square miles) as the mineral resources CIAA (see Map 3.5). Geologic hazards within the CIAA are generally as described below for the JIDPA.

All of Wyoming is seismically active, and the western quarter of the state is more active than the eastern three-quarters (Case 1997). The JIDPA is within an area where an earthquake could have an estimated peak acceleration of 16-20% gravity and an estimated 2,500-year recurrence interval. Earthquakes with acceleration of 16-20% gravity are equivalent to earthquakes with intensities of VII to VIII on the modified Mercali scale, which cause negligible to slight damage in well-designed buildings, slight to considerable damage in ordinary structures, and considerable to great damage in poorly built structures. In the western quarter of Wyoming, an intensity V earthquake (less intense than VII; windows broken, plaster cracked, objects overturned) can be expected to occur about every 1.5 years (Case 1997).

Numerous earthquakes have occurred in a north/south-trending belt between Big Piney and Evanston in recent years. An earthquake with a 3.3 magnitude (Richter scale) occurred within the area in 1978 (Case et al. 1995). The epicenter was located in the northern portion of T29N, R108W. The Continental Fault System and the Leckie Fault occur approximately 10 miles northeast of the JIDPA (Case 1997). It is not known whether these faults have been active in Quaternary times.

No landslides or active sand dunes are known to occur in the JIDPA (WyGISC 2003a), nor are there any known areas of subsidence (personal communication, October 1996, with Jim Case, Wyoming Geological Survey).

3.1.4.3 Paleontological Resources

The CIAA for paleontologic resources covers approximately 484.4 square miles (310,000 acres) on and surrounding the JIDPA (see Map 3.5). Approximately 3,331 acres of the CIAA have been disturbed primarily from existing oil and gas developments and associated road and pipeline networks. Forty-two percent of this disturbance (1,409 acres) occurs within the JIDPA, 1,388 acres are due to roads outside the JIDPA, 468 acres are due to well pads outside the JIDPA, and 66 acres are due to agricultural lands. Paleontologic resources within the CIAA are generally the same as described for the JIDPA, and 26 fossil localities are known from the CIAA (Erathem-Vanir Geological Consultants 1997). Vertebrate fossils, including mammalian species, are known from some of these localities. The localities occur on the Green River, Wasatch, and Bridger Formations.

The important fossil record of the Green River Basin is well known (BLM 1992; Grande 1984). Table 3.9 provides information on the various geologic formations present on and in the vicinity of the JIDPA and their paleontologic potential.

Table 3.9 Surface Geologic Formations Present on the Jonah Infill Drilling Project Area and Their Paleontologic Potential, Sublette County, Wyoming, 2005.[1]

Deposit[2]	Geologic Age	Type of Deposit/ Environment of Deposition	Thickness	Fossil Resources	Fossil Potential
Alluvial sediments	Holocene	Unconsolidated silts, sands of valleys and plains; terrestrial	<20 ft	None	Low
Terrace deposits	Pleistocene/ Holocene	Gravels, silts, and sands that predate current erosional cycle; terrestrial-fluvial	<40 ft	Pleistocene mammals	Moderate
Green River Fm Laney Mbr LaClede Bed	Middle Eocene	Chiefly oil shale, lesser algal limestone, sandstone, claystone, and tuff; lacustrine, accumulated during renewed expansion of Lake Gosiute	<100 ft	Vertebrates, invertebrates, trace fossils	High
Green River Fm Wilkins Peak Mbr (upper part)	Early-Middle Eocene	Chiefly brown or black oil shale interbedded with gray or green mudstone, evaporitic; lacustrine, deposited during re-expansion of Lake Gosiute (upper)	<150 ft	Vertebrates, invertebrates, plants	High
Wasatch Fm Alkali Creek or New Fork Tongue	Early Eocene	Interbedded brown, green, and gray sandstone, siltstone, mudstone, and shale, locally conglomeratic; chiefly terrestrial-fluvial to floodplain, some lacustrine	<100 ft	Vertebrates, invertebrates, plants	High

[1] Adapted from Erathem-Vanir Geological Consultants (1997).
[2] Fm = formation; Mbr = member; Ss = sandstone.

The Green River and Wasatch Formations contain fossils from each of the five biological kingdoms and is well-known for its abundant fish fossils (Grande 1984). The Laney Member of the Green River Formation is especially fossiliferous. Terrestrial mammalian fossils are not common because the Green River Formation was formed predominantly from lake deposits; however, reptile (crocodile, alligator, snake, lizard), amphibian (frog, salamander), bird (pelican, grouse, shorebird, and small perching bird), and insect and other invertebrate fossils have been recorded. Although uncommon, mammalian fossils, including marsupials, insectivores, primates, rodents, carnivores, and ungulates, have been recovered.

The fossil flora of the Laney Member is not well studied but includes sycamore, horsetail, and lily pads. Other members of the Green River Formation, however, include a diverse mixture of trees, shrubs, and flowers, suggesting that the fossil flora of the Laney Member may be more diverse than is now known. Insects and other invertebrates (gastropods, arthropods), algae, fungi, flagellates, and bacteria also have been recovered from the Green River Formation. A review of museum and university records and literature (Erathem-Vanir Geological Consultants 1997) indicated no known significant localities within the JIDPA, although two localities occur within 1.0 mile of the area. However, during past JIDPA developments, a few fossils of a Pleistocene horse (tentative identification) were discovered in JIDPA terrace deposits during construction of a well pad. It is likely that important fossils (including both Eocene and Pleistocene materials), are located in the JIDPA.

3.1.5 Soils

The CIAA for soil resources is the combined area of the 10 watersheds that drain the JIDPA (see Section 3.1.6). This CIAA covers approximately 328.6 square miles (210,300 acres) (Table 3.10, Map 3.6). Estimates of the types of soils most likely to be disturbed are based on coarse-scale Wyoming Gap Analysis soil information (Munn and Arneson 1999a, 1999b). Extant soils information for the CIAA (coarsely mapped) indicates that soil map units SU03 and SU05 are the predominant soil types in the area (see Table 3.10). Approximately 1.6% of the CIAA (3,354.7 acres) has been disturbed primarily by oil and gas developments and roads (Table 3.11) and approximately 42% of this disturbance (1,409 acres) exists as long-term disturbance in the JIDPA; no crop lands or residential areas are known to occur within the CIAA. The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance (991.5 acres), 4.2% of the watershed, and most of this disturbance (664.9 acres) is from existing natural gas developments in the JIDPA (see Table 3.11).

Seventeen soil mapping units (fine resolution mapping) occur within the JIDPA (Map 3.7 and Table 3.12) (ERO Resources Corporation 1988; Munn and Arneson 1999a, 1999b; BKS Environmental Associates, Inc. 2003; Natural Resources Conservation Service [NRCS] 2003). Table 3.12 lists the fine-scale soil map units, their JIDPA acreage, and soil use limitations and management considerations. Many of the soils within the JIDPA have characteristics that limit their suitability for road construction and may inhibit successful reclamation. The primary factors limiting soils use for road construction are shallow depth to rock, low strength, shrink-swell potential, frost action, flooding, and steep slopes. Reclamation potential is limited by alkalinity and salinity; excess stones, sand, clay, and/or lime; shallow depths; and steep slopes.

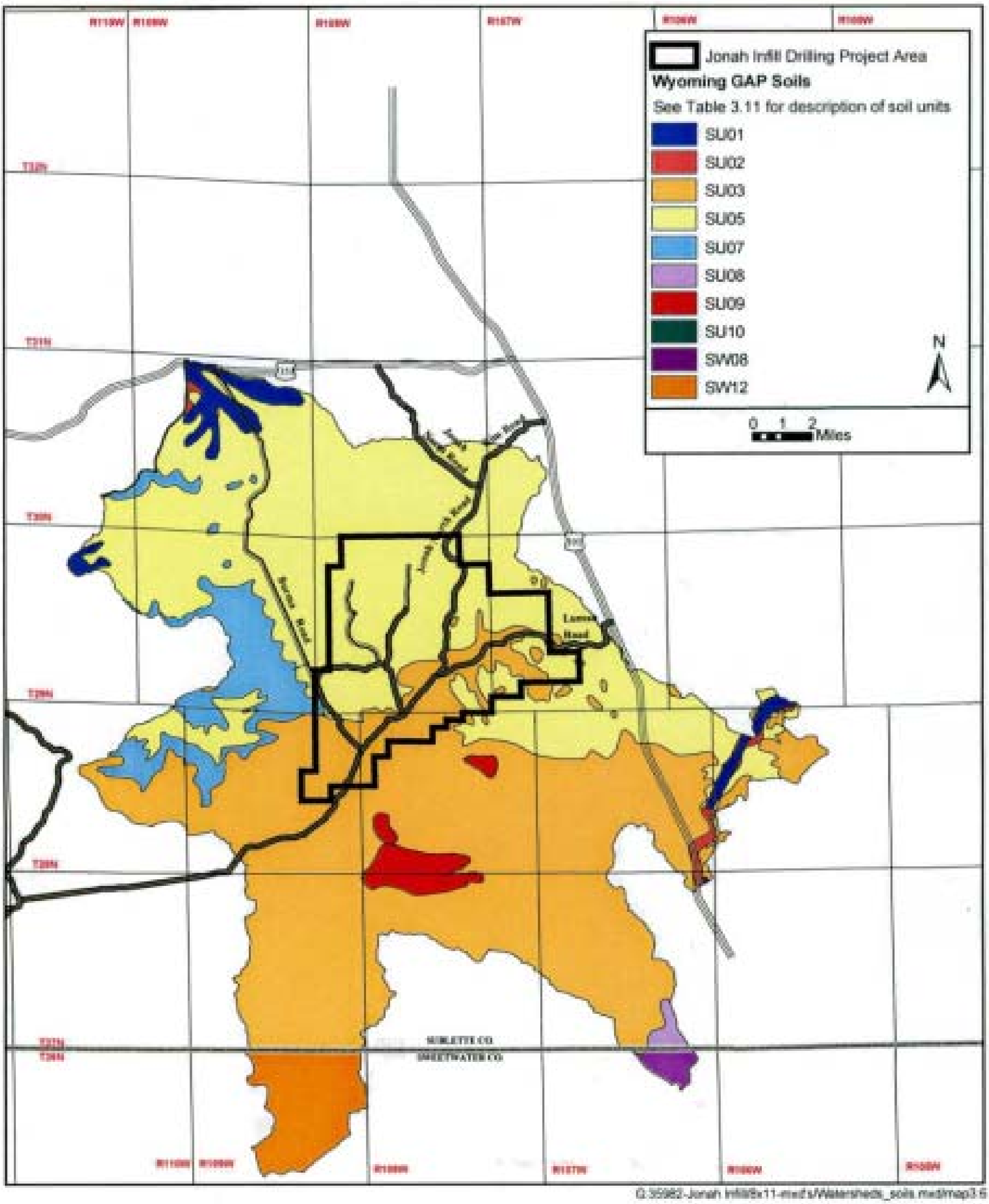
One known area of stabilized sand dunes and other aeolian (windblown) deposits occurs in the JIDPA (see Map 3.3) (Case and Boyd 1987), and it is likely that smaller areas of sand dunes or windblown deposits also occur in the area. The Spool Variant-Ouard Variant-San Arcacio Variant soil series (map unit 123) and Garsid-Terada-Langspring Variant complex (map unit 121) contain these features (Table 3.12; Maps 3.3 and 3.6). Stabilized dunes and other windblown deposits are usually very sandy and are highly susceptible to wind erosion. However, these soil types and/or known stabilized dunes are not common within the JIDPA and, where they do occur, they are limited in size and areal extent.

Major soils within the JIDPA include the Vermillion Variant-Seedskadee-Fraddle complex on 0-3% slopes (map unit 127); the Monte-Leckman complex on 1-6% slopes (map unit 106); the Fraddle-Ouard-San Arcacio Variant complex on 3-8% slopes (map unit 124); the Ouard-Ouard Variant-Boltus complex on 1-8% slopes (map unit 114); the Garsid-Monte Association on 1-6% slopes (map unit 119); the San Arcacio-Saguache association on 0-3% slopes (map unit 125); the Huguston-Horsley-Terada complex on 6-30% slopes (map unit 116); and the Haterton-Garsid complex on 1-8% slopes (map unit 113) (Table 3.12). These mapping units collectively cover approximately 78% of the JIDPA. The Cowestglen sand loam on 0-2% slopes (map unit 951/106) and the Monte-Leckman complex (map unit 106) on 1-6% slopes occur adjacent to drainage channels and on terraces and alluvial fans.

Table 3.10 Soil Types in the Soil Resources Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Wyoming, 2005.

Soil Map Unit[1]	Soil Type Description[1]	Total Acres	% of CIAA	Acres in JIDPA
SU01	Typic Torrifluvents, fine-silty and fine, mixed (calcareous), frigid-Typic Haplaquepts, fine-loamy and fine loamy over sandy or sandy-skeletal, mixed (calcareous), frigid	4,495	2.1	0
SU02	Aquic Haplustolls, coarse-loamy, mixed, frigid-Ustic Torriorthents, fine-loamy, mixed (calcareous), frigid-Typic Fluvaquents, fine-loamy, mixed (calcareous) frigid	899	0.4	0
SU03	Rock Outcrop-Typic Torriorthents, loamy, mixed (calcareous) frigid, shallow-Lithic Typic Torriorthents, loamy-skeletal, mixed (calcareous), frigid-Typic Natrargids, fine-loamy, mixed, frigid	93,700	44.6	9,913
SU05	Typic Torriorthents, loamy, mixed (calcareous) frigid, shallow-Typic Haplocalcids, coarse-loamy, mixed, frigid-Lithic Torriorthents, loamy-skeletal, mixed (calcareous), frigid	68,323	32.5	20,496
SU07	Ustic Torriorthents, fine loamy, mixed (calcareous), frigid-Ustic Torriorthents loamy, mixed (calcareous), frigid, shallow-Typic Haplocalcids, fine-loamy, mixed, frigid	20,229	9.6	91
SU08	Typic Haplosalids, fine, mixed, frigid-Typic Haplocambids, fine-silty, mixed, frigid	10,249	4.9	0
SU09	Typic and Lithic Torripsamments, mixed, frigid-Typic Torriorthents, loamy-skeletal, mixed, frigid-Rock Outcrop-Typic Haplocambids, loamy-skeletal, mixed, frigid	3,596	1.7	0
SW08	Typic Haplosalids, fine, mixed, frigid and Typic Haplocambids, fine-silty, mixed, frigid	1,079	0.5	0
SW12	Ustic Haplargids, fine-loamy and coarse-loamy, mixed, frigid-Ustic Haplocambids, sandy, mixed, frigid	7,730	3.7	0
Total		210,300	100.0	30,500

[1] Based on Munn and Arneson (1999a, 1999b).

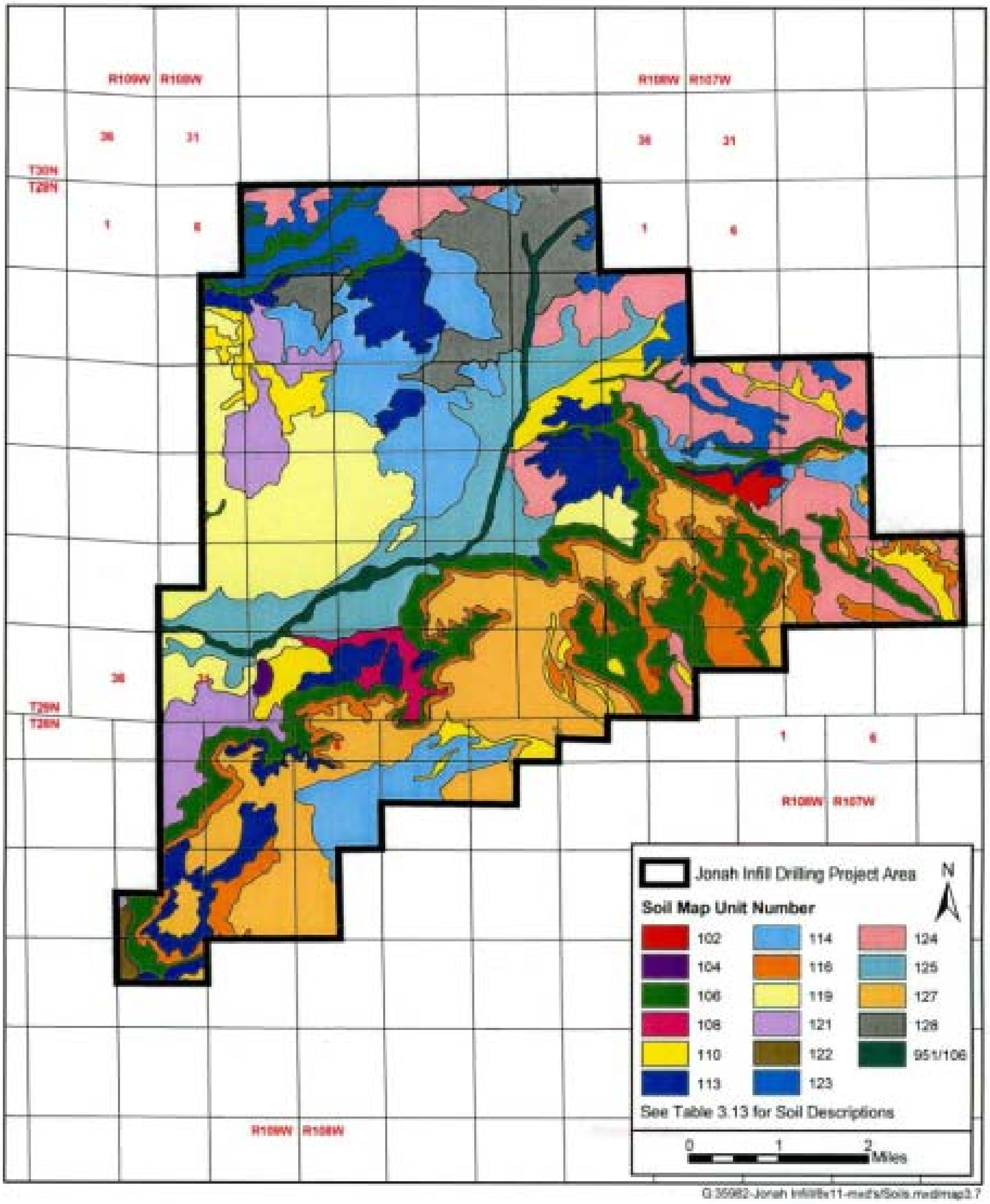


Map 3.6 Soil Types (Coarse-Scale) Within the Soils Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Wyoming, 2005.

Table 3.11 Existing Watershed Disturbance Acreage, Jonah Infill Drilling Project, Cumulative Impact Assessment Area, Wyoming, 2005.[1]

Type	Watersheds										
	Expanded Sand Draw-Alkali Creek	Granite Wash	Reduced Upper Alkali Creek-Green River	Upper Eighteenmile Canyon	Southeast New Fork River-Blue Ridge	North Alkali Draw	Big Sandy River-Bull Draw	Long Draw	Jonah Gulch	140401-040603	Total
Watershed Acreage	23,373	12,212	26,355	35,212	11,746	15,911	19,760	18,521	22,652	24,558	210,300
Disturbance in the JIDPA[2]											
	664.9	0.0	114.1	132.6	0.0	0.0	43.7	390.3	24.0	39.4	1,409.0
Disturbance Outside the JIDPA											
Wells [3]	4.0	0.0	8.0	56.0	0.0	12.0	0.0	8.0	12.0	12.0	112.0
Roads[4]											
Connecting road	0.0	1.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	4.4
Jeep trail	6.5	0.0	8.3	9.1	0.0	0.8	0.0	0.0	24.7	24.6	74.0
Neighbor-hood road	146.2	34.6	141.7	170.2	19.8	85.0	128.5	88.0	84.6	84.8	986.4
State highway	0.0	0.0	0.0	0.0	0.0	0.0	58.2	83.6	0.0	0.0	141.8
Other (new oil and gas roads)	169.9	0.4	80.6	241.8	0.0	0.0	30.2	101.6	5.6	0.0	630.1
Subtotal	322.6	36.0	230.6	421.1	23.2	85.8	216.9	273.2	114.9	109.4	1,833.7
Total Disturbance	991.5	36.0	352.7	609.7	23.2	97.8	260.6	671.5	150.9	160.8	3,354.7
% of Watershed Disturbed	4.2	0.3	1.3	1.7	0.2	0.6	1.3	3.6	0.7	0.7	1.6

1 Data gathered from WyGISC (2003b), WOGCC (2003), TRC Mariah (2004a, 2004b), and unpublished BLM aerial photography.
2 See Table 2.3.
3 Assumes 4 acres per well pad.
4 Road acreage based on 20-ft width for connecting roads, jeep trails, and neighborhood roads; 29-ft width for other roads; and 150-ft width for state highways.



Map 3.7 Soils Types (Fine-Scale) Within the Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Table 3.12 Soil Types[1], Soil Use, and Management Considerations for Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Map Unit No.	Map Unit Name	Use and Management Considerations	Acres
102	Langspring Variant-Langspring complex, 1-10% slopes	Gently sloping to nearly level mesa tops and uplands. Loamy uplands. Generally suitable for road construction. Rehabilitation limited due to excess lime and small stones.	149
104	Chrisman silty clay, 0 to 2% slopes	Saline upland sites, in closed basins. Construction activities limited due to severe shrink-swell properties. Rehabilitation potential limited by moderately alkaline soils.	42
106	Monte-Leckman complex, 1-6% slopes	Gently sloping alluvial fans and drainageways. Loamy, saline uplands. Mostly suitable for road construction. Rehab limited by excess sands or small stones.	3,488
108	Dines-Clowers-Quealman complex, 0-3% slopes	Nearly level to gently sloping drainageways and alluvial terraces. Loamy sites, saline uplands. Limited for road construction due to low strength. Rehabilitation potential limited by excess salt, sand, and small stones.	268
110	Fraddle-Tresano complex, 1-8% slopes	Rolling uplands, upper dissected fans, and valley-filling slopes. Loamy uplands. Limited for construction activities and reclamation due to thin soils.	1,541
113	Haterton-Garsid complex, 1-8% slopes	Nearly level to gently sloping uplands and sideslopes. Shallow loamy and loamy sites. Construction limited by shallow depth to bedrock, slope, and low strength. Rehabilitation limited by shallow depth to bedrock and steep slopes.	2,102
114	Ouard-Ouard Variant-Boltus complex, 1-8% slopes	Nearly level to gently sloping uplands. Shallow loamy, shallow clayey, and shaley sites. Limited due to low strength and shallow depth to bedrock. Rehabilitation limited due to thin soils.	3,132
116	Huguston-Horsley-Terada complex, 6-30% slopes	Gently sloping to moderately steep sideslopes and rolling uplands. Shaley and loamy sites. Limited due to shallow depth to bedrock, low strength, and steep slopes. Rehabilitation limited by shallow depths and slopes.	2,109
119	Garsid-Monte association, 1-6% slopes	Gently undulating uplands. Loamy sites. Construction limited by thin soils, low strength, and steep slopes. Rehabilitation limited by steep slopes.	3,087
121	Garsid-Terada-Langspring Variant complex, 1-6% slopes	Undulating uplands. Loamy sites. Construction limited due to thin soils, low strength, and steep slopes. Rehabilitation limited by steep slopes, small stones, and excess lime.	1,261
122	Baston-Boltus-Chrisman association, 0-6% slopes	Undulating and dominantly concave uplands. Clayey, shaley, and saline upland sites. Construction limited by low strength, shrink-swell potential, thin soils, and steep slopes. Rehabilitation limited by thin soils, clayey textures, excess salt and steep slopes.	85
123	Spool Variant-Ouard Variant-San Arcacio Variant complex, 4-25% slopes	Gently sloping to steep sideslopes and rolling uplands. Shallow sandy, shallow clayey and loamy sites. Construction limited by shallow depth to bedrock and low strength. Rehabilitation limited by shallow depths, small stones, sandy or clayey textures, or steep slopes.	1,260
124	Fraddle-Ouard-San Arcacio Variant complex, 3-8% slopes	Rolling uplands. Loamy and shallow loamy sites. Construction limited by thin soils and low strength. Rehabilitation limited by thin soils, clayey textures, or small stones.	3,194
125	San Arcacio-Saguache association, 0-3% slopes	Old floodplains, fans, and terraces. Loamy and sandy sites. Generally suitable for road construction. Rehabilitation limited by small stones.	2,304
127	Vermillion Variant-Seedskadee-Fraddle complex, 0-3% slopes	Nearly level uplands and mesas. Shallow loamy and loamy sites. Limited for construction due to shallow depth to bedrock, low strength, and thin soils. Rehabilitation limited by stoniness, excess lime, and thin soils.	4,427
128	Fraddle-Ouard-San Arcacio Variant complex, 0-3% slopes	Nearly level upland surfaces. Loamy and shallow loamy sites. Construction limited by low strength and shallow depth to bedrock. Rehabilitation limited by thin soils and small stones.	1,645
951/106	Cowestglen sandy loam, 0-2% slopes/see also Map Unit 106, above	Nearly level drainage ways. Road construction potentially limited by moderate frost action and flooding. See also Map Unit 106, above.	406
Total			30,500

[1] Adapted from: ERO Resources Corporation (1988) and BKS Environmental Associates Inc. (2003).

Several soils (i.e., Monte-Leckman [map unit 106], Fraddle-Tresano [map unit 110], Garsid-Monte [map unit 119], and Baston-Boltus-Chrisman [map unit 122] complexes/associations) may be good sources for topsoil (ERO Resources Corporation 1988) (see also Appendix G). The Spool Variant-Ouard Variant-San Arcacio Variant (map unit 123), the Fraddle-Ouard-San Arcacio Variant (map unit 124), and the San Arcacio-Saguache (map unit 125) complexes/associations may be good gravel sources. The San Arcacio soils are also considered to be archaeologically sensitive in that they contain intact buried cultural resources.

The Chrisman silty clay soil (map unit 104) is typically fine-textured and formed in thick clayey local alluvium in closed basins and is susceptible to high shrink-swell potential that may limit road construction activities (ERO Resources Corporation 1988).The extent of erosion in the JIDPA is currently undefined. However, the relatively flat nature of the area, desert-like precipitation patterns, and BLM's requirements for the use of BMPs to limit erosion are assumed to limit the extent of erosion in the area. Nonetheless, the BLM has determined that additional erosion/soil loss modeling will be performed for the JIDPA. The results of this modeling will be available in the Final EIS for this Project.

The Transportation and Reclamation Plans (Appendix G) contain further information on soil characteristics, suitability for road construction and reclamation, use and management considerations, and criteria for establishing soil suitability for various uses.

3.1.6 Water Resources

3.1.6.1 Surface Water

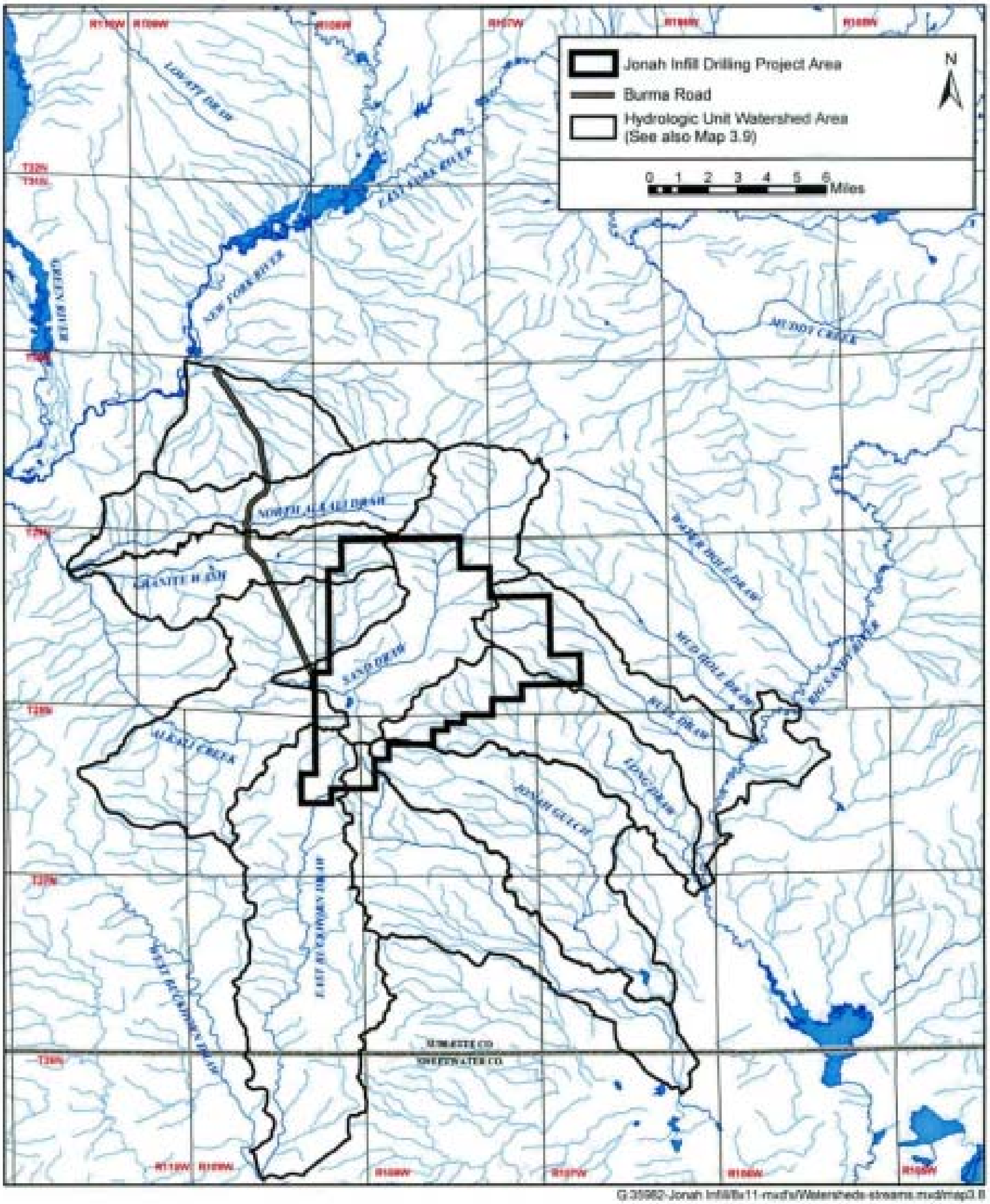
The CIAA for surface water resources is the combined area of the 10 watersheds that drain the JIDPA, which encompass approximately 328.6 miles (210,300 acres) (see Table 3.13 and Maps 3.8 and 3.9). Approximately 1.6% of the CIAA (3,354.7 acres) has been disturbed primarily by oil and gas developments and roads (see Table 3.11). The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance--4.2% of the watershed (991.5 acres)--and most of this disturbance (664.9 acres) is from existing natural gas developments in the JIDPA (see Table 3.11).

The JIDPA lies within the Upper Green River Basin and is part of the Colorado River drainage system. The entire JIDPA is drained by intermittent and ephemeral streams; there are no perennial streams or springs in the area. However, there are two playas and several reservoirs and stockponds constructed in ephemeral washes that may contain water for all or a part of some years. The nearest flowing perennial water bodies to the JIDPA are the Big Sandy, New Fork, and Green Rivers (see Map 3.8).

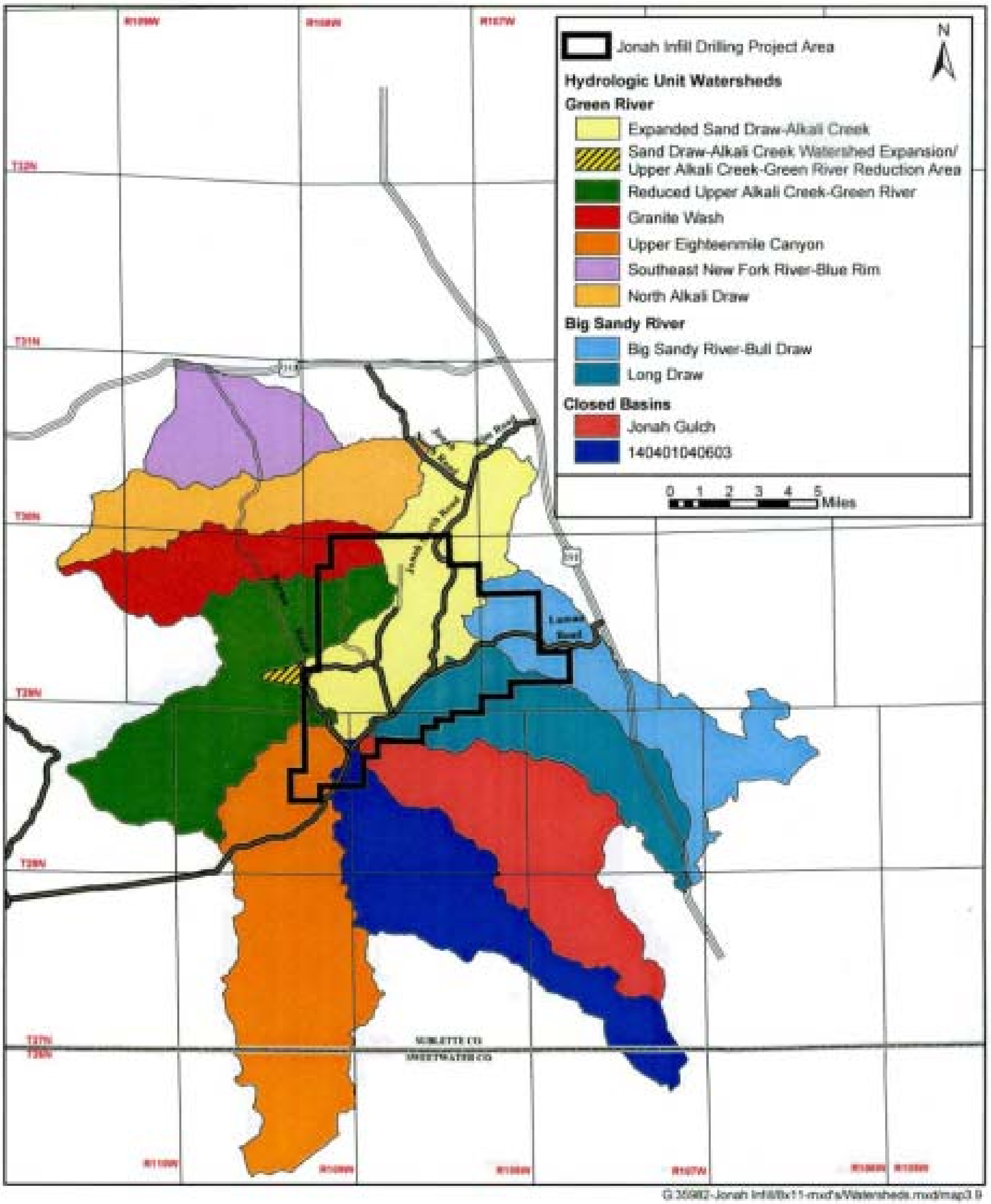
The Colorado River Basin Salinity Control Forum is a cooperative effort between federal agencies and seven states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) to address the problem of increasing salinity in the lower reaches of the Colorado River. Salinity has long been recognized as one of the major problems of the river. Salts contained within sedimentary rocks throughout the basin are easily eroded, dissolved, and transported into the river system, with salt-loading resulting from natural processes (i.e., saline springs, groundwater discharge into the river system, erosion and the concentrating effects of evaporation and transpiration) and human-caused processes (i.e., irrigation return waters, reservoir evaporation, municipal and industrial discharges) (Colorado River Basin Salinity Control Forum 2002).

Table 3.13 Watershed Acreages, Jonah Infill Drilling Project, Wyoming, 2005.

Major Drainage/Watershed	Total Acreage of Watershed	Acres within JIDPA	Percent of JIDPA in Watershed	Percent of Watershed in JIDPA	Watershed Acreage Along Burma Road (Outside JIDPA)
Green River/New Fork River					
Expanded Sand Draw-Alkali Creek	23,373	13,724	45.0	58.7	2
Granite Wash	12,212	1,312	4.3	10.7	5
Reduced Upper Alkali Creek-Green River	26,355	3,782	12.4	14.4	9
Upper Eighteenmile Canyon	35,212	1,958	6.4	5.6	0
Southeast New Fork River-Blue Rim	11,746	--	--	--	13
North Alkali Draw	15,911	--	--	--	6
Subtotal	124,809	20,776	68.1	16.6	35
Big Sandy River					
Big Sandy River-Bull Draw	19,760	3,630	11.9	18.4	0
Long Draw	18,521	5,028	16.5	27.1	0
Subtotal	38,281	8,658	28.4	22.6	0
Closed Basin					
Jonah Gulch	22,652	318	1.0	1.4	0
140401040603	24,558	748	2.5	3.0	0
Subtotal	47,210	1,066	3.5	2.3	0
Total	210,300	30,500	100.0	14.5	35



Map 3.8 Surface Water Resources in the Jonah Infill Drilling Project and Associated Cumulative Impact Assessment Areas (Project-affected Watersheds), Jonah Infill Drilling Project, Wyoming, 2005.



Map 3.9 Cumulative Impact Assessment Area (Project-affected Watersheds) for Surface Water, Soils, Vegetation, and Fisheries, Jonah Infill Drilling Project, Wyoming, 2005.

The purpose of the Colorado River Basin Salinity Control Forum is to provide information necessary to comply with Section 303(a) and (b) of the *Clean Water Act* and to meet national, international, and state water quality objectives (Colorado River Basin Salinity Control Forum 2002). The following measures have been identified to reduce salt loading in the Colorado River Basin:

- implementation of management practices that minimize soil disturbances, repair disturbed surface environments, and protect water quality;
- prevention of nonpoint-source salt mobilization through land-use planning, permit stipulations, land-use authorizations, best management practices, watershed protection strategies, and ecological restoration;
- control of point sources such as saline springs and seeps and abandoned flowing wells (i.e., well plugging) that yield saline water;
- implementation of water quality monitoring and analysis to assess the effectiveness of management practices;
- implementation of vegetation management practices that improve vegetative cover (i.e., control burns, reclamation, revegetation), control noxious weed infestations, and improve or repair riparian areas thereby decreasing the amount of runoff and soil erosion and the potential amount of salt leaving an area; and
- implementation of construction and maintenance activities such as road and trail maintenance and closures, protective fencing and access control, development of springs and water sources to improve livestock distributions, and erosion control and sediment-trapping structures (Colorado River Basin Salinity Control Forum 2002).

Portions of 10 watersheds occur within the JIDPA and/or along the Burma Road--Expanded Sand Draw-Alkali Creek, Granite Wash, Reduced Upper Alkali Creek-Green River, Big Sandy River-Bull Draw, Long Draw, Upper Eighteenmile Canyon, Jonah Gulch, 140401040603, North Alkali Draw, and Southeast New Fork River-Blue Rim (Map 3.9 and Table 3.13) (WyGISC 2003). The Sand Draw-Alkali Creek and Upper Alkali Creek-Green River watershed boundaries were modified and renamed to reflect more accurate hydrologic boundaries, and the New Fork River-Blue Rim watershed was reduced in size and renamed to the Southeast New Fork River-Blue Rim watershed for this project to eliminate drainage areas north of the New Fork River. The Expanded Sand Draw-Alkali Creek, Granite Wash, Reduced Upper Alkali Creek-Green River, and North Alkali Draw watersheds drain to the Green River (below the confluence with the New Fork River), approximately 12 miles west of the JIDPA. The Upper Eighteenmile watershed also drains into the Green River approximately 35 miles south of the JIDPA. The Southeast New Fork River-Blue Rim watershed drains north to the New Fork River. The Big Sandy-Bull Draw and Long Draw watersheds drain to the Big Sandy River located approximately 5 miles southeast of the JIDPA. The Jonah Gulch and 140401040603 watersheds drain to a closed basin approximately 15 miles southeast of the JIDPA.

Approximately 45% of the JIDPA is drained by the Expanded Sand Draw-Alkali Creek watershed (13,724 acres in the JIDPA), which includes Sand Draw and many other small ephemeral washes (see Maps 3.8 and 3.9 and Table 3.13). The northwest portion of the JIDPA is drained by the Granite Wash watershed (1,312 acres in the JIDPA), which includes Granite Wash, small ephemeral washes, and Wild Horse Reservoir. The Reduced Upper Alkali Creek-Green River watershed drains approximately 3,782 acres of western portions of the JIDPA. The southern portion of the JIDPA is drained by three watersheds--Upper Eighteenmile Canyon, 140401040603, and Jonah Gulch. The Upper Eighteenmile Canyon watershed (1,958 acres in the

JIDPA) includes the south side of Yellow Point Ridge and East Buckhorn Draw. The portions of the Jonah Gulch (318 acres) and 140401040603 (748 acres) watersheds contained in the JIDPA consist of small ephemeral channels. Eastern portions of the JIDPA are drained by the Long Draw (5,028 acres) and Big Sandy River-Bull Draw (3,630 acres) watersheds (see Table 3.13). The 12 miles of the Burma Road outside the JIDPA crosses approximately 0.6 mile of the Expanded Sand Draw-Alkali Creek watershed (2 acres); 3.1 miles of Reduced Upper Alkali Creek-Green River watershed (9 acres); 1.9 miles of the Granite Wash watershed (5 acres); 2.0 miles of the North Alkali Draw watershed (6 acres); and 4.4 miles of the Southeast New Fork River-Blue Rim watershed (13 acres) (see Table 3.13).

The current PFO RMP indicates that Sand Draw and Alkali Creek are prone to flooding (BLM 1987a, 1987b). However, flooding may occur in any of the ephemeral draws within the JIDPA after rainstorms. Drainages within the JIDPA flow only periodically in response to rain and snowmelt events, having extended periods of no flow (most of the year).

Surface Water Quality

Alkali Creek, Sand Draw, Granite Wash, and all other named and unnamed streams in the JIDPA are Class 3B surface waters (WDEQ/WQD 2001). Class 3B waters are tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies. They are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna. Uses designated on Class 3B waters are for aquatic life (other than fish), recreation, wildlife, industry, agriculture, and scenic value.

Down-channel of the JIDPA, the Big Sandy and New Fork Rivers are Class 2AB waters (i.e., waters known to support game fish populations and where a game fishery and drinking water use is attainable) (WDEQ/WQD 2001). Uses designated for Class 2AB waters include those listed above for Class 3B plus drinking water, game and non-game fish, and fish consumption, and these waters are protected for all these uses. The Green River, downstream from the New Fork River is also Class 2AB.

Section 303(d) of the *Clean Water Act* requires states to identify waters that are not supporting their designated uses and/or that need to have a total maximum daily load established to support their uses. There are no streams within the JIDPA or CIAA that are on the State of Wyoming's 2004 Section 303(d) list or included in the 2004 305(b) Report (WDEQ 2004).

The quantity of sediment and associated salt loads within ephemeral flows from the JIDPA is unknown. However, Alkali Creek and several associated watersheds have been listed as salinity concerns under the designation of “Long Island Watershed.” Stream surveys of Alkali Creek down stream from the JIDPA have noted drops in the channel base level (headcuts) that, while not within the immediate area of the JIDPA, have the potential to be affected and eventually affect the channels within the JIDPA as well as the salt and sediment loads coming from the affected watersheds. Efforts are underway to address the headcuts and their effects.

Due to the extent of proposed surface disturbance and topographic modification in the JIDPA for the LOP, BLM has determined that runoff condition modeling, including sediment and salt loading, will be performed for the JIDPA, and the results of this modeling will be available in the Final EIS for this project.

Surface Water Use

Five adjudicated and numerous unadjudicated surface water rights occur in the JIDPA (State Engineer's Office 2004). The major surface water uses in the JIDPA are for livestock and wildlife watering. Numerous impoundments and playas (internally drained, closed basins that periodically hold water) occur throughout the area. Several reservoirs (e.g., Warden, Lumen, Granite, Wild Horse, Sand Draw No. 4) have been constructed along drainages and may semipermanently, seasonally, or temporarily hold water. There are approximately 22 stock ponds scattered throughout the area. One large playa is located on private surface in Section 32, T29N, R108W. Other smaller playas or depressions occur throughout the JIDPA. No irrigation occurs on the JIDPA.

3.1.6.2 Ground Water

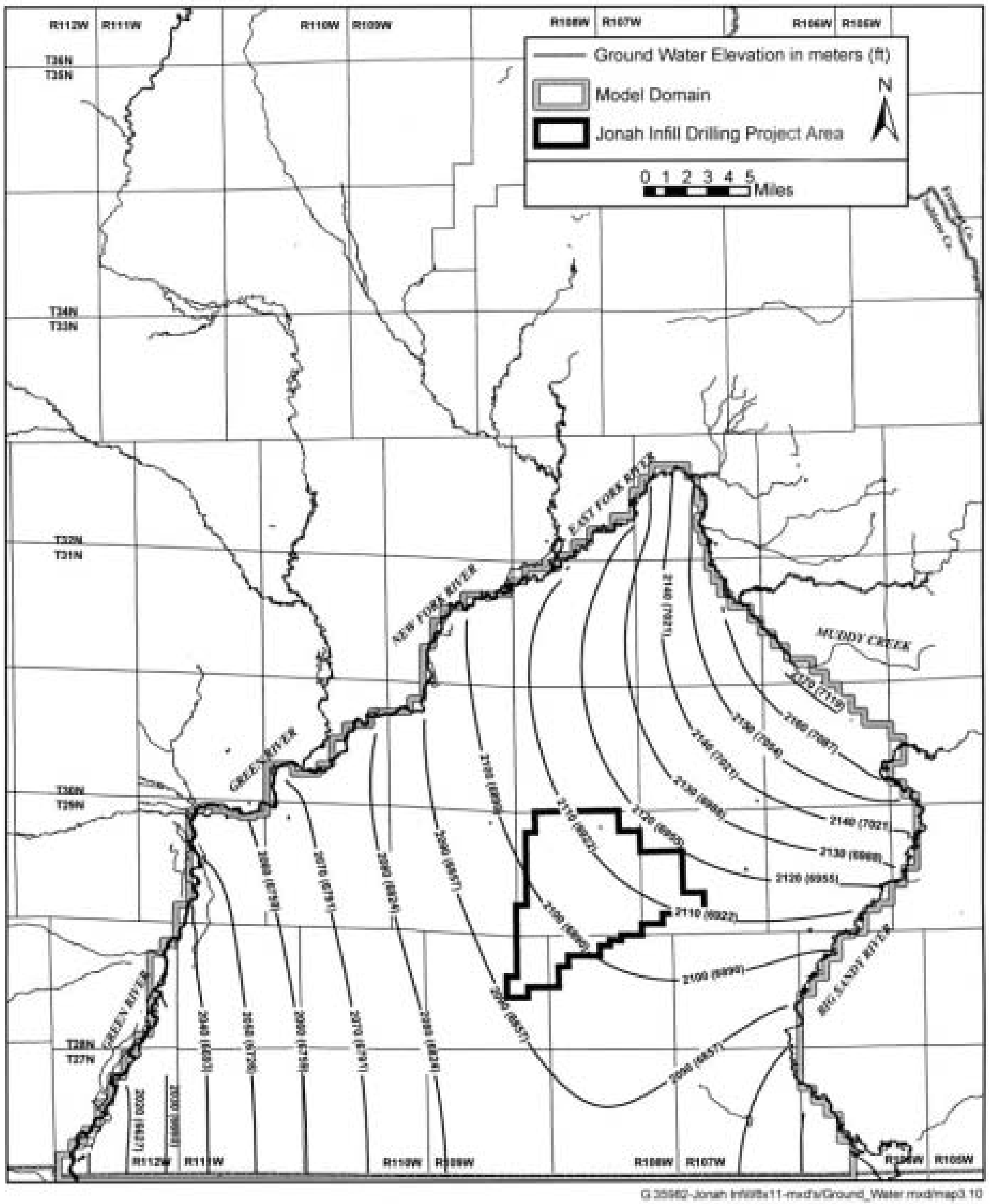
The JIDPA and associated ground water CIAA (i.e., the JIDPA and adjacent potential draw-down areas) are underlain, in descending order, by the Laney and Wilkins Peak Members of the Green River Formation or the Wasatch Formation, the Fort Union Formation, an unnamed Tertiary bed, and the Lance Formation (Dynamac Corporation 2002) (see Figure 3.11). The Laney and Wilkins Peak Members of the Green River Formation contain small quantities of water (Welder 1968; Ahern et al. 1981). The Wasatch and Fort Union Formations underlying the JIDPA and the surrounding region are known to contain significant amounts of water. Unconfined aquifers occur within about 300 ft of the surface and include the upper portions of Tertiary sedimentary rocks. Confined aquifers include the lower portions of Tertiary rocks (below about 300 ft) and all underlying strata (Welder 1968). Lenses of impermeable rock occur throughout these formations, creating perched aquifers and localized aquitards (areas with restricted flows) (personal communication, November 2003, with Dennis Doncaster, BLM).

The JIDPA and ground water CIAA are located on a recharge area for the Tertiary formations, and the main sources of recharge are precipitation and seepage from streams and reservoirs (Dynamac Corporation 2002). Ground water discharge occurs through transpiration, seepage into streams, and pumping. Ground water flow is predominantly from north to south, with a minor westerly component (Dynamac Corporation 2002); HydroGeo, Inc. (2004) indicates a northeast to southwest ground water flow. Estimated steady-state ground water levels (i.e., with no pumping), show that ground water levels slope gently from 7,100 ft in elevation in the northeast to 6,600 ft in elevation in the southwest (Map 3.10) (HydroGeo, Inc. 2004).

The Laney Member has good potential for ground water production (1-75 gallons per minute [gpm]), and well yields from the Wasatch Formation aquifer range from 1 to 3,000 gpm but typically less than 500 gpm (Ahern et al. 1981). The Fort Union Formation is deeply buried in the JIDPA so well yield data are not available. The Lance Formation produces non-potable water as a byproduct of hydrocarbon production (referred to as produced water).

Ground Water Quality

The standard for total dissolved solids (TDS) in drinking water is 500 mg/l (WDEQ 1990), and much of the ground water in the area exceeds this standard. TDS is used as a general measurement of ground water condition, but does not cover all aspects of water quality. Sandstones in the Green River and Wasatch Formations contain fresh to brackish water, with TDS concentrations of 500 to 100,000 mg/l. Ground water tends to become more mineralized with increasing depth below the surface. Ground water in the Laney Member of the Green River



Map 3.10 Estimated Steady-State Ground Water Levels (Potentiometric Surface), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Formation contains 2,000-7,000 mg/l TDS. Sodium and sulfate are the main salts, and calcium concentrations are high. Water quality in the Wilkins Peak Member is typically poor, with TDS concentrations of 7,000-100,000 mg/l. Sodium bicarbonate and sodium carbonate are the dominant ions (Welder 1968; Ahern et al. 1981). Ground water quality in the Wasatch aquifer is highly variable and tends to decline with distance from recharge areas. These waters are predominantly a calcium-bicarbonate type where, toward the basin center, sodium and chloride replace calcium (Bruce 1993). To a depth of about 2,300 ft, ground water in the Wasatch Formation has a TDS content of about 640 mg/l. At a depth of 5,000 ft, TDS concentrations are about 21,000 mg/l; this disparity suggests that these waters occur in different aquifers within the Wasatch Formation (personal communication, November 2003, with Frank Bain, BLM).

Natural gas well logs from existing wells in the JIDPA indicate that the Fort Union and Lance Formations contain discrete water-bearing sandstones, with water quality ranging from brackish to saline and TDS typically averaging 2,000-5,000 mg/l, within the range of 1,722 to 28,476 mg/l (Table 3.14). The ground water standards for TDS are 500 mg/l for domestic use, 2,000 mg/l for agricultural use, and 5,000 mg/l for livestock use, so untreated produced water is not suitable for domestic use, is only marginally suited for agricultural, but is suitable for livestock use.

Chloride concentrations in produced waters exceeded state ground water standards for domestic and agricultural use and for livestock use in three of the wells tested. Chloride concentrations range from 290 to 18,300 mg/l (see Table 3.14), whereas the standard for domestic use is 250 mg/l, for agricultural use is 100 mg/l, and for livestock use is 2,000 mg/l.

Iron concentrations also exceeded standards for domestic use (0.3 mg/l) and agricultural use (5.0 mg/l) in at least 18 and 13 of the wells sampled, respectively.

<u>Ground Water Use</u>

Ground water in the JIDPA and CIAA contributes only a small fraction (less than 2.5%) of the water used in the Green River Basin (Ahern et al. 1981). Ground water in the JIDPA and CIAA primarily is used for oil and gas development and stock and wildlife watering. More than 130 recognized ground water wells/ground water permits occur in the JIDPA, the majority of which are for existing oil and gas development use (State Engineer's Office 2004). The location of ground water wells is provided in Chapter 4 (see Map 4.1). No ground water irrigation occurs in the JIDPA or CIAA.

3.1.7 Noise and Odor

The noise CIAA includes the JIDPA and surrounding 20-mile area. Noise levels depend on the loudness and pitch of the source, the listener's distance from the source, air temperature, humidity, turbulence, wind gradient, and the screening effects of terrain. Existing natural gas development activities in the JIDPA generate noise through wellpad, road, and pipeline construction; flaring, drilling, and facility operations; vehicle traffic; and site reclamation. Drilling rig and well testing (fracturing and flaring) operations produce noise levels of up to 115 A-weighted decibels (dBA) (constant exposure endangers hearing), with a noise level of 55 dBA (which is considered quiet) at 3,500 ft (0.66 mile) from the source (BLM 1991b). Typical natural gas development noise levels are provided in Figure 3.13, and Table 3.15 provides example noise levels for commonly heard sounds. Flaring (one component of completion operations) tends to be the loudest noise event; however, with the use of flowback separators, noise from completion operations is reduced to approximately 64 dBA at the source.

Table 3.14 Produced Water Quality, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

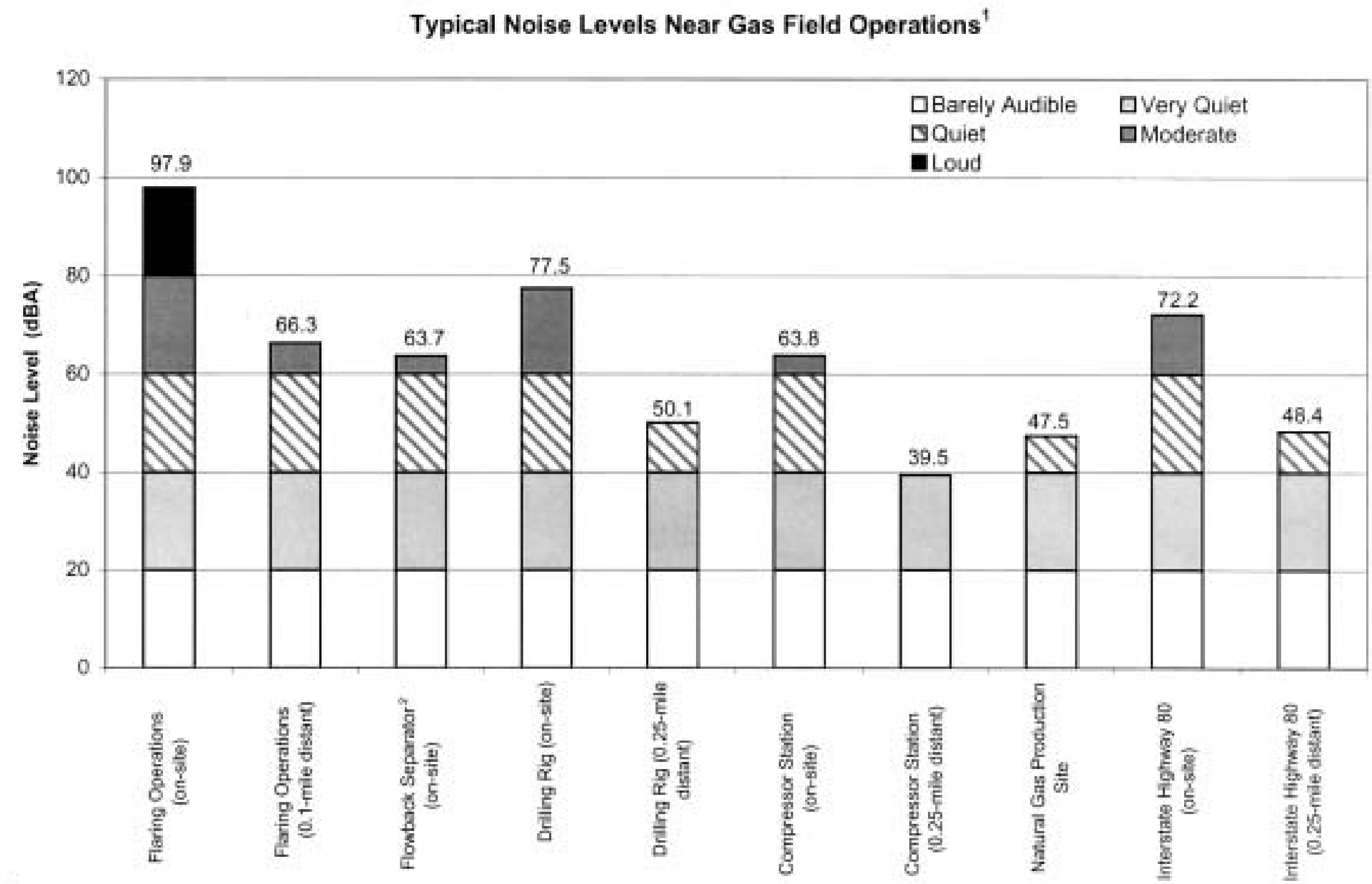
Constituent	Evaporation Pond	Well No.												
		SHB 3-34	JF 1-5X	YP 2-1	JF 2-8X	CAB 2-25	SHB 2-33	YP 4-24	SHB 4-34	JF 5-4	SHB 7-35	JF 4-18	SHB 5-34	YP 8-13
pH	7.80	6.50	7.72	7.81	7.06	7.63	7.71	7.45	7.81	7.94	7.48	7.91	7.79	8.05
Chloride	2,153	18,300	520	470	480	970	460	2,329	470	430	1,520	430	710	350
Sulfate	51	5.00	99	12	11	58	29	128	33	30	29	45	58	18
TDS	4,752	28,476	3,004	3,208	2,694	3,656	2,486	6,434	3,200	2,752	3,746	2,634	3,126	2,462
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	747	139	1,148	1,441	934	961	907	1,121	1,308	1,148	552	1,201	1,121	1,174
Conductivity	6,950	39,100	3,850	4,060	3,350	4,690	3,200	7,770	4,170	3,650	5,710	3,450	4,210	3,250
Sodium	1,051	3,190	964	1,040	839	1,090	801	1,180	1,025	900	1,050	878	992	793
Potassium	83.0	7,304	41.3	17.9	28.5	32	20.7	81.5	43.2	17.7	35.1	12.0	61.1	7.80
Calcium	651	6,850	22.5	11.9	12.2	11.6	12.3	9.31	17.6	9.45	22.0	6.92	17.9	6.50
Magnesium	6.02	18.1	4.23	2.04	1.4	1.25	1.13	1.92	2.64	1.69	3.88	0.6	2.81	1.06
Iron	<2.09	58.5	43.5	4.97	54.4	60.3	15.5	9.48	<0.68	<0.68	<0.68	9.48	4.7	<0.68
Barium	6.01	6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	2.67	--	--	--	--	--	--	--	--	--	--	--	--	--

[1] Data provided by EnCana. See also Appendix G.

Table 3.14 (continued)

	Well No.												
Constituent	YP 9-12	YP 10-11	CSHB 10-31	JF 11-7	SHB 11-20	SHB 11-28	CAB 12-19	SHB 12-27	SHB 13-17	SHB 13-32	CAB 14-30	SHB 16-26	SHB 31-36
pH	6.38	7.87	8.00	8.00	7.97	7.90	7.95	7.94	8.07	7.78	7.52	8.05	8.07
Chloride	1,500	290	600	340	1,300	1,150	910	450	2,100	950	390	790	960
Sulfate	15	23	34	29	48	63	45	34	24	16	49	7	30
TDS	2,848	2,154	3,552	2,192	4,740	4,260	2,996	2,850	5,084	2,088	1,722	2,954	4,062
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	214	854	1,521	881	1,575	1,201	827	1,041	623	240	534	694	1,201
Conductivity	4,850	2,670	4,640	2,890	6,620	5,860	4,500	3,600	5,530	2,760	2,420	4,010	5,100
Sodium	884	640	1,160	654	1,540	1,280	993	854	1,470	630	535	868	1,120
Potassium	15.9	8.64	28.6	10.2	2,108	67.0	21.3	13.1	14.2	58.4	18.3	12.3	32.5
Calcium	37.0	17.5	15.3	6.16	1,208	29.5	13.8	14.1	37.8	18.1	5.8	10.1	8.55
Magnesium	6.25	1.07	4.18	1.15	2.38	4.38	3.45	2.06	6.88	2.90	1.18	1.36	1.20
Iron	56.0	<0.68	<0.68	0.86	8.39	<0.68	3.56	1.56	10.5	<0.68	45.4	26.7	43.0
Barium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	--	--	--	--	--	--	--	--	--	--	--	--	--

[1] Data provided by EnCana. See also Appendix G.



1 Adapted from BLM (1999c).
2 Data collected at JIDPA (Jonah Federal 5-7) on September 28, 2003.

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Figure 3.13 Typical Natural Gas Field Noise Levels, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Table 3.15 Comparison of Measured Noise Levels with Commonly Heard Sounds, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

Source	dBA[2]	Description
Normal breathing	10	Barely audible
Rustling leaves	20	
Soft whisper (at 16 ft [5 m])	30	Very quiet
Library	40	
Quiet office	50	Quiet
Normal conversation (at 3 ft [1 m])	60	
Busy traffic	70	Moderately noisy
Noisy office with machines; factory	80	
Heavy truck (at 49 ft [15 m])	90	Loud

1 Adapted from Tipler (1991).
2 dBA = A-weighted decibels.

Noise levels at the Luman compressor station, just south of the JIDPA, are about 69-86 dBA at the compressor station, 58-75 dBA about 1.0 mile to the southeast, and 54 dBA about 1.25 miles to the southeast (TRC Mariah 2003a). Noise levels at the Falcon compressor station, just north of the JIDPA, are about 77 dBA at the compressor station and about 65 dBA about 1.0 mile east. Noise levels associated with construction activities range from 70 dBA (similar to busy traffic) to over 90 dBA within 50 ft of the activity; however, these noise levels attenuate with distance with a reduction of approximately 6 dBA with each doubling of distance (Thuman and Miller 1996). While it is likely that noise from existing natural gas operations in the JIDPA during certain weather conditions (low winds) may be heard 20 or more miles from the area (outside the CIAA), noise levels at this distance are expected to be very quiet to barely audible (see Table 3.15). Background noise levels in the JIDPA are between 29 and 38 dBA (TRC Mariah 2001a, 2003a) but may be higher depending on wind conditions.

Outside development areas, noise levels can be characterized as rural or natural. Wind, thunderstorms, livestock, and wildlife (primarily passerine birds) are the primary noise sources, except for the occasional vehicle or aircraft.

Noise-sensitive areas in the JIDPA include greater sage-grouse leks during the breeding season and occupied greater sage-grouse and raptor nests. No residences occur in or immediately adjacent to the area.

No specific data on odors are available from the JIDPA or the surrounding 2-mile CIAA area; however, odors present in the area, other than the natural odors of vegetation and wildlife, include those from vehicle emissions along roads, natural gas development, activities at well sites, compressor stations, other ancillary facility sites, and livestock. Odors are likely to be quickly dispersed by the wind.

3.2 BIOLOGICAL RESOURCES

3.2.1 Vegetation

3.2.1.1 Plant Communities

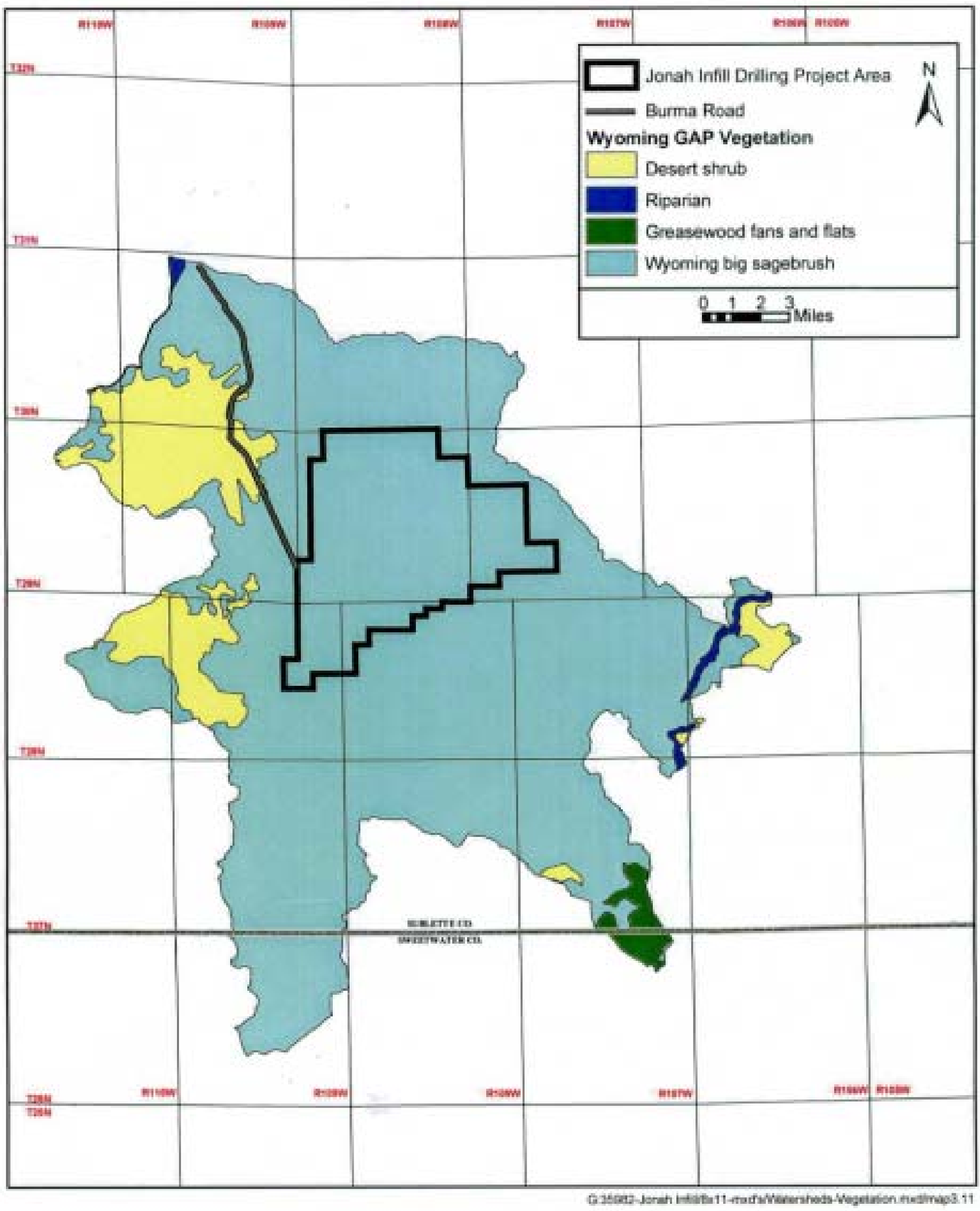
Vegetation in the JIDPA and CIAA (the same CIAA as for soils and other surface water; see Sections 3.1 and 3.16) is dominated by Wyoming big sagebrush grasslands communities with inclusion of saltbush and cushionplant communities (BLM 1987b; Intermountain Ecosystems LC 1996; TRC Mariah 2001a; WyGISC 2003) (Map 3.11, Table 3.16). Important plants in the Wyoming big sagebrush grasslands include Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*), western wheatgrass (*Elymus smithii*), thickspike wheatgrass (*Elymus lanceolatus*), Sandberg bluegrass (*Poa secunda* var. *secunda*), winterfat (*Kraschenninikovia lanata*), granite prickly gilia (*Leptodactylon pungens*), Hood's phlox (*Phlox hoodsii*), stemless goldenweed (*Haplopappus acaulis*), and rabbitbrush (*Chrysothamnus* spp.) (Fertig 1993). Needle-and-thread (*Stipa comata*) and Indian ricegrass (*Oryzopsis hymenoides*) are major species on sandy soils (TRC Mariah 2001a).

The CIAA for vegetation resources is the 10 watersheds that drain the JIDPA, which encompasses approximately 210,300 acres (see Map 3.9). Wyoming big sagebrush is the predominant vegetation type based on 1:100,000 scale mapping information of the CIAA (WyGISC 2003) (see Table 3.16). Based upon WyGISC digital data and aerial photographs of the CIAA, approximately 1.6% (3,355 acres) of the area has been disturbed by well pads, agricultural lands (i.e., hay meadows), reservoirs, pipelines, roads, and residences (i.e., ranches) (see Table 3.11). The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance 4.2% (992 acres), the majority of which is from natural gas development in the JIDPA (665 acres).

Habitat mapping (TRC Mariah 2001a) in the JIDPA delineated the Wyoming big sagebrush communities into three sagebrush habitat types in an effort to define optimal greater sage-grouse nesting and brood-rearing areas (Table 3.17, Map 3.12). Moderate-density sagebrush (formerly referred to as dense sagebrush) was the most common habitat type, occupying approximately 87.2% (26,601 acres) of the JIDPA. This habitat type generally occurs on flat to rolling terrain and generally exhibits sagebrush cover of >20% (n = 15).

The low-density sagebrush (formerly referred to as moderate-density sagebrush) type occupies approximately 8.9% (2,721 acres) of the JIDPA (Table 3.17). This habitat type primarily occupies slopes in the southeastern portion of the project area. Sagebrush cover in this type is approximately 6-8% of the total vegetative cover (n = 15) (TRC Mariah 2001a). Grass and forb species composition is generally similar to species growing in the dense sagebrush habitat type; however, Gardner's saltbush (*Atriplex gardneri*), winterfat, and spiny hopsage (*Grayia spinosa*) are more common.

The scattered/no sagebrush habitat type (2.5% of the JIDPA, 750 acres) contains saltbush and cushionplant communities. The saltbush communities support Gardner's saltbush, shadscale (*Atriplex confertifolia*), bud sagebrush (*Artemisia spinescens*), winterfat, and western wheatgrass and generally occur on level lowland topographic locations or are associated with playas. The cushionplant communities--which are characterized by the near absence of big sagebrush and low overall vegetative cover--generally occupy rocky outcrops, ridgetops, or steep slopes. Dominant



Map 3.11 Vegetation Communities (Course-Scale) in the Jonah Infill Drilling Project Area and Cumulative Impact Assessment Area, Sublette and Sweetwater Counties, Wyoming, 2005.

Table 3.16 Acreages of Vegetation Communities in the CIAA and Vegetation Types in the JIDPA, Sublette and Sweetwater Counties, Wyoming, 2005.

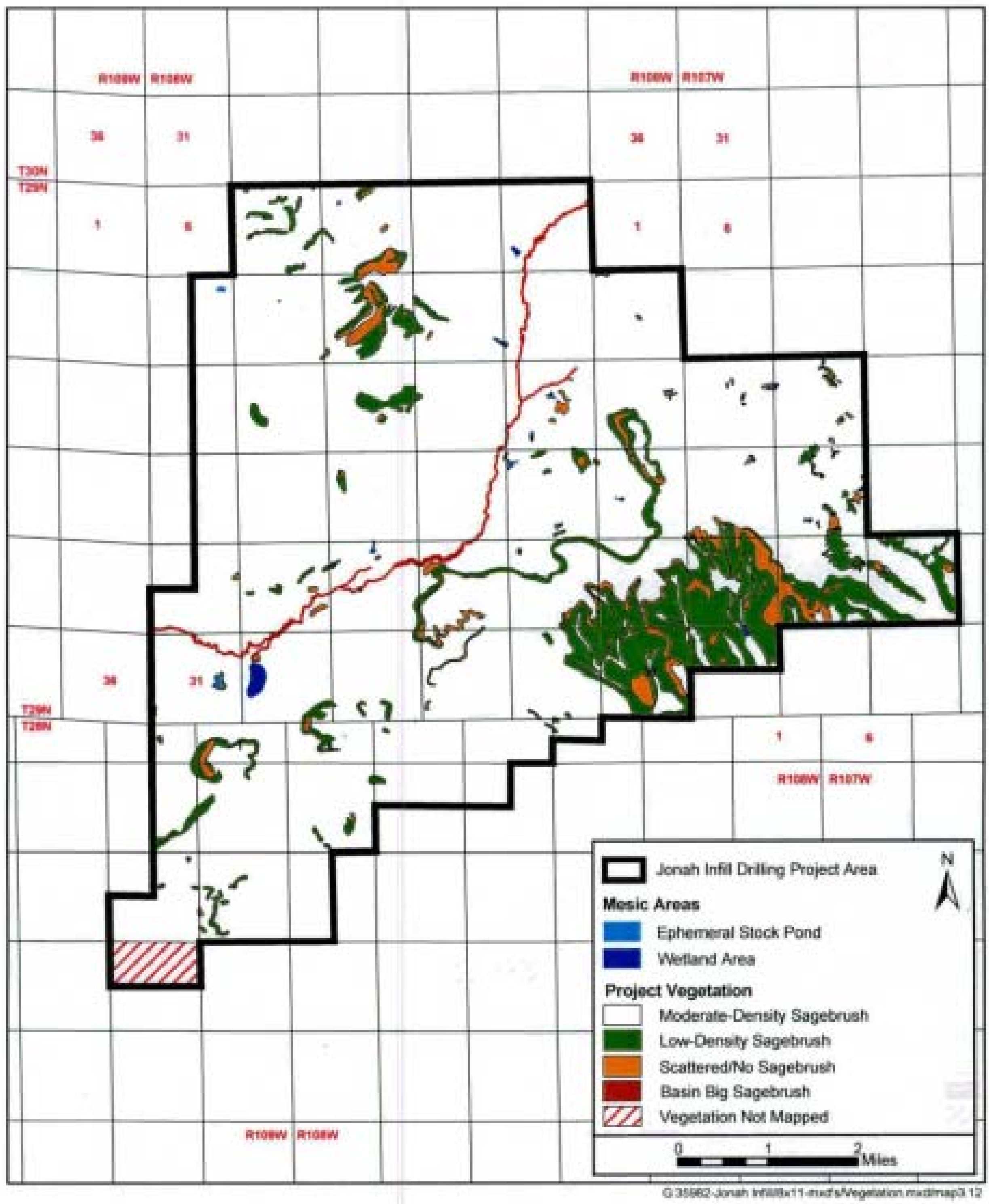
	Hydrologic Unit Watersheds										
	Expanded Sand Draw-Alkali Creek	Granite Wash	Reduced Upper Alkali Creek-Green River	Upper Eighteenmile Canyon	Southeast New Fork River-Blue Rim	North Alkali Draw	Big Sandy River-Bull Draw	Long Draw	Jonah Gulch	140401-040603	Total
CIAA Vegetation Communities[1]											
JIDPA											
Wyoming big sagebrush	13,724	1,312	3,781	1,957	0	0	3,632	5,028	317	748	30,500
Outside JIDPA											
Wyoming big sagebrush	9,648	3,081	14,681	32,532	10,678	10,289	13,207	13,492	22,179	20,943	150,730
Desert shrub	0	7,819	7,892	722	843	5,623	1,805	0	0	369	25,073
Greasewood fans and flats	0	0	0	0	0	0	0	0	155	2,497	2,652
Riparian (shrub and forest)	0	0	0	0	225	0	1,119	1	0	0	1,345
Subtotal	9,648	10,900	22,573	33,254	11,746	15,912	16,131	13,493	22,334	23,809	179,800
Total	23,372	12,213	26,354	35,211	11,746	15,912	19,763	18,521	22,651	24,557	210,300
JIDPA Vegetation Types[2]											
Scattered/ no sagebrush	170	21	110	15	0	0	61	371	2	0	750
Low density sagebrush	404	76	223	118	0	0	320	1,566	8	6	2,721
Moderate density sagebrush	13,053	1,211	3,448	1,504	0	0	3,247	3,089	307	742	26,601
Basin big sagebrush	47	0	0	0	0	0	0	0	0	0	47
Wetlands	42	1	0	0	0	0	2	2	0	0	47
Ephemeral stockponds	8	3	0	0	0	0	2	0	0	0	13
Unmapped vegetation	0	0	0	320	0	0	0	0	0	0	320
Total	13,724	1,312	3,781	1,957	0	0	3,632	5,028	317	748	30,500

1 Vegetation types based on Wyoming GAP Analysis land cover for Wyoming (WyGISC 2003).
2 Vegetation types based on TRC Mariah (2001a).

Table 3.17 Vegetation Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

Parameter	Vegetation Type[2]		
	Moderate Density Sagebrush (n=15)	Low Density Sagebrush (n=15)	Basin Sagebrush (n=5)
Sagebrush height (inches)	9.8	7.9	31.0
Percent sagebrush cover			
Daubenmire	21.7	6.5	30.8
Line intercept	24.5 (99%)	7.9 (89%)	36.7 (79%)
Percent total shrub cover			
Daubenmire	22.0	6.8	31.4
Line intercept	24.7 (99%)	8.1 (92%)	38.0 (80%)
Grass/forb height (inches)	5.6	6.5	6.5
Percent grass and forb cover	10.6 (89%)	15.1 (96%)	20.1 (65%)
Residual grass height (inches)[3]	6.3	6.1	6.5
Percent residual grass cover	8.5	10.9	20.1
Sagebrush plants/acre	7,260 (99%)	2,636 (92%)	4,494 (86%)
Total shrubs/acre	7,665 (99%)	2,951 (96%)	5,088 (91%)

1 Adapted from TRC Mariah 2001a. Data on file at TRC Mariah, Laramie, Wyoming. Measurements recorded in late summer 2000.
2 See map 3.12 for type locations. Numbers in parentheses are the confidence level achieved with 80% precision using the appropriate z statistic.
3 Excludes pre-2000 litter.



Map 3.12 Project Area Vegetation Types (Finely Mapped), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

species in the cushionplant community include fringed sagebrush (*Artemisia frigida*), squarestem phlox (*Phlox muscoides*), spoonleaf milkvetch (*Astragalus spatulatus*), goldenweed (*Haplopappus* spp.), Hooker sandwort (*Arenaria hookeri*), cutleaf daisy (*Erigeron compositus*), mat beardtongue (*Penstemon caespitosus*), and silky locoweed (*Oxytropus sericea*). This habitat type also includes barren side slopes and fans derived from clay and shale substrates.

The basin big sagebrush (*Artemisia tridentata tridentata*) type occupies less than 0.1% (47 acres) of the JIDPA. Sagebrush canopy cover in this type is approximately 30-38% (n = 5) (Table 3.17). This type occurs as a narrow strip from less than 5 ft wide to approximately 150 ft wide along the Sand Draw drainage, where basin big sagebrush is the dominant species. The understory is relatively sparse, with scattered rabbitbrush, western and thickspike wheatgrasses, Sandberg bluegrass, and Great Basin wildrye (*Elymus cinereus*).

Approximately 4,200 acres of the JIDPA have been disturbed by existing oil and gas development (see Table 2.3). Approximately 1,400 acres of this disturbance is anticipated to remain for another 40 to 60 years; however, approximately 2,800 acres of disturbance are in various stages of reclamation.

3.2.1.2 Riparian and Wetlands Areas

Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent water bodies (rivers, streams, lakes, or drainageways) and are usually transitional between wetland and upland communities. Riparian areas generally exhibit distinctly different vegetative species than adjacent areas and/or vegetative species similar to adjacent areas but exhibiting more vigorous or robust growth forms (USFWS 1997). Based on this definition, no riparian communities occur within the JIDPA. However, riparian communities are present in the CIAA along the New Fork and Big Sandy Rivers.

Wetlands are protected under Section 404 of the *Clean Water Act* (33 C.F.R. 1251 et seq.) and *EO 11990* and are considered sensitive and valuable resources. The current regulatory definition of wetlands for administrating the *Clean Water Act* Section 404 permit program for dredge and fill activities is "areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and [which] under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (U.S. Army Corps of Engineers [COE] 1987; Wetlands Training Institute, Inc. 1995). A wetland must possess the following three general diagnostic characteristics:

- Hydrophytic vegetation - The prevalent vegetation consists of macrophytes that are typically adapted to areas having hydrologic and soil conditions described in the wetland definition above. That is, they are adapted to actively grow in saturated soils.

- Hydric soil - Soils are present and have been classified as hydric, or they possess characteristics that are associated with reducing (often saturated) soil conditions.

- Hydrology - The area is inundated either permanently or periodically at mean water depths less than or equal to 6.6 ft, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

In 2003, field investigations were conducted to verify the wetland designations indicated on existing USFWS National Wetland Inventory (NWI) maps of the JIDPA. The maps generally proved to be accurate in the classification and location of wetlands; however, many of the mapped NWI sites may not be subject to regulation under Section 404 due to a lack of the three general diagnostic environmental characteristic described above. While some of the NWI-identified wetlands lack one or more or the regulatory requirements (i.e., hydric soils, dominance of hydrophytic vegetation, or wetland hydrology), these areas provide unique habitats for wildlife, as well as water for both wildlife and livestock, throughout all or part of the year. Approximately 13 acres of the NWI-identified wetland areas within the JIDPA are ephemeral stockponds (see Table 3.16, Map 3.11). Approximately 47 acres (<0.1% of the JIDPA) of potentially jurisdictional wetlands (i.e., regulated under Section 404) occur within the JIDPA (see Map 3.11). These areas are generally classified as palustrine emergent seasonally or semipermanently flooded wetlands on the NWI maps and are primarily associated with stockponds and reservoirs. These wetlands generally range in size from 0.1 acre to 2.1 acres. The largest reservoirs in the area (e.g., Sand Draw No. 4 and Wild Horse) are classified as temporarily, seasonally, or semipermanently flooded and are 5 to 10 acres in size. A large playa located on private surface in Section 32, T29N, R108W, is classified as temporarily or seasonally flooded and occupies approximately 36 acres. There are also several small depressions or playas less than an acre in size and classified as palustrine unconsolidated shore, temporarily, seasonally, or semipermanently flooded wetlands in the area.

Waters of the U.S. (WUS) have an active channel that exhibits relatively stable characteristics; the criterion for a WUS is the presence of a defined bed and bank. The boundary of a WUS extends to the ordinary high-water mark or to the boundaries of adjacent wetlands. Intermittent and ephemeral streams that exhibit a defined bed and bank qualify as WUS, as do reservoirs constructed on these streams.

Numerous ephemeral channels (WUS) classified as riverine intermittent streambed temporarily flooded on the NWI maps occur in the JIDPA (see Map 3.8). Bed channel widths range from 1 ft to over 30 ft along Sand Draw, the largest ephemeral drainage in the JIDPA.

3.2.1.3 Noxious Non-Native, and Invasive Plant Species

The Wyoming State Legislature enacted the *Wyoming Weed and Pest Control Act* in 1973 for the purpose of controlling designated weeds and pests. *EO 13112 "Invasive Species"* was signed by President Clinton on February 3, 1999, to prevent the introduction of invasive species, to provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause. Potential invader species (which include noxious weeds) identified by the Sublette County Weed and Pest Control for the JIDPA and vicinity include black henbane (*Hyoscyamus niger*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Dyer's woad (*Isatis tinctoria*), spotted knapweed (*Centaurea maculosa*), hoary cress (*Cardaria draba* and *C. pubescens*), perennial pepperweed (*Lepidium latifolium*), Russian knapweed (*Centaurea repens*), and perennial sow thistle (*Sonchus arvensis*). Sources of invasion include gravel obtained from outside the JIDPA and soil carried to the area on vehicles and drilling and construction equipment.

A reconnaissance of JIDPA in 2003 found Russian thistle (*Salsola kali*) and halogeton (*Halogeton glomeratus*) establishment on reclaimed areas (i.e., well pads, pipeline and road ROWs) reseeded from 1992 through 2002. Though Russian thistle and halogeton are not identified as noxious weeds by Sublette County Weed and Pest Control, they are generally considered undesirable for livestock and wildlife forage (Stubbendieck et al. 1997).

3.2.2 Wildlife and Fisheries

3.2.2.1 Big Game/Other Mammals

Pronghorn antelope is the only big game species that regularly inhabits the JIDPA. Occasionally, mule deer have been observed in the area (TRC Mariah 2004a), but no range designation for mule deer has been delineated on the JIDPA by the WGFD, so mule deer are not discussed further.

The WGFD determines range classifications for big game species and is in the process of revising big game ranges across the state. This revision is not complete for the big game herds in the JIDPA; therefore, the range designations that have been in place for the last several years are used in this EIS.

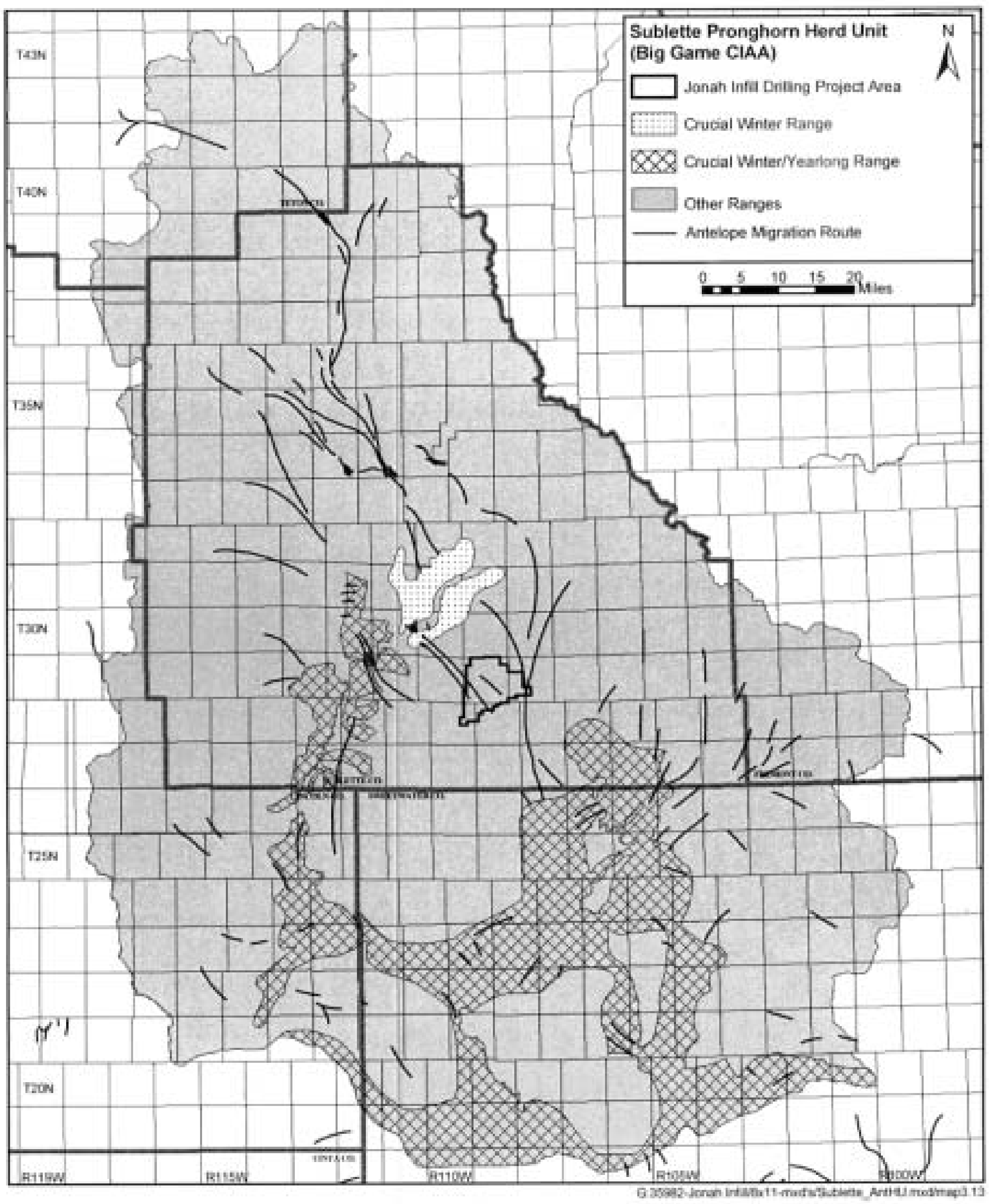
Pronghorn Antelope

The entire JIDPA is within spring/summer/fall range of the Sublette Pronghorn Antelope Herd Unit (the CIAA). This herd unit occupies approximately 10,546 square miles and includes most of the Green River drainage north of Interstate 80, exclusive of the Black's Fork and Ham's Fork drainages (Map 3.13). Approximately 3,006,000 acres (4,697 square miles) of the Sublette Herd Unit CIAA is designated as spring/summer/fall habitat. Limited portions of other drainages, including the Gros Ventre/Hoback River area near Jackson Hole are also included in the Sublette Herd Unit. Within these boundaries, the Sublette Herd Unit pronghorn migrate farther between seasonal ranges than any other pronghorn in Wyoming, with documented movements of as much as 150 miles between several ranges (WGFD 2001). WGFD has documented migration corridor occurrence within and adjacent to the JIDPA (Map 3.13).

Total existing disturbance (from roads, wells, towns) within the Herd Unit CIAA is approximately 87,200 acres (136 square miles) or 1.3% of the total herd unit. Though no pronghorn crucial range occurs within the JIDPA, approximately 27,200 acres (2.5%) of pronghorn crucial range in the Sublette Herd Unit have been disturbed. BLM is responsible for the majority of surface management in the Sublette Herd Unit. Other surface management entities include the USFS, the Bureau of Reclamation, the State of Wyoming, and private entities.

The WGFD population objective for the Sublette Herd Unit is 48,000 pronghorn antelope. The 2002 population was estimated at 44,700 (93% of the current objective), and the estimated population averaged 44,080 from 1997 to 2001 (WGFD 2002). Because of its large size, the Sublette Herd Unit has been divided into three sub-units. The JIDPA is within the North sub-unit, which has a population objective of 22,000 and an estimated 2001 population of 18,600 (84.5% of objective). The population trend in the North sub-unit has been relatively stable in recent years, ranging from 17,900 head in 1998 to 19,700 in 1994 (WGFD 2001).

Reproductive success of the Sublette North sub-unit from 1985 to 2001 has been highly variable, ranging from 45 fawns/100 does in 1993 to 90 fawns/100 does in 1987. Fawn/doe ratios in 2000 and 2001 were toward the low end of the range at 53/100 and 55/100, respectively (WGFD 2001). Drought conditions from 2000 to 2003 have reduced forage production and available water throughout the Sublette Herd Unit. Low summer precipitation typically results in poor body condition and subsequently, poor fawning rates and overwinter fawn survival (WGFD 2001).



Map 3.13 Sublette Herd Unit and Pronghorn Migration Routes, Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Other Mammals

The CIAA for other mammal species and general wildlife encompasses approximately 188,888 acres (295 square miles) (Map 3.14). Existing disturbance within the CIAA includes approximately 2,729 acres (4.3 square miles), or 1.4% of the CIAA, and results primarily from road and pipeline ROWs (44%) and existing long-term disturbance in the JIDPA (52%).

Other mammals known or likely to occur in the JIDPA based on observations and range and habitat preference (Clark and Stromberg 1987; WGFD 1999; WYNDD 2003) include: dwarf shrew, 10 bat species (California myotis, small-footed myotis, Yuma myotis, little brown myotis, long-legged myotis, silver-haired bat, big brown bat, hoary bat, Townsend's big-eared bat, and pallid bat); four species of hares and rabbits (pygmy rabbit, Nuttall's cottontail, desert cottontail, and white-tailed jackrabbit); five squirrel species (least chipmunk, Uinta ground squirrel, Wyoming ground squirrel, thirteen-lined ground squirrel, and white-tailed prairie dog); northern and Idaho pocket gophers; six species of new world rats and mice (Ord's kangaroo rat, deer mouse, grasshopper mouse, bushy-tailed woodrat, sagebrush vole, and long-tailed vole); coyote and red fox; four mustelid species (long-tailed weasel, badger, western spotted skunk, and striped skunk); and bobcat. Porcupines have been observed in the vicinity of the project area but are uncommon and not likely to be residents.

All identified prairie dog colonies on the JIDPA have been mapped. Colonies vary from 6 to 893 acres in size (Map 3.15) and are visited annually during wildlife surveys conducted for the Jonah wildlife studies project (TRC Mariah 2004a). During these studies, newly observed colonies are mapped, and regular updates to colony boundaries are made.

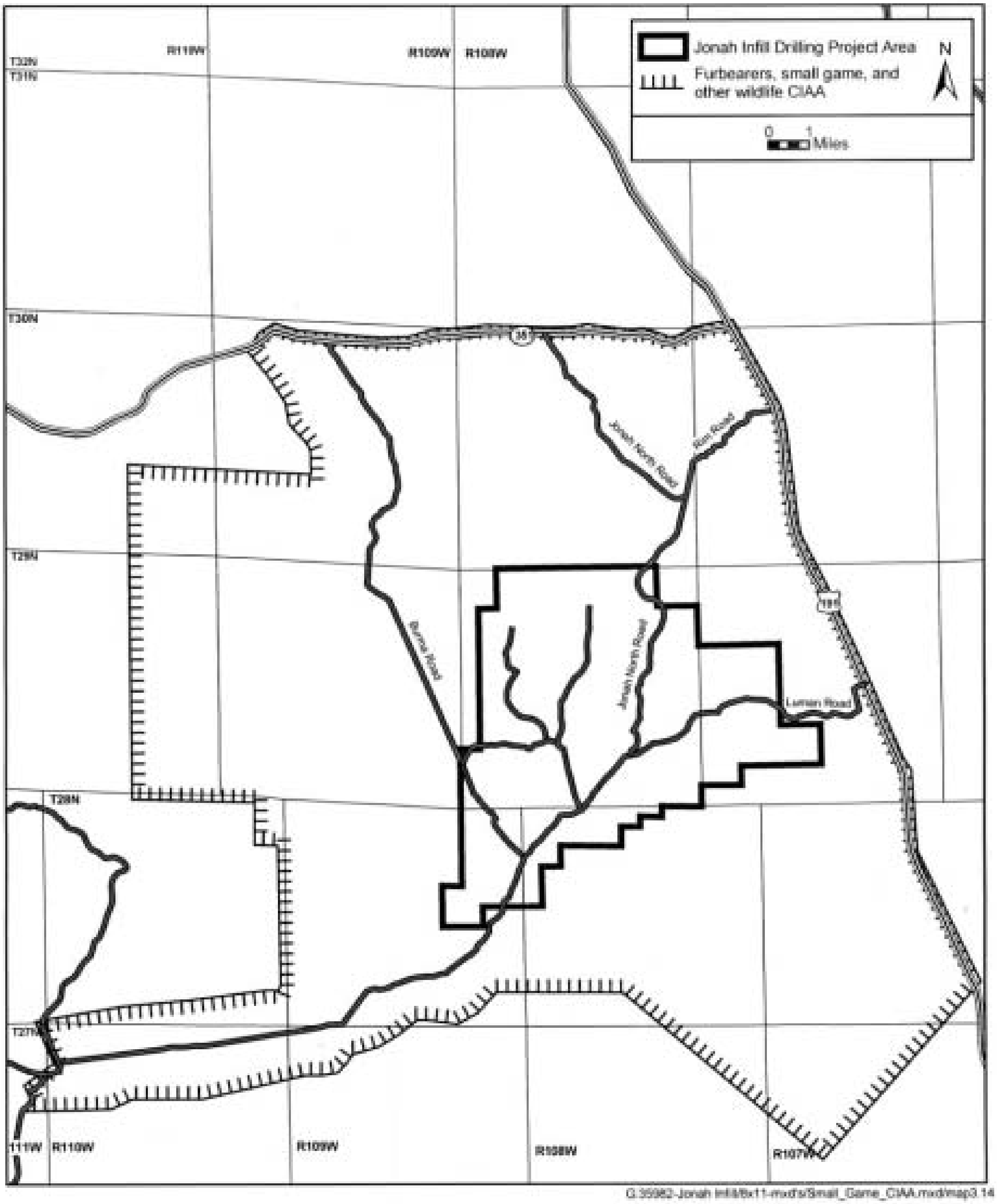
3.2.2.2 Birds

Raptors

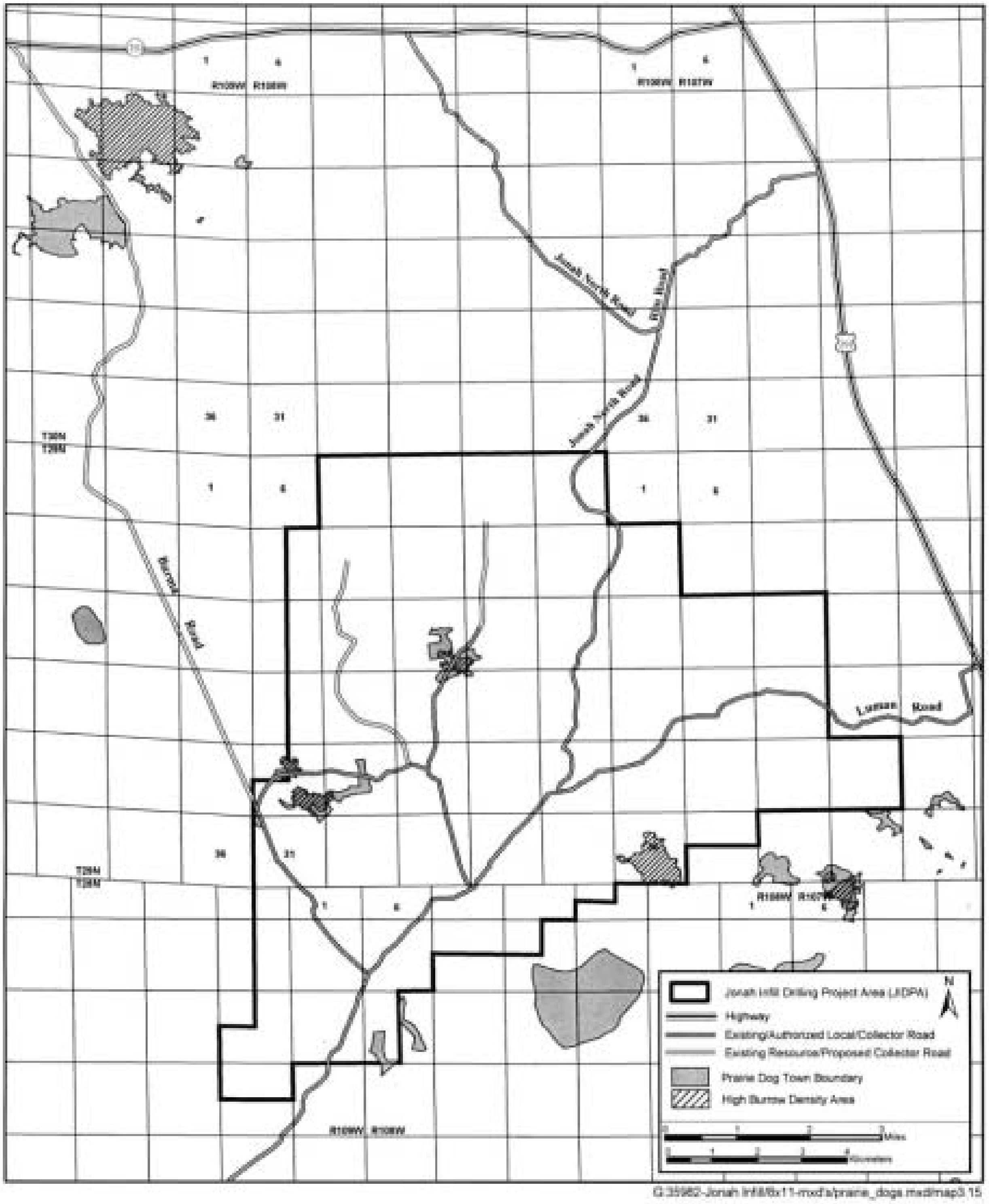
The CIAA for raptors encompasses approximately 1,184,443 acres (1,850 square miles) (Map 3.16). Existing disturbance within this CIAA is approximately 113,092 acres (176 square miles), or 9.5% of the area. This disturbance is primarily from agriculture (88%) and road and pipeline ROWs (8%).

Based on geographic range and habitat preferences, a variety of raptor species may occur within the JIDPA (Dorn and Dorn 1999; WGFD 1999). Raptor nest surveys are conducted annually on the JIDPA and within the greater Jonah wildlife study area in association with Jonah wildlife studies (TRC Mariah 2004a). All known raptor nests/nest sites are inventoried, and other suitable nesting habitat is observed to determine if there are new nests in the area (Map 3.17). These inventories have revealed declines in the number of active ferruginous hawk nests on and adjacent to the JIDPA over the last 8 years.

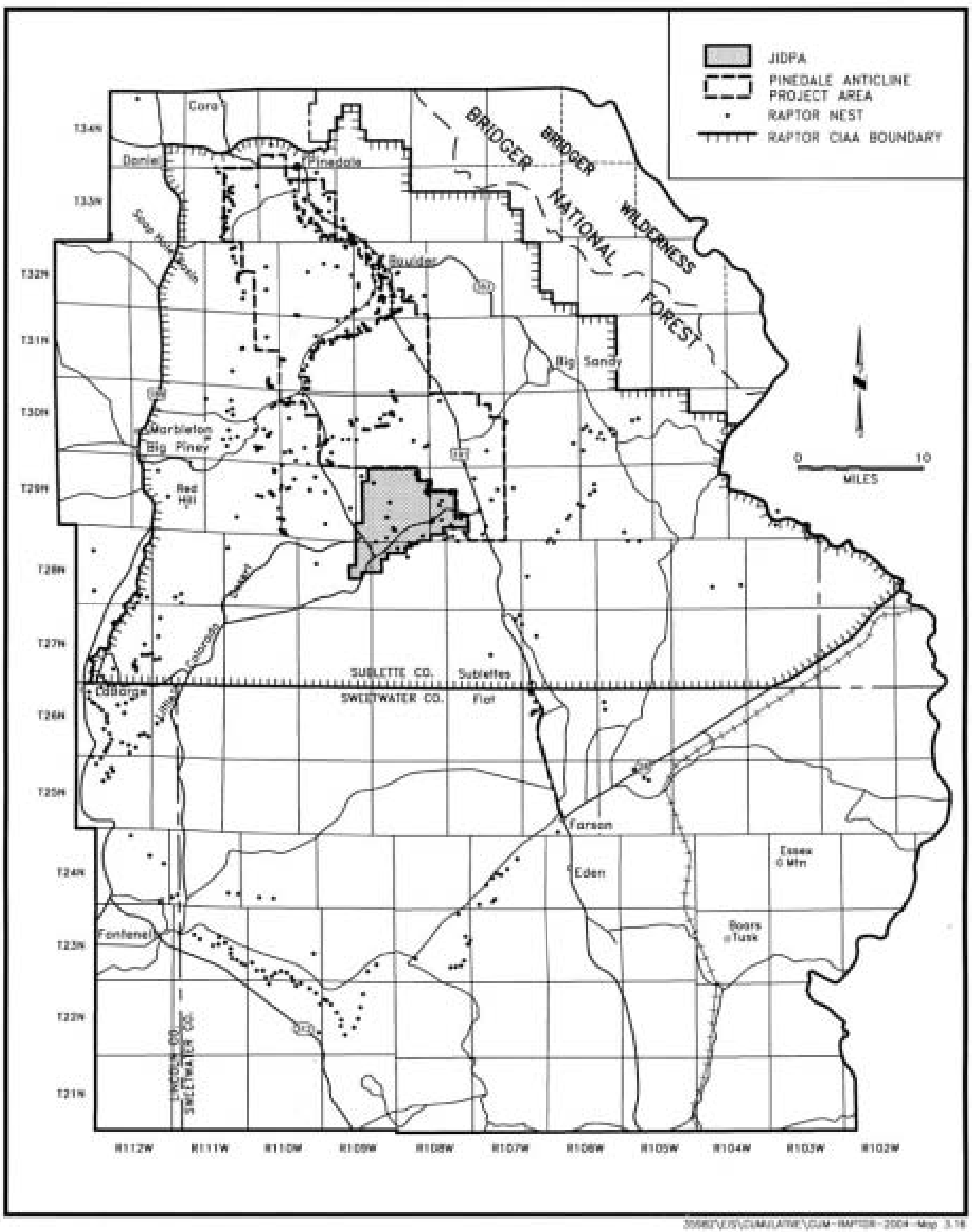
Approximately 35 raptor nests are known to occur within the JIDPA, and in 2004, seven were occupied, including five American kestrel nests, one ferruginous hawk nest, and one burrowing owl nest. In addition to the seven occupied nests, nine other nests on the JIDPA are considered active (i.e., occupied at least once during the last three years or having an unknown status) for management purposes. These include four ferruginous hawk, one American kestrel, and one burrowing owl nest. Approximately 19 known nests within the JIDPA have had no recent activity or use. A detailed analysis of raptor nesting history in the area is provided in *2003 Wildlife Studies, Jonah Field II Natural Gas Development Project* (TRC Mariah 2004a).



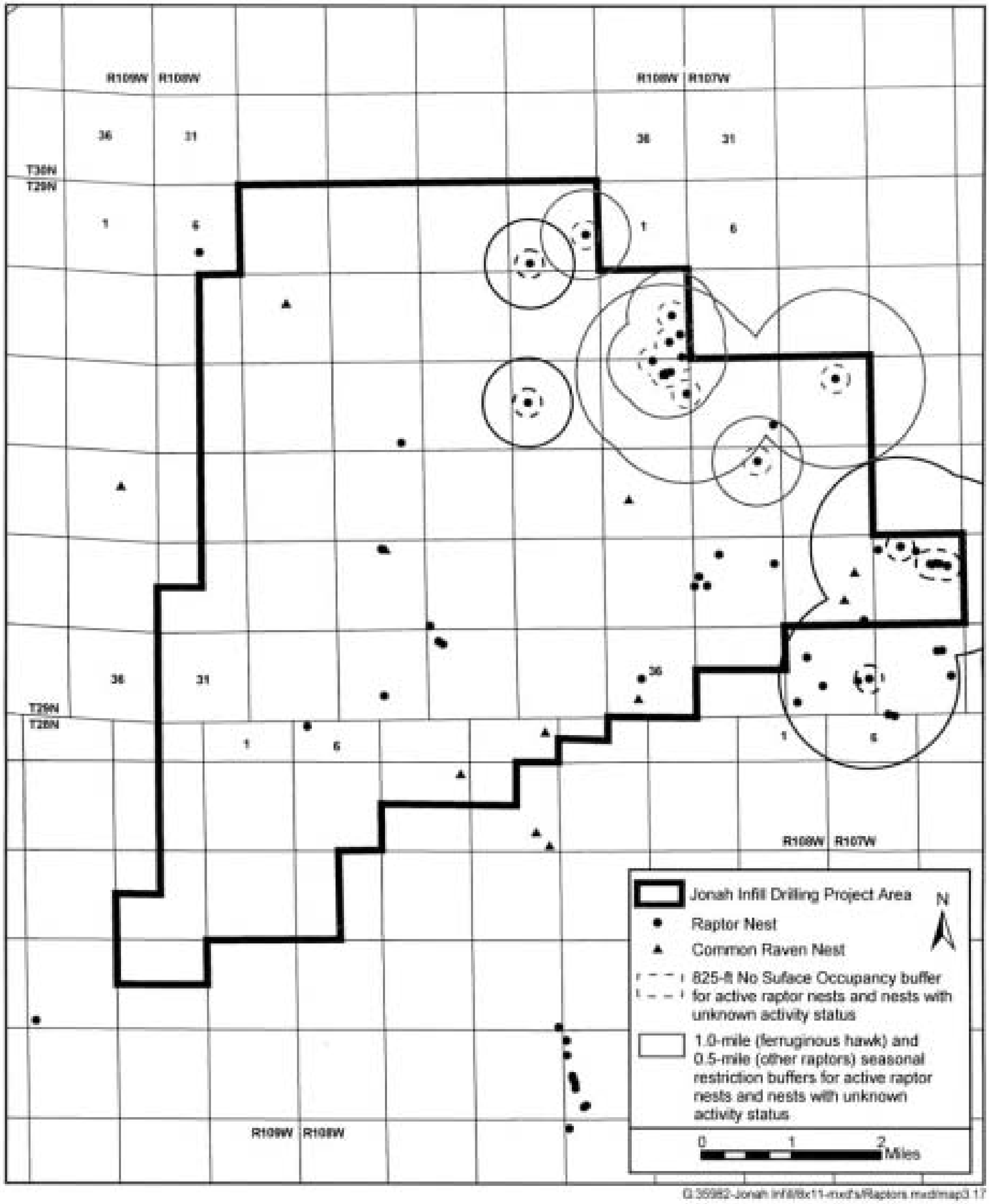
Map 3.14 General Wildlife Species Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 3.15 Prairie Dog Colonies, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 3.16 Raptor Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 3.17 Raptor Nests On or Adjacent to the Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Game Birds

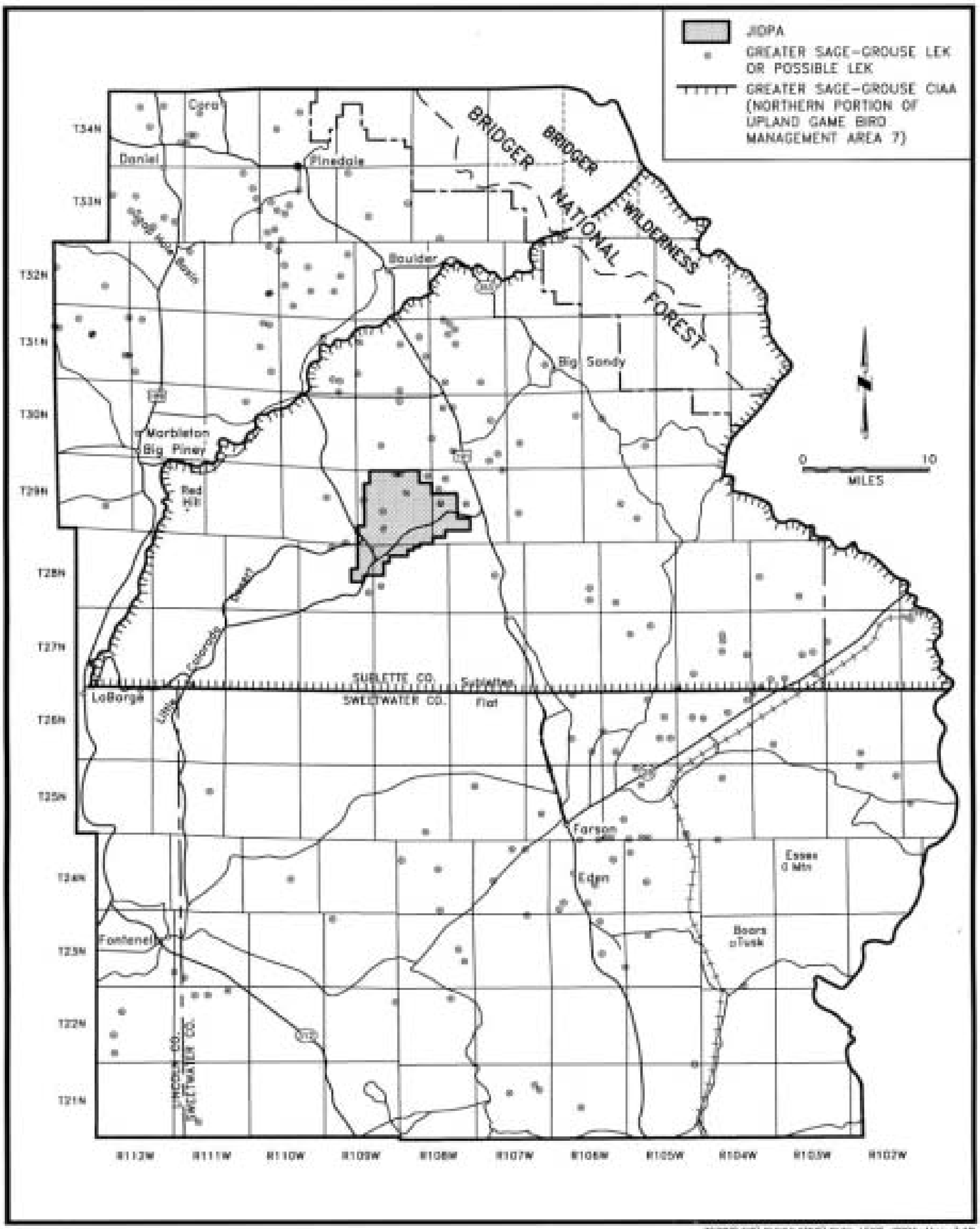
The principal upland game bird inhabiting the JIDPA is greater sage-grouse. A detailed summary of known greater sage-grouse lek activity on the JIDPA is provided in *2003 Wildlife Studies, Jonah Field II Natural Gas Project* (TRC Mariah 2004a). The CIAA for greater sage-grouse encompasses 1,061,805 acres (1,659 square miles) (Map 3.18). Existing disturbance within this CIAA includes approximately 28,767 acres (45 square miles), or 2.7% of the CIAA, and results primarily from agriculture (70%) and road and pipeline ROWs (21%).

Greater sage-grouse have been extirpated from two states and populations over the remainder of its range have notably declined (Connelly and Braun 1997; Braun 1998; Connelly et al. 2004). Conservative estimates suggest that only 56% of the pre-European settlement area occupied by greater sage-grouse is still occupied or capable of supporting the species on an annual basis (Braun et al. 1976; Braun 1995; Connelly et al. 2004). Eleven of 13 states have shown significant declines. Historically, Wyoming supported more greater sage-grouse than any other state due to the presence of extensive sagebrush habitats (Patterson 1952). The areas in central and western Wyoming, where sagebrush-dominated landscapes and greater sage-grouse populations remain relatively contiguous and intact, cumulatively represent one of the species' last strongholds (Braun 1998). The number of male sage-grouse counted per lek in Wyoming decreased 17% between 1985 and 1995 (Connelly and Braun 1997), and regional declines as high as 73% between 1988 and 1999 have been recorded. The average decline in male attendance on leks in Wyoming from 1965 -2003 is 49% and lek size has also significantly decreased (Connelly et al. 2004). Changes in the sagebrush-dominated areas where birds typically reside are thought to be one of the principal factors for population declines (Braun 1998). Factors include fire, plant invasions, land conversions, urbanization, livestock grazing, energy development, noise, and others.

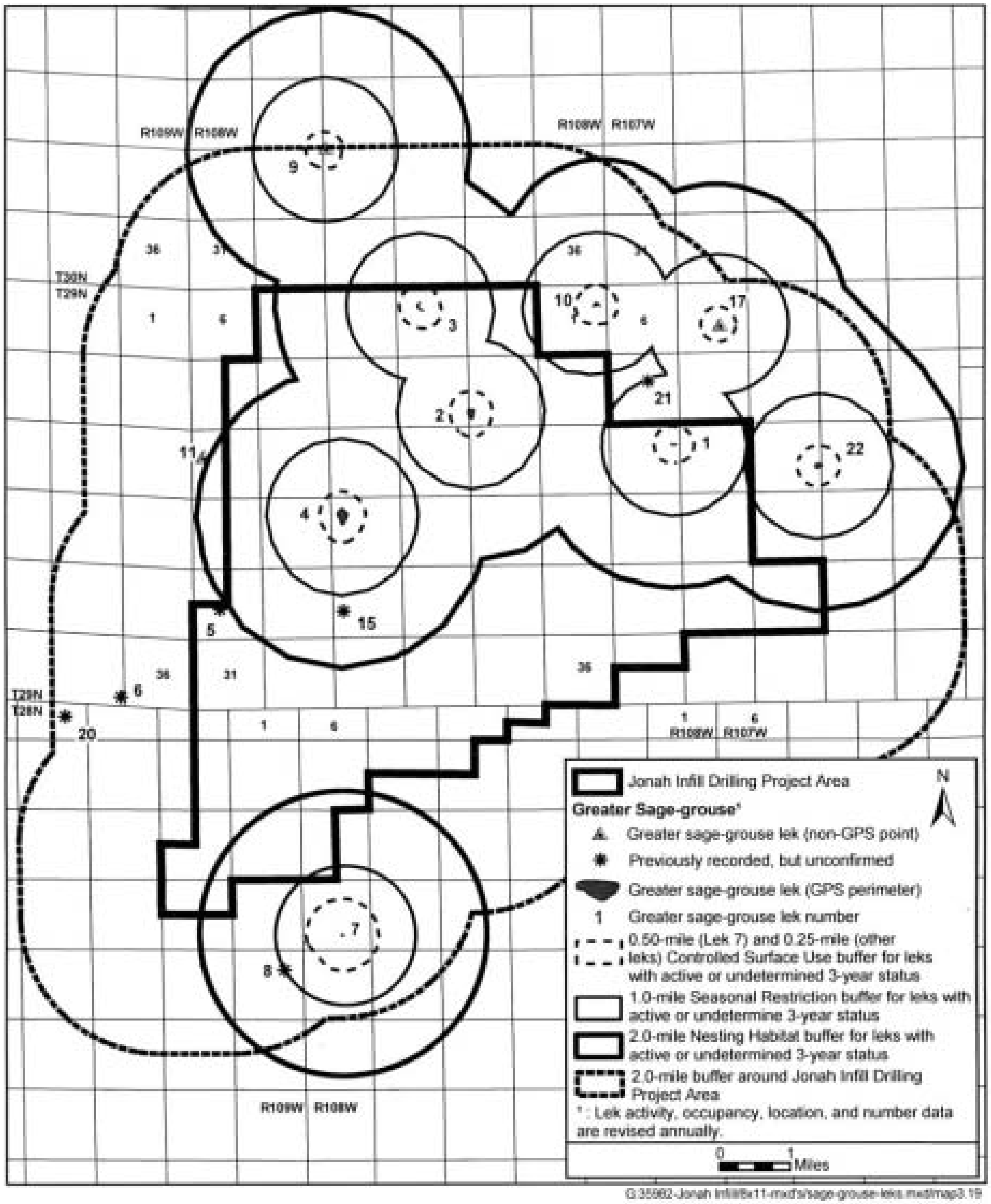
Greater sage-grouse lek monitoring is conducted annually on the JIDPA and surrounding areas. The WGFD, BLM, University of Wyoming Cooperative Fish and Wildlife Research Unit, and TRC Mariah are responsible for the lek activity status monitoring in the area (TRC Mariah 2004a). Ten active leks have been identified on or within a 2-mile buffer of the JIDPA (Map 3.19 and Table 3.18). In addition, six formerly identified leks occur in the area; however these areas are no longer classified as leks (Table 3.18). Data from the JIDPA and for the entire Upper Green River Basin show declines in male greater sage-grouse attendance at leks. Additionally, declines appear to be occurring at a faster rate in areas with oil and gas development (WGFD unpublished data; personal communication, December 2004, with Dean Clause, WGFD Biologist). Declines in lek attendance likely indicate a reduction in the regional population.

Site-specific surveys of the JIDPA conducted over the last few years indicate that while the area is still used for nesting and summer and winter foraging, use of the area by greater sage-grouse continues to decline. This decline is likely due in part to the increased loss of habitat resulting from oil and gas development. Habitat vegetation conditions in the JIDPA are described in Section 3.2.1.

To maintain or move PFO greater sage-grouse habitat toward RMP goals, existing PFO area-wide and statewide stipulations on leases and COAs on APDs and ROWs apply a Controlled Surface Use restriction within 0.25 mile of an occupied lek. There are also timing stipulations protecting breeding activities, nesting and brood-rearing females, and wintering grouse, but these stipulations do not preclude exploration and development from occurring in nesting and wintering



Map 3.18 Greater Sage-grouse Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 3.19 Greater Sage-grouse Leks, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Table 3.18 Greater Sage-Grouse Lek Attendance Trends, Jonah Infill Drilling Project, Sublette County, Wyoming, 1992-2004.[1]

Lek No.[2]	Most Recent Activity	History[3]												
		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	2004	NS	NS	9	NS	26	6	31	25	22	12	10	14	13
2	2004	NS	NS	2	NS	2	17	12	7	14	16	NS	6	7
3[4]	2004	NS	NS	NS	NS	16	0?	36	26	22	27	17	23	15
4	2003	NS	NS	16	NS	15	4	4	0	1	1	0	1	0
5[5]	1996[6]	NS	NS	NS	NS	1	0?	0	0	NS	NS	NS	0	NS
6[5]	1996[6]	NS	NS	NS	NS	3	0?	0	0	0	NS	NS	0	0
7	2004	NS	NS	36	NS	0	16	17	11	9	6	NS	3+	2
8[5]	1996[6]	NS	NS	NS	NS	2	0?	0	0?	0	NS	0	0	0?
9	2004	NS	NS	NS	NS	NS	-50	26	62	47	45	46	36	13
10	2004	NS	NS	NS	NS	NS	60	53	79	64	62	47	25	16
11[5]	UNK	NS	NS	UNK	NS	UNK	NS	0	0	0	NS	NS	0	0?
15[5]	1996[6]	NS	NS	NS	NS	1	0?	0	0	0	NS	NS	0	0
17	2001[6]	NS	NS	NS	NS	NS	NS	NS	5	3	3	0	0?	0
20[5]	UNK	NS	NS	0	NS	0	NS	NS	NS	NS	NS	NS	0	0
21[5]	2000[6]	NS	NS	NS	NS	NS	NS	NS	NS	10	NS	NS	NL	0
22	2000	NS	NS	NS	NS	NS	NS	NS	NS	9	0	0	0	0

1 Further detail is provided in TRC Mariah 2004a.
2 See Map 3.19 for locations; lek numbering is consistent with TRC Mariah 2004a.
3 Numbers refer to maximum male attendance observed; NS = not surveyed; NL = not located- survey was attempted but no birds were observed and exact location of lek could not be confirmed; UNK = unknown; + = unclassified birds observed but not included; ? = no males were observed on the lek, but the lek was visited less than three times during that breeding season.
4 This lek/lek location may be revised to accommodate two leks.
5 WGFD in consultation with BLM has removed these locations from consideration as leks because they may never have met WGFD lek criteria and/or they may represent areas where birds were observed after departure from an established lek.
6 The lek may have been active more recently than indicated because data are lacking for at least one year since the last known activity.

habitat outside of the timing restriction dates, and therefore, habitat is not protected from development. Given the noted decline in greater sage-grouse use of the JIDPA, existing protection measures within the JIDPA appear to be inadequate.

Sand Draw and adjacent areas have been identified as containing important greater sage-grouse habitat (particularly for nesting and wintering); therefore, past BLM decisions for the Jonah Field identified specific measures for the protection of this drainage (BLM 1998b, 2000b). These measures include no well construction within 300 ft of the edge of Sand Draw and the basin big sagebrush-dominated areas associated with this drainage channel. Roads and pipelines that must cross these draws would be constructed perpendicular to drainage channels, and engineering designs would specifically address each road/pipeline crossing in an effort to minimize disturbance.

Greater sage-grouse breeding habitats are sagebrush-dominated rangelands, typically consisting of large, relatively contiguous sagebrush stands, which are critical for the survival of greater sage-grouse populations (Connelly et al. 2000). Since grouse populations typically inhabit large interconnected expanses of sagebrush, they have been characterized as a landscape-scale species (Patterson 1952; Wakkinen 1990). Therefore, conserving landscapes with suitable winter habitat also may be important for species conservation (Eng and Schladweiler 1972). Total shrub canopy cover, residual grass cover, non-food forb cover, and litter cover are the best predictors of greater sage-grouse nesting habitat (Holloran 1999; Lyon 2000). Typically greater sage-grouse nests are located in habitat with >20% sagebrush canopy cover (Holloran 1999; Lyon 2000). Braun et al. (1976) indicated that most hens nest within 3.2 km (2.0 miles) of a lek, but more recent studies suggest many hens nest further away. The average distance moved by hens from undisturbed leks to nests in western Wyoming was 2.1 km (1.3 miles), whereas the average distance traveled from disturbed leks to nests was 4.1 km (2.5 miles) (Lyon and Anderson 2003). Nest initiation rate was also higher for hens captured on undisturbed leks than those captured on disturbed leks (Lyon and Anderson 2003), and the presence of vehicle traffic also appears to lower nest initiation rates. The chance of successfully hatching chicks (nest success) increases by 30% if there is at least 20% cover that includes both sagebrush and herbaceous vegetation and if the vegetation is at least 15 cm in height (Holloran 1999). Greater sage-grouse nest success ranges from 12% to 86% and is relatively low compared to other prairie grouse species (Connelly et al. 2000). While sage-grouse have used highly fragmented habitats in some oil fields and reclaimed areas, population levels in these areas are below pre-disturbance numbers (Connelly et al. 2004).

Important greater sage-grouse wintering habitat within the Jonah and Anticline Fields and surrounding areas currently is being identified by the BLM in cooperation with WGFD. Identification of sage-grouse wintering areas will be based, at least in part, on aerial winter sage-grouse surveys.

The other game bird likely to occur on the JIDPA is the mourning dove. The mourning dove is a common summer resident that prefers open land with scattered vegetation and requires trees or some other type of structure for nesting. Mourning doves that frequent the JIDPA likely utilize the shrub-covered areas along Sand Draw that provide suitable cover for nesting and roosting.

<u>Other Birds</u>

The CIAA for other birds is the same as that for other general wildlife (see Map 3.14). Based on observations and range and habitat preference (WGFD 1999; Dorn and Dorn 1999; TRC Mariah 2001a, 2001b, 2002, 2004a), other bird species known or likely to occur on the area include common raven, horned lark, lark bunting, loggerhead shrike, sage sparrow, sage thrasher, Brewer's sparrow, cliff swallow, barn swallow, mountain bluebird, western kingbird, grasshopper sparrow, killdeer, common nighthawk, black-billed magpie, American crow, canyon wren, western meadowlark, Brewer's blackbird, common grackle, and brown-headed cowbird. Several species of wading/shore birds and waterfowl also may occur around reservoirs. Wading/shore birds include black-necked stilt, willet, Wilson's phalarope, common snipe, great blue heron, snowy egret, long-billed dowitcher, and black-crowned night-heron. Waterfowl include pied-billed grebe, eared grebe, western grebe, green-winged teal, blue-winged teal, cinnamon teal, mallard, northern pintail, northern shoveler, gadwall, American wigeon, and ruddy duck.

3.2.2.3 Amphibians and Reptiles

The CIAA for amphibians and reptiles is the same as that for other general wildlife (see Map 3.14). Based on range and habitat preference (Baxter and Stone 1980), two amphibian and four reptile species are likely to occur on the JIDPA. Amphibians include the Great Basin spadefoot and northern leopard frog, and reptiles include the northern sagebrush lizard, eastern short-horned lizard, bullsnake, and wandering garter snake.

3.2.2.4 Fisheries

The fisheries CIAA is the combined area of project-affected watersheds (see Map 3.8). There are no perennial streams on the JIDPA, and no fish are known to occur in the area. The nearest perennial streams with significant fishery resources are the Big Sandy, New Fork, and Green Rivers (see Section 3.1.6.1 and Map 3.8). The Big Sandy River is approximately 5 miles east of the JIDPA, the New Fork River is approximately 7 miles northwest of the area, and the Green River is approximately 12 miles west of the area.

3.2.3 Threatened, Endangered, Proposed, and Candidate Species and BLM Wyoming Sensitive Species

The *Endangered Species Act* (16 *United States Code* [U.S.C.] 1531-1543) protects listed threatened and endangered plant and animal species and their critical habitats. To ensure compliance with this act, a biological assessment (BA) would be prepared and USFWS concurrence of effects determinations for the TEP&C species potentially occurring in the JIDPA would be obtained prior to project authorization.

A list of TEP&C species that potentially occur on or in the vicinity of the JIDPA was compiled from several sources, including a written communication from the Wyoming State Supervisor's Office of the USFWS and the WYNDD (Table 3.19). Seven federally listed TEP&C plant and animal species potentially occur in the vicinity of the JIDPA or could otherwise be potentially affected by the proposed project, including the black-footed ferret, bald eagle, four Colorado River endangered fish species--Colorado pikeminnow, humpback chub, razorback sucker, and bonytail chub--and one plant species--Ute ladies'-tresses.

3.2.3.1 Black-footed Ferret

Black-footed ferret, a federally endangered species (endangered species are those that are in danger of extinction throughout all or a significant portion of their range), was once distributed throughout the high plains of the Rocky Mountain and western Great Plains regions (Forrest et al. 1985). Prairie dogs are the main food of black-footed ferrets (Sheets et al. 1972), and few

Table 3.19 Federal Threatened, Endangered, Proposed, and Candidate Species and Their Potential Occurrence on the Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.

Species[1]			
Common Name	Scientific Name	Federal Status[2]	Potential Occurrence on JIDPA[3]
Mammals			
Black-footed ferret	*Mustela nigripes*	E	X
Birds [4]			
Bald eagle[5]	*Haliaeetus leucocephalus*	T	U
Fish			
Bonytail chub	*Gila elegans*	E	X
Colorado pikeminnow	*Ptychocheilus lucius*	E	X
Humpback chub	*Gila cypha*	E	X
Razorback sucker	*Xyrauchen texanus*	E	X
Plants			
Ute ladies'-tresses	*Spiranthes diluvialis*	T	X

1 List of species provided by USFWS (2003).

2 Federal status:
E = Listed as federally endangered.
T = Listed as federally threatened.

3 Potential occurrence:
U = Uncommon; species may be present in the JIDPA but in such low numbers or in such small and widely scattered populations that an encounter during field development and operation is unlikely; the species could be present for a significant part of the year (e.g., breeding season, summer resident) or the entire year.
X = Unlikely; there has been no recent historical record of the species' occurrence in the JIDPA; probability of encountering the species during field development and operation is very unlikely.

4 The mountain plover was previously included as proposed for listing as federally threatened by the USFWS, but the decision not to list the species has since been published (*Federal Register*, September 9, 2003, 68[174]: 53083-53101).

5 Proposed for removal from federal listing.

black-footed ferrets have been collected away from prairie dog towns (Forrest et al. 1985). The *Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act* (USFWS 1989) defines potential black-footed ferret habitat as any white-tailed prairie dog towns or complexes greater than 200 acres in size with a burrow density greater than 20 active burrows per hectare (8 active burrows per acre). The USFWS Wyoming Field Office has block-cleared large portions of Wyoming for black-footed ferrets, including all lands within the JIDPA (USFWS 2004). USFWS considers block-cleared areas unlikely to be inhabited by black-footed ferrets, and surveys for ferrets in these areas are not required. However, block-clearance of an area "does not provide insight into an area's value for survival and recovery of the species through future reintroduction efforts"; thus, prairie dog towns in the JIDPA (see Map 3.15) may still provide important habitat for the species. Therefore, BLM continues to evaluate actions in these areas to determine if actions could adversely affect the value of prairie dog towns as future black-footed ferret reintroduction sites.

3.2.3.2 Bald Eagle

Protection for bald eagles was initially provided through the passage of the *Bald Eagle Protection Act of 1940* (16 U.S.C. 668-668dd) and the *Migratory Bird Treaty Act* (16 U.S.C. 701-715). In 1973, the bald eagle was listed as endangered under the ESA (43 C.F.R. 6233).

Bald eagle population estimates have increased in Wyoming since the species was listed as endangered. This increase is due, in part, to population growth, to significant reduction of environmental contaminants, and to the initiation of intensive nesting surveys (Greater Yellowstone Winter Wildlife Working Group 1999). On July 12, 1995, a final rule to downlist the bald eagle from endangered to threatened in the lower 48 states was published in the *Federal Register* and on July 6, 1999, the USFWS proposed delisting the bald eagle.

The JIDPA is outside of any major bald eagle nesting or roosting areas. Bald eagles generally require cliffs, large trees, or sheltered canyons associated with concentrated food sources (e.g., fisheries or waterfowl concentration areas) for nesting and/or roosting areas (Edwards 1969; Snow 1973; Call 1978; Steenhof 1978; Peterson 1986). Bald eagle winter habitat generally is associated with areas of open water where fish and/or waterfowl congregate (Stahlmaster 1987; Greater Yellowstone Winter Wildlife Working Group 1999). Wintering bald eagles frequent unfrozen portions of lakes and free-flowing rivers and may occupy upland areas where ungulate carrion, game birds, and lagomorphs (rabbits and hares) are available (Swenson et al. 1986). Additionally, bald eagles forage over wide areas during the non-nesting season (i.e., fall and winter) and scavenge on animal carcasses such as pronghorn, deer, and elk; they may therefore potentially forage in the JIDPA.

No bald eagle nests or winter roosts are known to occur in the JIDPA, and the lack of suitable nesting areas or winter roosting habitats within the JIDPA precludes its use for such activities by bald eagles. Fourteen bald eagle sightings (10 adults, two juveniles, and two unclassified) have been recorded within and adjacent to the JIDPA (WGFD 1996), although no bald eagles have been documented in the area since 1984. A WYNDD search revealed no records of bald eagle in the vicinity of the JIDPA (WYNDD 2003), and they have not been observed during annual wildlife investigations conducted on the JIDPA and surrounding wildlife study area (TRC Mariah 1999, 2001a, 2001b, 2002, 2004a). Bald eagles are known to nest and roost along the New Fork and Green Rivers north of the JIDPA (TRC Mariah 2003c), and they also have been observed in the Farson-Eden area south of the JIDPA (BLM 1994).

3.2.3.3 Colorado River Endangered Fish Species

Four endangered Colorado River fish species--Colorado pikeminnow, razorback sucker, bonytail chub, and humpback chub--occur downstream from the JIDPA in the Green and Colorado Rivers. Water depletions from tributary waters within the Colorado River drainage jeopardize the continued existence of these fish and require formal consultation with the USFWS.

3.2.3.4 Ute Ladies'-Tresses

Ute ladies'-tresses is a perennial member of the orchid family that inhabits moist stream banks, wet meadows, and abandoned stream channels at elevations of 4,500-6,800 ft (Fertig 1994; Spackman et al. 1997). Where this plant occurs in ephemeral drainages, the soil typically is saturated within approximately 18 inches of the ground surface (USFWS 1992). Based on elevational range and lack of suitable habitat within the JIDPA, Ute ladies'-tresses is unlikely to occur in the area.

3.2.3.5 BLM Wyoming Sensitive Species

The BLM PFO identifies 27 BWS animal and 25 BWS plant species that may occur in the JIDPA. These species and their preferred habitats are listed in Table 3.20. Management efforts for these species primarily involve habitat maintenance.

Based on habitat preference and geographic location, three mammal and eight bird BWS species of the 27 BWS animal species potentially occur in the JIDPA (see Table 3.20). BWS animal species recorded recently in the JIDPA include Idaho pocket gopher, white-tailed prairie dog, pygmy rabbit, Brewer's sparrow, sage sparrow, loggerhead shrike, long billed curlew, mountain plover, greater sage-grouse, sage thrasher, burrowing owl, and ferruginous hawk (WYNDD 2003; TRC Mariah 2004a).

Based on habitat preference and geographic location (Hallsten et al. 1987; Dorn 1992), five of the 25 BWS plant species--bastard draba milkvetch, Trelease's milkvetch, Cedar Rim thistle, large-fruited bladderpod, and tufted twinpod--have the potential to occur in the vicinity of the JIDPA, and all five species have been recorded in the area (WYNDD 2003). The scattered/no sagebrush vegetation type (see Section 3.2.1.1 and Map 3.12) provides potential habitat for these species within the JIDPA.

3.2.4 Wild Horses

Spanish explorers originally introduced wild horses, also known as the American feral horse or mustang, to the western United States. Over the years, wild horses have become a mix of numerous breeds that have escaped or been released by the U.S. cavalry, farmers, ranchers, and miners. That portion of the JIDPA contained in the RSFO area is included in the Little Colorado Herd Management Area (LCHMA) (Map 3.20). The LCHMA encompasses 519,541 acres (of which 6,310 acres [1.2%] are in the JIDPA). The estimated wild horse population was 240 in 2001; the appropriate management level (AML) for this herd area is 69 to 100 horses (BLM 2001). The entire LCHMA is the wild horse CIAA for this Project. The portion of the JIDPA within the LCHMA does not receive a high level of wild horse use due to the limited availability of water. No managed wild horse herds occur in the PFO portion of the JIDPA and a fence separating the RSFO and the PFO areas restricts wild horse movement into the PFO area.

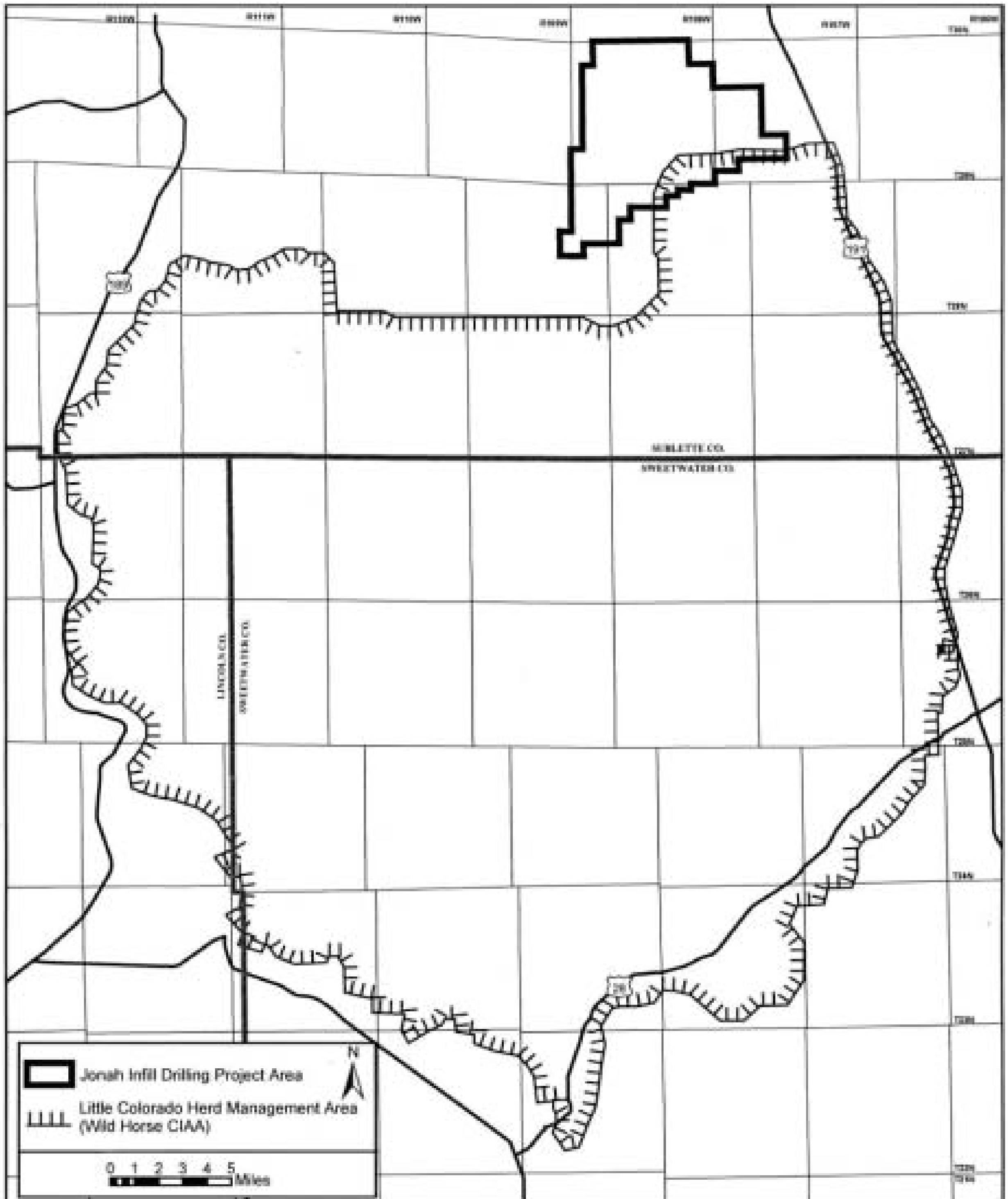
Table 3.20 BLM Pinedale Field Office Sensitive Animal and Plant Species and Potential Occurrence in the Jonah Infill Drilling Project Area, Sublette County, Wyoming, 2005.[1]

Common Name	Habitat Preference[2]	Recorded Occurrence[3]
MAMMALS		
Long-eared myotis	Conifer and deciduous forests, caves, and mines	
White-tailed prairie dog	Basin-prairie shrub, grasslands	X
Idaho pocket gopher	Shallow stony soils	X
Pygmy rabbit	Basin-prairie and riparian shrub	X
BIRDS		
White-faced ibis	Marshes, wet meadows	
Trumpeter swan	Lakes, ponds, rivers	
Northern goshawk	Conifer and deciduous forests	
Ferruginous hawk	Basin-prairie shrub, grassland, rock outcrops	X
Peregrine falcon	Tall cliffs	
Greater sage-grouse	Basin-prairie shrub, mountain-foothill shrub	X
Long-billed curlew	Grasslands, plains, foothills, wet meadows	X
Mountain plover	Cushionplant communities; low sparse vegetation	X
Yellow-billed cuckoo	Open woodlands, streamside willow and alder groves	
Burrowing owl	Grasslands, basin-prairie shrub	X
Sage thrasher	Basin-prairie shrub, mountain-foothill shrub	X
Loggerhead shrike	Basin-prairie shrub, mountain-foothill shrub	X
Brewer's sparrow	Basin-prairie shrub	X
Sage sparrow	Basin-prairie shrub, mountain-foothill shrub	X
FISH		
Roundtail chub	Colorado River drainage, mostly large rivers, also streams and lakes	
Leatherside chub	Bear, Snake, and Green River drainages, clear cool streams and pools	
Bluehead sucker	Bear, Snake, and Green River drainages, all waters	
Flannelmouth sucker	Colorado River drainage, large rivers, streams, and lakes	
Yellowstone cutthroat trout	Yellowstone drainage, small mountain streams, and large rivers	
Colorado River cutthroat trout	Colorado River drainage, clear mountain streams	
Fine-spotted Snake River cutthroat trout	Snake River drainage, clear fast water	
AMPHIBIANS		
Northern leopard frog	Beaver ponds, permanent water in plains and foothills	
Boreal toad (Northern Rocky Mountain population)	Pond margins, wet meadows, riparian areas	
Spotted frog	Ponds, sloughs, small streams	
PLANTS		
Pink agoseris	Mountain meadows	
Meadow pussytoes	Subirrigated meadows within broad stream channels	
Soft aster	Mountain parks and meadows	
Meadow milkvetch	Moist alkali meadows and swales in sagebrush valleys, 4,400-6,300 ft in elevation	

Table 3.20 (continued)

Common Name	Habitat Preference[2]	Recorded Occurrence[3]
Bastard draba milkvetch	Rocky areas with low cover within sagebrush and cushionplant communities on sandstone, stony clay, badlands, and barren clay slopes and ridges, 6,900-7,200 ft in elevation	X
Payson's astragalus	Clear cuts, burns, and blow-down areas in the Wyoming Range, 6,700-9,600 ft in elevation	
Trelease's milkvetch	Sparsely vegetated sagebrush communities on shale or limestone outcrops and barren clay slopes at 6,500-8,200 ft in elevation	X
Seaside sedge	Alpine and subalpine meadows	
Black and purple sedge (F)	High mountain slopes and meadows	
Cedar Rim thistle	Barren, chalky hills, gravelly slopes, and fine textured, sandy-shaley draws, 6,700-7,200 ft in elevation	X
Boreal draba	Volcanic slopes; cliffs and riparian areas with loamy alluvium, and mossy mats, 6,200-8,550 ft in elevation	
Rockcress draba	Rocky ridges and slopes in mountains	
Giant helleborine	Wet areas in Grand Teton and Yellowstone Parks	
Wooly fleabane	Talus steep alpine slopes or rims, 10,800-11,000 ft in elevation	
Narrowleaf goldenweed	Semi-barren clay flats and slopes, gravel bars and sandy lake shores, northwest and central Wyoming	
Keeled bladderpod	Sparsely vegetated outcrops on slopes and ridge crests, Teton County	
Large-fruited bladderpod	Gypsum-clay hills and benches, clay flats, and barren hills, 6,800-7,700 ft in elevation	X
Payson's bladderpod	Windswept gravelly ridge crests, semi-open slopes, and talus slopes in mountain sagebrush/grassland communities and conifer clearings, 5,500-10,600 ft in elevation	
Marsh muhly	Bogs, springs, peaty or calcareous meadows, floating mats, and stream edges, 4,700-6,600 ft in elevation	
Contracted Indian ricegrass	Plains and hills, basin areas, northwest-central, northeast, east-central, southwest and south-central Wyoming	
Naked-stemmed parrya	Steep talus slopes in alpine or upper subalpine zones, 9,600-12,240 ft in elevation	
Beaver Rim phlox	Sparsely vegetated slopes, Wind River Basin, Fremont County, 6,000-7,400 ft in elevation	
Tufted twinpod	Sparsely vegetated shale slopes and ridges 6,500-7,000 ft in elevation	X
Creeping twinpod	Barren, rocky, calcareous hills and slopes in mountainous areas, 6,500-8,600 ft in elevation	
Greenland primrose	Wet meadows and calcareous montane bogs, 6,600-8,000 ft in elevation	

1 Based on BLM (2003b).
2 Plant habitat preference based on Hallsten et al. (1987), Dorn (1992), and Keinath et al. (2003).
3 Recorded occurrences on or in the vicinity of the JIDPA (WYNDD 2003; TRC Mariah 2001a, 2001b, 2002, 2004a).



G:35982-Jonah Infill/8x11-mxd's/HMA_Little-Colorado.mxd/map3.20

Map 3.20 Little Colorado Wild Horse Herd Management Area (CIAA), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

However, horses from the LCHMA have entered the PFO area and the JIDPA (often through gates being left open); and are subsequently herded back to the RSFO and LCHMA.

3.3 CULTURAL AND HISTORIC RESOURCES

The following sections discuss the cultural resources within the JIDPA. An historic overview was provided in the Jonah II EIS (BLM 1997a, 1998a) and is not repeated in this EIS.

3.3.1 Introduction

Cultural resources, which are managed pursuant to the *National Historic Preservation Act of 1966* and the *Archaeological Resources Protection Act of 1979* and other statutes, are the nonrenewable remains of past human activity. The CIAA for cultural resources includes the JIDPA and surrounding area as depicted on Map 3.5. The archaeological record of the JIDPA has been created and identified through Class III cultural resource inventories (100% coverage pedestrian surveys), informal surveys, construction monitors, test excavations, salvage excavations, formal data recovery excavations, examination of ethnographic materials used to determine ethnic origin, local informant interviews, consultation with modern Native American people, archival sources, and the historic record. Continued development since 1997 and at an accelerated pace has steadily increased the number of cultural resource inventories performed (estimated at approximately 1,500), and the number of known sites has increased accordingly (estimated at between 1,000 and 2,000 sites).

3.3.2 Site Types

The JIDPA is rich in prehistoric resources but contains few historic period sites. The historic period sites predominately relate to open-range ranching, stock grazing, and wagon road passage. Most historic sites consist of nonsignificant debris scatters.

An informal search of the SHPO cultural records database indicated that (as of November 2003) there are over 1,000 known cultural properties within the JIDPA, the majority of which are prehistoric archaeological sites. Extrapolating from the results of seismic inventories that have provided broad systematic survey coverage of the area, roughly one site per 17 acres occurs within the JIDPA (an average of 38 sites per section). Actual site density is probably even higher due to frequently encountered buried archaeological sites that lack surface manifestations.

Known prehistoric site types within or near the JIDPA include open campsites, lithic scatters, housepits, rock alignments, kill/butchering sites, rockshelters, floral processing locales, sacred or respected sites, extensive lithic procurement locales (see Archaeological Landscapes, Appendix F-1.5 of the Jonah II EIS [BLM 1997a, 1998a]), limited activity sites, Traditional Cultural Properties, and sacred or respected places. A "Traditional Cultural Property" can generally be defined as a property that is eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that are rooted in the community's history and are important in maintaining the continuing cultural identity of the community. The Traditional Cultural Properties in the JIDPA also are considered sacred or respected places (areas that local Native American tribes consider sensitive, important for current uses [e.g., plant collection], and/or of religious importance pursuant to *EO 13007*. These properties include rock alignment sites, visionquest locales, stone circle sites such as tipi rings, and cairns. No drivelines are currently known, but they may be present in the area. No petroglyph or pictograph sites are presently known, even though the geology of the area (i.e., the presence of numerous rock outcrops) is conducive to the presence of these site types. One prehistoric human burial has been encountered. Prehistoric sites between 4,000 and 7,000 years old are common, many of which are completely buried with few (if any) surface manifestations.

A considerable amount of inventory, testing, monitoring, and salvage excavation has been completed in the JIDPA, especially since the mid-1990s (estimated at over 1,500 actions). It has resulted in the identification and recording of a large number of prehistoric cultural properties (estimated at over 1,000), most notably those discovered during construction. Larger-scale data recovery excavations are becoming more common as discoveries continue to be made and adverse effects are mitigated.

3.3.3 Native American Sensitive Sites and Traditional Cultural Properties

In the late nineteenth century, the JIDPA was used predominantly by the Shoshone Tribe, though Bannock, Ute, and other Tribes frequented the Upper Green River. Sites relating to prehistoric tribal use exist, but identifying specific tribal affiliation to these remains is difficult. Some prehistoric sites, as well as some of the more modern Native American use sites, may be considered respected areas or sensitive sites by modern Native Americans and may be formally considered Traditional Cultural Properties.

Sites and properties within this class are protected by numerous laws, such as the *Native American Graves Protection and Repatriation Act* (NAGPRA), the *American Indian Religious Freedom Act* (AIRFA), and by various executive orders (e.g., *EO 13007*). Human burials, rock alignment sites, petroglyphs, steatite procurement locales, and modern-day Native American use, extraction, or religious sites are considered sensitive or sacred to modern Native Americans. Several such sites have been identified in the area. Consultation with potentially affected Native American Tribes concerning the identification and management of specific Traditional Cultural Properties and other sensitive sites began in 1998, and this consultation resulted in several recommendations concerning the management of sensitive/sacred/respected sites, disturbance buffers, holistic management approaches and guidelines, and how Native American traditional practitioners want BLM to manage sensitive areas. The general theme of the consultation has been to leave these sensitive areas undisturbed.

Representatives of the Shoshone and Ute Tribes have visited the Jonah area during the period of 1997 through 2001. Consultation particularly focused on the site 48SU4000 Archaeological District. Additionally, in 2002, formal NAGPRA consultation with the Shoshone Business Council took place concerning the 7,300-year-old human remains encountered during construction of a well pad. Consultation among the BLM, Shoshone Tribe, and possibly other tribes would continue throughout Project development.

3.3.4 Culture Historic Context and Chronology

The prehistory of the Green River Basin, which encompasses the JIDPA, is typically considered in relationship to the prehistory of the larger western Wyoming Basin, which also includes the Great Divide and Washakie Basins and the Rock Springs and Rawlins Uplifts. The prehistory of the western Wyoming Basin is typically discussed in terms of a series of periods and phases originally defined specifically for the region by Metcalf (1987) (Table 3.21). The breakdown of periods and phases is based on such characteristics as artifact assemblages, house and pit forms, shifts in settlement or resource procurement patterns, and peaks and valleys in the frequencies of radiocarbon dates (Wheeler et al. 1986; Metcalf 1987; McNees et al. 1992; Thompson and Pastor 1995; Vlcek 1997). At the broader level, the prehistory of the region is broken down into the Paleoindian, Early Archaic, Late Archaic, Late Prehistoric, and Protohistoric periods. The Early Archaic, Late Archaic, and Late Prehistoric periods are typically further subdivided into the Great Divide and Opal phases, the Pine Spring and Deadman Wash phases, and the Uinta and Firehole phases, respectively. Though most researchers agree on the general nature and sequence of the phases, some disagreement exists on their beginning and ending dates. Table 3.21 uses the dating modified from McNees et al. (1992) and Vlcek (1997).

Evidence indicates that the JIDPA has been occupied almost continuously since at least the Folsom stage of the Paleoindian period about 10,900 years before present (B.P.). Occupation of the area apparently intensified after approximately 8,500 years B.P. and especially after 7,200 years B.P.

The Paleoindian period in Wyoming is typically discussed in terms of the sequence of "classic" Paleoindian point types initially established on the basis of data from the Hell Gap site in eastern Wyoming and subsequently amplified and refined. In the Wyoming Basin, it is typically represented by the Clovis, Goshen, Folsom, Agate Basin, and Hell Gap points. Alberta, Alberta-Cody, and Cody cultural complexes are also commonly represented but appear to be more transitional to the lifeways represented in the subsequent Archaic period. The Paleoindian period was characterized by a large-animal hunting-oriented economy that was specialized even in contrast to later bison-hunting groups on the plains.

Initially, that strategy focused on the procurement of mammoth and/or other megafauna, but then it shifted to bison and apparently incorporated an increasingly broader spectrum of smaller animal and plant resources.

Occasional surface finds of fluted projectile points of the Clovis and Folsom traditions indicate that, at a minimum, human beings have lived in the Green River Basin since the end of the Pleistocene geologic epoch. However, evidence of the big game foraging tradition, which has defined the early Paleoindian adaptation, is rare. Evidence most commonly consists of surface finds of Paleoindian points.

Table 3.21 Prehistoric Cultural Chronology for the JIDPA and Southwestern Wyoming.[1]

Period	Phase	Age (Years Before Present [B.P.])
Paleoindian	--	11,500-8,500
Early Archaic	Great Divide	8,500-6,000
	Opal	6,000-3,600
Late Archaic	Pine Spring	3,600-2,900
	Deadman Wash	2,900-1,800
Late Prehistoric	Uinta	1,800-1,000
	Firehole	1,000-250
Protohistoric	--	250-0

[1] Metcalf 1987; McNees et al. 1992; Vlcek 1997.

Few sites containing classic Paleoindian points have been discovered in the area, although such sites are known. For example, the site complex containing Sites 48SU389, 48SU907, 48SU908, and 48SU909 just south of the JIDPA has produced artifacts from the Folsom, Hell Gap, Agate Basin, Scottsbluff, and Cody complexes spanning a time period from 12,000 to 8,000 years B.P. (Frison 1991). Folsom points have been found at three localities in the JIDPA (two along Sand Draw and one in the 48SU4000 Archaeological District). At least 16 sites or locations have produced surface Paleoindian projectile points in the Jonah area. Site 48SU1421, situated adjacent to an ancient playa, contained several projectile points that tentatively date two components at the site from 9,000 to 8,500 years B.P. Another site (Site 48SU2980) encountered during pipeline construction has been dated to 8,600 years B.P. and has a possible Paleoindian connection, and sites/site complexes that include Sites 48SU2662, 48SU3087, and 48SU3090 have also produced Paleoindian material. A Hell Gap point was discovered eroding out of a low sand sheet in the northern Jonah field, and Scottsbluff complex artifacts have been recorded in various portions of the field, including within the Site 48SU4000 Archaeological District (see Section 3.3.7). Additionally, three Early Archaic period JIDPA sites (48SU2094, 48SU2324, and 48SU4479) dating from 4,590 to 8,210 years B.P. were recently excavated (McKern and Harrell 2004).

The lifeways defining the Early Archaic period in the western Wyoming Basin may have begun as early as the middle Paleoindian period, possibly as a result of a "settling-in" process (McNees 1998:36). These lifeways apparently were characterized by the more-intensive use of the landscape by groups pursuing an increasingly broad-spectrum hunting and gathering lifestyle. Specific characteristics of those lifeways are believed to have included a settlement and subsistence strategy oriented to specific geographic areas on a year-round basis, including especially a reliance on a broader range of plant and animal food resources. This more "place-oriented" lifeway resulted in the apparent elaboration of house and cooking pit forms represented in the archaeological record.

In the western Wyoming Basin in general, the archaeological record contains a gradually increasing number of dated components through the time period beginning around 8,500 years B.P., with a more significant increase after 6,000 years B.P. The number of radiocarbon-dated sites then generally declines again across the region throughout the Late Archaic period. Cultural remains dating to the Late Archaic period become more complex and more diverse through time. The earlier part of the Early Archaic period corresponding to the Great Divide phase is typically characterized by sites containing limited remains, typically a simple firepit or two, a few flaked stone artifacts, and bone scraps, most commonly from rabbits and occasionally pronghorn. Artifacts associated with Early Archaic period sites in the area tend to be limited in number and type. The Great Divide phase tends to be characterized by large side-notched points, which give way to more-diverse, less-distinctive, and less-frequent collections of side- and corner-notched projectile points of the Opal phase. After about 6,500 years B.P., housepits become a prominent trait of the period, as do slab-lined cylindrical baking pits and deep unlined baking pits after about 6,000 years B.P. The coalescence of those traits is judged to represent the transition to the Opal phase around 6,500 to 6,000 years B.P. The Opal phase appears to have been a time of a significant increase in the number of sites and population compared with the preceding and subsequent phases in the western Wyoming Basin in general (Smith 2003). Small mammals, especially rabbits probably opportunistically captured near the camps, are the most commonly identified animals from the housepit bone assemblages. However, pronghorn bone is also relatively common, and the Trapper's Point site to the north of the JIDPA evidences relatively intensive pronghorn procurement. The deep baking pits suggest the relatively widespread use of roots, most likely biscuitroot and onion.

One of the most distinctive aspects of the archaeological record of the JIDPA and its immediate surroundings is the abundance of archaeological sites dating to the later Great Divide phase, in contrast to the rest of the western Wyoming Basin (TRC Mariah 2001c). The archaeological record indicates that occupation of the JIDPA began to intensify after approximately 8,500 years B.P. as elsewhere in the region. However, the major increase in occupation apparently began around 7,200 years B.P. The appearance of the remains of house structures in and around the JIDPA likewise pre-dates that in the rest of the region. Figure 3.14 illustrates the excavation of a typical housepit. Most of the houses have yielded radiocarbon dates between 7,110 and 6,000 years B.P. A post mold associated with a house at Site 48SU3835 yielded an age estimate of 8,240 years B.P. (Nelson and Richard 2004) and one associated with a house at the J. David Love site (Site 48SU4479) yielded an age estimate of 8,210 years B.P. (McKern and Current 2004), the two earliest dates for house structures recorded in the region. Only a few structures in the project area have yielded dates of less than 6,000 years B.P. By contrast, only one housepit out of 41 fully excavated housepits from 21 sites in Wyoming listed by Smith (2003) and a list of excavated housepits from the Green River Basin and immediately adjacent areas compiled by Thompson and Pastor (1995) yielded a date of 6,000 years B.P. or older, and it was dated at 6,000 years B.P. Therefore, it is clear that the house remains in the Jonah area represent a distinctive temporal phenomenon in the archaeological record of the region.

The house structures excavated in the JIDPA are distinctive in other ways as well. They include both "classic" housepits characterized by large, circular stains that are basin-shaped in cross section, as well as circular or semicircular areas delineated by apparent post molds around the perimeter of clusters of hearth-type basins. The latter type appears to be distinctive to the Jonah area.

The transition from the Early Archaic period to the Late Archaic period is marked by a decrease in radiocarbon-dated sites in the western Wyoming Basin at about 3,600 years B.P. Despite minor regional peaks from 3,200 to 3,000 years B.P., 2,900 to 2,700 years B.P., and 2,000 to 1,800 years B.P., the frequencies of radiocarbon-dated sites remain depressed into the early Late Prehistoric period. Because of the limited number of investigated sites dating to the Late Archaic period, it remains poorly understood. The period was apparently marked by the decreased use of the area by interior basin-adapted groups, possibly reflecting a decline in population and/or a shift in settlement and subsistence strategies (McNees 1992).

Some investigators in the region have placed the end of the Opal phase Early Archaic period and the start of the Pine Spring phase Late Archaic period around 4,400 years ago to coincide with the full time span of McKean complex dart points in the region. However, sites containing McKean complex points appear to represent a different cultural phenomenon than the abundance of sites displaying more typical Opal phase traits such as housepits, slab-lined cylindrical pits, deep baking pits, and side- and corner-notched projectile points. Only after the cultural complex exhibiting these latter traits becomes attenuated around 3,600 years B.P. do sites containing McKean complex points become dominant as a result of the vacuum created by the absence of the more typical Opal phase sites.

The Pine Spring phase of the Late Archaic period is typically defined by the prevalence of McKean complex dart points. McKean complex stemmed and lanceolate dart points occur at sites in the western Wyoming Basin beginning as early as 4,900 years B.P. (McNees 1992). They appear to be most common at sites dated between 4,400 and 3,000 years B.P. Surface finds of McKean complex dart points are common within and around the JIDPA. McKean complex points

Figure 3.14 Typical Housepit Excavation, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

have been reported for Site 48SU1754 in the Bull Draw drainage, Site 48SU1328 on a bench above Sand Draw, and Site 48SU3090 at the Sand Draw playa complex. The McKean complex point at Site 48SU3090 is consistent with age estimates obtained from features in the complex, including estimates of 3,580 and 3,900 years B.P. from a cobble-lined and a bell-shaped basin, respectively, suggesting the presence of intact McKean complex components in the area (Plastino 1999). Based upon radiocarbon dating, a McKean concentration has been found in the JIDPA. The presence of Pine Spring phase sites in the JIDPA is also indicated by firepits radiocarbon dated to that time period.

The transition from the Pine Spring phase to the Deadman Wash phase is typically placed around 3,000 or 2,900 years B.P. to correspond with the transition from the use of McKean complex dart points to the use of corner-notched dart points. Evidence for Deadman Wash phase use of the JIDPA area is even more limited than for Pine Spring phase use. Corner-notched dart points diagnostic of the phase are not as distinctive or definitive as McKean complex points, making them less effective as an indicator of occupation of the area during that time period. Likewise, fewer features have been dated to this phase, which suggests that the phase may be poorly represented in the area.

The Uinta phase of the Late Prehistoric period exhibits a peak in the number of radiocarbon-dated components in the western Wyoming Basin, specifically between 1,500 and 1,000 years B.P. In many aspects, this phase of the Prehistoric period more closely resembles the Early Archaic period than the immediately preceding Late Archaic period or the subsequent Firehole phase. The Uinta phase is generally considered to coincide with the introduction or general adoption of bow and arrow technology. Pottery also first appears in the archaeological record of the region during this period, although it apparently only became an integral element of the indigenous inhabitants of the region after approximately 900 years B.P.

The Uinta phase is characterized by repeated occupation of the same site localities and the use of deep cylindrical basins, small circular habitation structures, more common ornamental artifacts (e.g., bone tubes and bone disks), and a broad spectrum of large and small animals and plant resources, including pronghorn, occasionally bison, and seeds from weedy annuals. Uinta phase sites and components are often much more artifact- and data-rich than sites from other periods. Classic Uinta phase sites contain Rose Spring arrow points but lack pottery. Interestingly, radiocarbon-dated Uinta phase sites or sites with Rose Spring points are relatively uncommon in the JIDPA.

Following the Uinta phase is the Firehole phase. In most of the western Wyoming Basin, Firehole phase sites are rare in comparison to Uinta phase sites. McNees (1992) argues the Firehole phase represents a return to a lifeway that relied more heavily on hunting large game animals, including bison, similar to that of the Pine Spring and Deadman Wash phases, with less reliance on more intensive use of smaller animals and plants. The Firehole phase is characterized by the predominance of side-notched, tri-notched, and unnotched points; by quartz sand-tempered (Intermountain Ware) pottery; and by the abrupt disappearance of typical Uinta phase traits between 1,000 and 950 years B.P. The historic Shoshone inhabitants of the region likely first arrived during the Firehole phase.

In contrast to much of the western Wyoming Basin, the JIDPA and surrounding area contain a large number of sites dating to the Firehole phase. Site 48SU4000 Archaeological District appears to be dominated by Firehole phase materials (Miner 2001). The phase is associated with an extensive and distinct area of interior basin sandstone outcrops and includes numerous rockshelter alcoves and stone circles. Associated artifacts include side-notched and unnotched points and ceramics from five distinct localities. Ceramics recovered from 48SU4000 have been subject to thin sectioning analysis, and local manufacture is indicated. These ceramics show similarities to those found at the Wardell Buffalo Trap (Frison 1993). This ceramic assemblage (two sites with 500 sherds each) represents the highest known concentration of prehistoric ceramics anywhere in southwestern Wyoming. Ceramics have also been recovered from other sites in the area, including Sites 48SU1443, 28SU2261, and 48SU3017.

3.3.5 Geomorphology

Geomorphological studies that examine the relationship among geology, soils, topography, and vegetation are important to archaeologists because most significant prehistoric sites are located within specific soil matrices (i.e., the history of which contributes to the integrity of the site, the integrity of cultural deposits, and the post-depositional history of the site). These factors are critical for understanding the nature, integrity, and preservation potential of the archeological resources in the JIDPA.

Of particular interest in the JIDPA is the San Arcacio-Saguache soils complex (soil map unit 125), which occurs along the lower and middle reaches of Sand Draw. The San Arcacio soils form on geomorphically stable surfaces at less than 3% slopes, mainly on level or uniformly sloping surfaces with deposits of uniform depth. They typically exhibit a sandy clay loam horizon with oxidized colors and clay enrichment over coarse sand (Eckerle and Taddie 1997) and occur on old floodplains, fans, and terraces. The soils are typically sandy and have formed in coarse sandy alluvium (ERO Resources Corporation 1988:49). Plastino (Plastino and Randolph 2000:4) describes the soils as "sandy loam above coarse sand with an increasing gravel content with increasing depth." According to Eckerle and Taddie (1997:8), "The [San Arcacio] soil is formed into a coarse, moderately well-sorted, subangular to subrounded, nonfrosted sand, [the] exact genesis of which is not presently known." They argue that the source material of the sand does not appear to be local. The depth of the sand deposit exceeds 4 m in at least one location.

Eckerle and Taddie (1997) state that the San Arcacio soils compare well to the Vonalee-Hiland soil/paleosol documented in other parts of the Wyoming Basin on aeolian deposits that have been stable since the middle Holocene, except that they are slightly older. They suggest that occupation occurred on a sheet deposit intermittently active from sometime before 7,000 years B.P. until approximately 3,700 years B.P., after which the surface stabilized, and the San Arcacio soils began to form. The San Arcacio soils remain the modern surface.

Buried cultural features have frequently been encountered in San Arcacio soils during construction in the Sand Draw area. Those features typically range in age from approximately 4,000 years B.P. to greater than 7,000 years B.P. The tops of the features typically occur at depths of only 15 to 20 cm below the ground surface, yet the locales frequently lack any surface manifestation or topographic relief to differentiate them from other portions of the surrounding landscape. The features typically include hemispherical basins with and without rock, as well as housepits and other house remains. They are typically encapsulated within the aforementioned sandy clay loam soil horizon and exhibit remarkable preservation.

3.3.6 Discovered Sites

In recent years, discoveries have occurred in a number of management contexts. Those contexts include discoveries at previously recorded sites at which subsurface components were not expected or detected (sometimes despite extensive testing and/or magnetometer surveys), previously unidentified sites with (often very sparse) surface expressions, and previously unidentified sites lacking any surface expression. The latter are by far the most prevalent and the most problematic because there is no favorable or adequate current methodology to identify them in a cost- and time-effective manner prior to construction. Discoveries have occurred in a number of different construction contexts, including well pad stripping and leveling, access road construction, and pipeline trench construction. The sites include locales with housepits or other structural remains and basins with low to moderate densities of artifacts, locales with stained layers and basin features with moderate densities of associated flaked stone artifacts and bone, locales consisting primarily of basin features with few associated artifacts, and locales with a single hearth or cultural stain. In portions of the JIDPA (i.e., Stud Horse Butte, Corona, and Cabrito units), nearly one in six projects have yielded discoveries (TRC Mariah 2001c).

As of August 2004, one prehistoric human burial has been encountered within a discovery scenario, although the actual human remains were found during salvage excavations. The majority of the discoveries to date have occurred at a relatively shallow depth (15 to 30 cm) in sheet deposits. The best known of those deposits are the San Arcacio soils of the Sand Draw area. Other sediment types in the JIDPA, away from the Sand Draw terraces, have yielded discoveries in often geomorphologically complex contexts that have also proven difficult to identify by surface analysis and preconstruction testing. These discoveries have generally not been as significant or as time-consuming to mitigate as the structural remains that are mostly found in the San Arcacio soil contexts along Sand Draw.

House remains initially identified during well pad or access road construction have been partially or completely excavated at a minimum of seven sites in the JIDPA to date. They include the remains of 17 housepits or surface structures excavated at the McKeva Ryka site (Site 48SU2094), Jonah's House site (Site 48SU2324), and J. David Love site (Site 48SU4479), and Sites 48SU3835, 48SU2317, 48SU3291, and 48SU3519. The houses generally had interior firepits, but few flaked stone artifacts, bone fragments, or other remains were associated with most of the houses. Fossils, tentatively identified as Pleistocene horse bones, a very rare occurrence in Wyoming, have also been discovered and a human burial dated at 7,290 years B.P. was encountered in a shallow circular pit at the J. David Love site (McKern and Current 2004). This burial represents the earliest known human remains from Wyoming and is one of the earliest known burials from the entire Rocky Mountain region.

3.3.7 Highly Sensitive Archaeological Locales

The following section discusses the most highly sensitive and threatened archaeological locales in the JIDPA. Development and implementation of specific activity plans may be necessary to ensure that these valuable resource areas are adequately protected from impacts directly or indirectly related to energy development.

3.3.7.1 Sand Draw/Bull Draw Divide

The Sand Draw/Bull Draw Divide upland is one of the most sensitive and complex locales currently known for the JIDPA. During 2000-2001, it was the subject of an intensive block inventory followed by formal site recordations and evaluations (Miner 2001). The site complex has been designated the "Site 48SU4000 Archaeological District" and is also known as the "Vlcek Archaeological District." This is the first Archaeological District established within the PFO.

The site complex is characterized by sandstone outcrops containing vertical rock faces, overhangs, nooks, and boulders bordering and enclosing sand-filled openings and pockets. A nearly continuous scatter of cultural material is present across that area. Identified archaeological remains include numerous rockshelters and alcoves containing cultural deposits, stone circles, buried hearths, areas of culturally stained sediment, numerous projectile points and point fragments, abundant bifaces and other flaked stone tools, ceramics, abundant obsidian artifacts, groundstone, at least one sandstone abrader, abundant burned bone, and mussel shell, among other things. Rock art is conspicuously absent from the cultural remains noted to date, despite the presence of suitable rock faces. Prehistoric human burials or interments have also not been identified to date, although their occurrence somewhere within or around the rock outcrops is likely.

Much of the described cultural remains apparently date to the Late Prehistoric period (primarily to the Firehole phase) but all other temporal periods are represented as well. Projectile points and point fragments typically include small side-notched points. Small triangular points and at least one base-notched point have also been recovered. Potsherds were recovered from at least five loci within the locale, some of which apparently closely resemble the ceramics from the Wardell Bison Kill site. Small- and medium-sized corner-notched points and point fragments are also present. A Folsom point was also reportedly collected from one locale within the site complex. Numerous clusters of artifacts were thought to be collectors' piles and indicators of extensive vandalism. Miner (2001) refutes this, however, making a strong argument that most of the piles are the result of packrat activity.

The Site 48SU4000 Archaeological District is an exceedingly significant set of properties unique to the region. The area is also considered highly sensitive by Native Americans. The types, density, and diversity of the remains all contrast sharply with the remains typically encountered in the JIDPA and the region. The District contains numerous areas of apparently intact deposits containing dense, well-preserved remains with rich data potential. Moreover, it appears to have significant, and perhaps unique potential to provide insight into some of the more distinctive and prominent cultural manifestations known in the region, especially during the Late Prehistoric period, including potentially the poorly understood but distinctive cultural manifestation represented at the nearby Wardell Bison Kill site. There is also a possibility of relict Folsom and other Paleoindian deposits in isolated nooks or pockets.

3.3.7.2 Sand Draw Playa Complex

The Sand Draw playa is situated toward the lower (western) end of Sand Draw approximately 700 ft south of the stream channel. It is encircled by a low rim around its western, southern, and eastern sides but opens north toward Sand Draw. It has been modified by historic ranching activity by way of a ditch into Sand Draw. The playa area is privately owned. Another large enclosed depression is located slightly less than 1 mile to the north, and a smaller enclosed depression is located just over 0.5 mile to the north-northwest, north of Sand Draw. Both of these depressions are on BLM surface. Neither of these depressions are presently mapped as playas, but both may have been playas in the past and they suggest that a complex of playas may have once been present in the area.

The playa complex area may have served as a focus for Paleoindian period occupations. A similar playa complex in the Jonah Gulch site complex (including Sites 48SU389, 48SU907, 48SU908, and 48SU909), located approximately 12 miles to the southeast, contains extensive Paleoindian components. To date, no significant intact Paleoindian components have been identified in the vicinity of the Sand Draw playa complex. However, both a Folsom point and a point tentatively identified as Goshen or Dalton have been recovered as surface finds, suggesting that such components may be present.

The Sand Draw playa complex, due to its capture of more moisture than other JIDPA locations, may preserve archaeologically important paleoclimatic data. Specifically, pollen, which usually is not preserved or recovered from archaeological deposits in other JIDPA locations, may be well preserved in the playa complex. These data are critical for establishing baseline information concerning the paleoenvironmental reconstruction of the JIDPA.

Plastino (1999) noted two soil types within the playa complex area during testing at Site 48SU3090 in a sheltered backslope context with colluvial and aeolian deposits, and in a lower slope/drainage bottom context characterized by slopewash deposits. Testing and monitoring have indicated the presence of intact subsurface deposits of both types, including a basin well out into and under modern playa deposits at a depth of 25 cm below the ground surface at Site 48SU3089 at the northern tip of the playa. A stain of possible cultural origin was also noted at a greater depth of 51 cm.

Three sites adjacent to the Sand Draw playa were tested as part of a testing program associated with a geophysical project (Kohler et al. 2003). The sites (Sites 48SU2662, 48SU3087, and 48SU3090) were selected because of their abundant surface artifacts and potential to contain buried Paleoindian cultural remains. These sites have usually been avoided by development projects, and little subsurface testing has been performed. The limited testing program revealed few, if any, cultural remains at the three sites, and no intact cultural components were identified. The tested areas generally exhibited colluvial/slopewash deposits and did not contain San Arcacio soils.

Discoveries made during testing and monitoring indicate that the Sand Draw playa area is characterized by a large proportion of basin types not commonly represented in other parts of the JIDPA. They include cobble-lined and cobble-filled basins, bell-shaped basins, and U-shaped basins (e.g., at Sites 48SU3049, 48SU3850, and 48SU3089). Point types noted in the area include a McKean complex point, a point described as a "Pelican Lake or Rose Spring" point, and a Rose Spring point. The apparent McKean point is consistent with age estimates obtained from features in the complex, including estimates of 3,580 and 3,900 years B.P. from a cobble-lined basin and a bell-shaped basin, respectively, which suggest the presence of intact McKean complex components in the area.

These patterns suggest that the playa complex may have been a locus of different procurement/processing activities and/or of more concentrated occupation by different groups and/or at different times than other portions of the JIDPA. Therefore, sites in the area have the potential to provide distinct and important information concerning prehistoric land use patterns in the JIDPA and the region.

3.3.7.3 Central Sand Draw

Terraces along the central part of Sand Draw contain a concentrated locus of early to mid-Holocene housepits and other structural remains and contemporaneous basins, as was discussed above with regard to the Sand Draw/Bull Draw Divide. This segment of Sand Draw lies below and to the west of Stud Horse Butte at its upper end and above the Sand Draw playa at its lower end. The housepit occupations may have been intentionally positioned in proximity to the playa complex.

Plastino (1999) describes a series of at least three terraces above Sand Draw. He estimates the three terraces occur at 2 m, 4 m, and >4 m above the modern Sand Draw channel. He describes two of the terraces as strath terraces with nearly level trends. Sediments across the lower terraces are classified as San Arcacio soils.

As part of the geophysical project mentioned above, four sites were selected for testing along Sand Draw to investigate areas of interest that are usually avoided during development projects (Kohler et al. 2003). Sites in the testing program along Sand Draw included Sites 48SU1779, 48SU2246, 48SU3088, and 48SU4011. Most of the testing was conducted in San Arcacio sediments, and the majority of cultural material was recovered from San Arcacio strata. Two San Arcacio strata were identified: San Arcacio "A" stratum was interpreted as post-dating 3,000 years B.P., and San Arcacio "B" stratum was the lower, older layer dating between 3,000 and 7,000 years B.P. Site 48SU2246 was the only site tested that did not contain San Arcacio soils. Ceramic and obsidian artifacts were found on the surface of this site, and additional pieces of pottery were recovered from the test unit. Site 48SU2246 appears to date to the Late Prehistoric period based on the ceramic assemblage, while the remaining sites appear to date to the Archaic period based on their presence in San Arcacio soils. Only a few features were identified in the 67 m^2 of excavation, none were structural, and none were radiocarbon dated. Few of the test units yielded more than a small number of artifacts or other types of cultural remains.
Recent notable housepit/structure data recovery excavations along Sand Draw have occurred at the McKeva Ryka site (Site 48SU2094), Jonah's House site (Site 48SU2324), the J. David Love site (Site 48SU4479), Site 48SU3835, and Site 48SU3519. These sites are all located on the Sand Draw terraces in San Arcacio sediments, and all were excavated to mitigate impacts to features encountered during well pad or access road construction.

The McKeva Ryka site contained two housepits with postholes and interior and exterior features (McKern and Current 2002). Artifacts included a light scatter of flaked stone and bone. The housepits were radiocarbon dated to between 5,990 and 6,880 years B.P. The housepits appear to represent short-term habitations that were revisited seasonally over hundreds of years.

The Jonah's House site is similar to the McKeva Ryka site in setting, cultural remains, and apparent function. It contained two housepits with postholes and a sparse scatter of artifacts and bone (McKern and Current 2003). It was radiocarbon dated to between 6,590 and 7,070 years B.P. and also is interpreted as representing short-term, repeated habitations.

The J. David Love site is rich in structural remains, containing six housepits and three surface structures dating between 4,590 and 8,210 years B.P. (McKern and Current 2004). A pit feature in one of the housepits contained human burial remains dating to 7,290 years B.P. The burial represents the remains of an elderly woman, and it is suggested that the structure was constructed specifically for the burial. Artifacts at this site were sparse but did include fragments of red ochre.

Site 48SU3835 included a single, flat-floored surface structure with 26 postholes, six internal features, and an intact roof layer (Nelson and Richard 2004). A sparse scatter of lithic artifacts was present on the site surface, but a magnetometer survey of the area conducted prior to well pad blading did not yield evidence of buried cultural remains. Radiocarbon dates from the discovery ranged from 5,600 to 8,240 years B.P. Of particular interest was the presence of about 300 pieces of microdebitage (small discarded materials such as flakes) and about 1,000 small bone fragments recovered from feature fill. The recovery of this quantity of artifacts from a single structure is uncommon.

Site 48SU3519 was not identified during the Class III inventory that included magnetometer survey, but well pad construction revealed a cluster of 10 basin features and 11 scattered basin features (Sines and Roufs 2001). Twenty-five flakes and approximately 802 small pieces of bone were recovered from the heavy fraction of flotation fill samples. A series of possible post molds associated with the feature cluster suggests that this site also contained a shelter. Six age estimates ranging from 4,050 to 7,110 years B.P. were obtained from the features.

The housepits and other features in the central Sand Draw area provide excellent potential to contain cultural material from a time period that is crucial for understanding North American prehistory, particularly the Paleoindian-Archaic lifeway transition and hunter-gatherer adaptation to the severe climatic conditions of the Altithermal climatic episode. Intact buried components dating to that time period are uncommon, as are concentrations of housepit loci. The combination of the two in central Sand Draw would be unparalleled anywhere in the western United States.

3.4 SOCIOECONOMICS

Unless otherwise cited, the socioeconomic information that follows has been summarized from the Socioeconomic Analysis Technical Support Document for the Jonah Infill Drilling and South Piney Projects Environmental Impact Statements (BLM 2005). This document is available from the BLM PFO. Please refer to that document for more detailed socioeconomic information and analysis. Additional information has been taken from the socioeconomic profile (BLM 2003d) prepared for inclusion in the new Pinedale RMP (now in preparation). Unless otherwise stated, all dollar amounts are presented in year 2000 dollars, adjusted for inflation. Formulas used to make the calculations presented herein (e.g., change, average annual change) are illustrated and explained in detail in BLM (2005).

3.4.1 Study Area

The economic study area (i.e., the CIAA) includes the counties and communities most likely to be impacted by the proposed project, including LaBarge in Lincoln County; Pinedale, Big Piney, Marbleton, and Boulder in Sublette County; and Eden, Farson, and Rock Springs in Sweetwater County. Rock Springs is a hub of natural gas development activity and likely will be home to some of the workers. Wyoming and the United States are also included in the profile and impact analyses (see Section 4.4) where information is available and pertinent. The three-county area and the listed communities also comprise the CIAA.

3.4.2 Demography

3.4.2.1 Population Dynamics and Census Data

Population data were obtained from the U.S. Census Bureau (2000a, 2000b, 2000c, 2000d), Taylor and Lieske (2002), and the Wyoming Department of Administration and Information (WDAI) (2001a, 2001b, 2002a, 2002b, 2003a) (Tables 3.22 and 3.23). Sonoran Institute Economic Profile System (EPS) reports, charts, and raw data are on file TRC Mariah's Laramie, Wyoming, office.

Table 3.22 Historic and Projected Population.

Location	Population[1]			Total Change in Population[1]			Projected Population[1]				
	1980[2]	1990[2]	2000[2]	1980-1990	1990-2000	1980-2000	2002[3]	2010[4]	2015[4]	2020[4]	2025[4]
United States	226,542,199	248,709,873	281,421,906	9.8%	13.2%	24.2%	288,368,698	297,716,000	310,133,000	322,742,000	335,050,000
State of Wyoming	469,557	453,588	493,782	-3.4%	8.9%	5.2%	498,703	607,000	641,000	670,000	694,000
Lincoln County	12,177	12,625	14,573	3.7%	15.4%	19.7%	14,890	15,520	NP	NP	NP
LaBarge	302	493	431	63.2%	-12.6%	42.7%	NR	NR	NP	NP	NP
Sublette County	4,548	4,843	5,920	6.4%	22.2%	30.2%	6,240	6,690	NP	NP	NP
Big Piney	530	454	408	-10.1%	-1.3%	-23.0%	NR	461	NP	NP	NP
Bondurant	NR	NR	155	--	--	--	NR	NR	NP	NP	NP
Boulder	NR	NR	30	--	--	--	NR	NR	NP	NP	NP
Cora	NR	NR	76	--	--	--	NR	NR	NP	NP	NP
Daniel	NR	NR	89	--	--	--	NR	NR	NP	NP	NP
Marbleton	537	634	720	18.0%	16.9%	34.1%	NR	814	NP	NP	NP
Pinedale	1,066	1,181	1,412	10.7%	20.3%	32.5%	NR	1,596	NP	NP	NP
Sweetwater County	41,723	38,823	37,613	-6.9%	-3.1%	-9.9%	37,194	35,400	NP	NP	NP
Eden	NR	NR	388	--	--	--	NR	NR	NP	NP	NP
Farson	NR	NR	242	--	--	--	NR	NR	NP	NP	NP
Rock Springs	19,458	19,050	18,708	-2.1%	-1.7%	-3.9%	NR	17,607	NP	NP	NP

1 NR = not reported; -- = not calculated due to lack of information; NP = no projection available at this geographic level.
2 WDAI (2001a). Information for Bondurant, Boulder, Cora, Daniel, Eden, and Farson was not collected until the 2000 census. U.S. Census Bureau information was not collected for LaBarge until the 1990 census; however, WDAI reported 1980 estimates (WDAI 2001a).
3 Estimate as of July 2002. WDAI (2003a).
4 U.S. (Campbell 1997) and Wyoming (WDAI 2002b) projections.

Table 3.23 Urban and Rural Population and Density, 2000.

	Population[1]				
		Rural			
Location	Urban	Total	Farm[2]	Non-Farm[2]	Density per Square Mile
United States					
No. of People	222,358,309	59,063,597	2,987,531	56,076,066	79.6
Percent	79%	21%	5%	95%	NA
State of Wyoming					
No. of People	322,073	171,709	15,150	156,559	5.1
Percent	65%	35%	9%	91%	NA
Lincoln County					
No. of People	2,958	11,653	718	10,897	3.6
Percent	20%	80%	6%	94%	NA
Sublette County					
No. of People	--[3]	5,920	477	5,443	1.2
Percent	--	100%	8%	92%	NA
Sweetwater County					
No. of People	33,512	4,101	416	3,685	3.6
Percent	89%	3%	10%	90%	NA

[1] U.S. Census Bureau (2000a).
[2] Total rural residents living on farms and not living on farms.
[3] Sublette County has no urban population as defined by the U.S. Census Bureau.

Lincoln County

The Lincoln County population increased 3.7% between 1980 (12,177) and 1990 (12,625); however, by 2000, the population rose to 14,573, a 15.4% increase from 1990 (U.S. Census Bureau 2000a, 2000b) (see Table 3.22). Thus, the Lincoln County population increased by 2,396 (19.7%) during the 20-year study period. The majority of Lincoln County residents (11,653, 80.0%) live in rural areas (see Table 3.23). Of these, 93.5% (10,897) are nonfarm residents (U.S. Census Bureau 2000d). Lincoln County has a population density of 3.6 people/square mile (U.S. Census Bureau 2000a).

LaBarge is the community in Lincoln County that is most likely to be affected by the proposed project. Unlike Lincoln County as a whole, the population of LaBarge rose from 302 in 1980 to 493 in 1990 (63.2% increase) then fell to 431 in 2000 (-12.6%), for a net increase of 129 (42.7%) during the 20-year study period (see Table 3.22).

Sublette County

The Sublette County population in 2000 was 5,920, up from 4,843 (22.2%) in 1990 and up from 4,548 (30.2% overall) in 1980 (U.S. Census Bureau 2000a, 2000b) (see Table 3.22). Sublette

County has no urban areas as defined by the U.S. Census Bureau. Therefore, the entire population is considered rural, but of that number, 477 (8.1%) are farm residents, while 5,443 (91.9%) are nonfarm residents (U.S. Census Bureau 2000d) (see Table 3.23). Sublette County has a population density 1.2 people/square mile (U.S. Census Bureau 2000c).

Pinedale, Big Piney, Marbleton, and Boulder in Sublette County are the communities most likely to be affected by the proposed project. Bondurant, Cora, and Daniel may also be affected. Census data for Bondurant, Boulder, Cora, and Daniel were not collected until the 2000 census. In 2000, Pinedale had the largest population in Sublette County (1,412), while Boulder had the smallest population in the entire study area (30) (see Table 3.22).

According to local officials, populations have changed in the Sublette County area since the census was conducted. Pinedale has grown, although the growth has not been quantified (personal communication, May 20, 2004, with Patti Raisch, Pinedale Town Clerk); Marbleton has increased to possibly 750 residents (personal communication, May 21, 2004, with Alice Griggs, Marbleton Town Clerk), and Big Piney has remained stable or declined (personal communication, May 20, 2004, with Vickie Brown, Big Piney Town Clerk).

<u>Sweetwater County</u>

The Sweetwater County population in 2000 was 37,613, down from 38,823 (-3.1%) in 1990 and from 41,723 in 1980, thus the decrease over the 20-year study period was 9.9% (-4,110) (U.S. Census Bureau 2000a, 2000b) (see Table 3.22). Sweetwater County has a population density of 3.6 people/square mile; however, unlike Sublette County, 89.1% (33,512) of the Sweetwater County population lives in urban clusters (U.S. Census Bureau 2000d) (see Table 3.22). Of the 4,101 rural residents, only 416 (10.1% of rural residents; 1.1% of county residents) reside on farms.

Rock Springs is the community most likely to be affected in Sweetwater County; however, Eden and Farson may also be affected. No census data were collected for Eden and Farson until 2000. Rock Springs reflected Sweetwater County's trend, declining 1.7% from 19,458 in 1980, to 19,050 (-2.1%) in 1990, to 18,708 (-3.9% from 1980) in 2000. In 2000, Rock Springs had the largest population in the entire study area (18,708) (see Table 3.22). In the affected portion of Sweetwater County, Farson had the smallest population (242) (U.S. Census Bureau 2000a, 2000b).

3.4.2.2 Income, Poverty, and Unemployment

Income, poverty, and unemployment data are presented in Table 3.24. Households throughout the United States experienced increased income over the 20-year study period, although poverty levels remained relatively static and unemployment decreased. Overall, for the 20-year study period there was no change in poverty levels in the United States (U.S. Census Bureau 1981, 1990, 2000a). The national unemployment rate dropped throughout the 20-year study period from 7.1% to 4.0% from 1980 to 2000 (Bureau of Labor Statistics 2003). Both median household income and personal per capita income increased throughout the United States over the course of the 20-year study period--19.3% and 38.5%, respectively.

In contrast, the median household income throughout Wyoming fell by 9.3% over the course of the 20-year study period, although personal per capita income increased by 11.4% (only 0.5%

Table 3.24 Income, Poverty, and Unemployment.

	Median Household Income[1,2] ($)			Personal Per Capita Income[1,2] ($)			Poverty Rate[1] (%)			Unemployment Rate[1] (%)		
Location	1980[3]	1990[4]	2000[5]	1980[3,6]	1990[4,6]	2000[5,6]	1979[3]	1989[7]	1999[5]	1980[8,9]	1990[9,10]	2000[10,11]
United States	35,194	39,599	41,994	21,280	25,787	29,469	12.4	11.8	12.4	7.1	5.6	4.0
State of Wyoming	41,784	35,700	37,892	24,561	23,696	27,372	7.9	11.2	11.4	4.0	5.5	3.9
Lincoln County	37,627	37,534	40,794	19,602	19,071	20,980	11.5	11.1	9.0	6.0	6.6	5.2
LaBarge	NR	12,142	18,837	NR	6,995	18,837	NR	24.5	12.3	NR	NR	NR
Sublette County	36,425	35,343	39,044	25,201	24,746	26,927	9.7	8.8	9.7	2.7	2.9	3.8
Big Piney	NR	15,418	17,647	NR	8,882	17,647	NR	6.2	11.5	NR	NR	NR
Bondurant	NR	NR	19,432	NR	NR	19,432	NR	NR	19.2	NR	NR	NR
Boulder	NR	NR	12,500	NR	NR	NR	NR	NR	33.3	NR	NR	NR
Cora	NR	NR	20,831	NR	NR	20,831	NR	NR	7.9	NR	NR	NR
Daniel	NR	NR	21,213	NR	NR	21,213	NR	NR	24.4	NR	NR	NR
Marbleton	NR	15,125	18,446	NR	8,713	18,446	NR	10.1	4.2	NR	NR	NR
Pinedale	NR	17,030	20,441	NR	9,811	20,441	NR	12.9	8.9	NR	NR	NR
Sweetwater County	50,394	47,707	46,357	10,955	16,810	28,037	5.2	7.4	7.8	3.7	5.5	4.8
Eden	NR	NR	52,625	NR	NR	18,392	NR	NR	17.6	NR	NR	NR
Farson	NR	NR	44,545	NR	NR	16,140	NR	NR	0.0	NR	NR	NR
Rock Springs	19,525	19,456	51,539	4,471	11,208	19,396	5.8	8.5	9.4	NR	NR	NR

1 NR = not reported.
2 All national, state, and local area dollar estimates are in year 2000 dollars adjusted for inflation based on U.S. average consumer price index (for urban consumers). EPS uses the urban consumer base; therefore, it was also applied to inflation adjustments for this technical report to maintain consistency.
3 U.S. Census Bureau (1981) (based on 1979 income); median household income for all geographic units; personal per capita for towns and cities. Poverty rate is the percent of people in poverty.
4 U.S. Census Bureau (1990) (based on 1989 income); median household income for all geographic units; personal per capita for towns and cities. Poverty rate is the percent of people in poverty.
5 U.S. Census Bureau (2000c) (based on 1999 income); median household income for all geographic units; personal per capita for towns and cities.
6 Bureau of Economic Analysis (BEA) (2003a); EPS (2003) for nation, state, and counties.
7 WDAI (2001b). Poverty rate is the percent of people in poverty.
8 Wyoming Department of Employment, Research, and Planning (WDERP) (2002a). Unemployment rate is the percentage of people actively seeking work but unemployed.
9 Bureau of Labor Statistics (BLS) (2003a). Unemployment rate is the percentage of people actively seeking work but unemployed.
10 WDERP (2002b). Unemployment rate is the percentage of people actively seeking work but unemployed.
11 WDERP (2002c). Unemployment rate is the percentage of people actively seeking work but unemployed.

average annual growth) over the 20-year study period (see Table 3.24). Over the 20-year study period, the median household income in Lincoln County increased 8.4%, Sublette County increased 7.2%, and Sweetwater County fell 8.0%.

Personal per capita income in 2000 in Wyoming was $27,372, whereas personal per capita income in the study area ranged from $28,037 in Sweetwater County to $20,980 in Lincoln County (see Table 3.24). The poverty rate in Wyoming was 11.4% in 2000, while poverty rates in the study area ranged from 33.3% in Boulder (Sublette County) to 0.0% in Farson (Sweetwater County) (U.S. Census Bureau 2000a).

In distinct contrast to national increases, Wyoming's personal per capita income fell by 3.5% from 1980 to 1990 but experienced a recovery of 15.5% from 1990 to 2000, for an overall increase of 11.4% (only 0.5% average annual growth) over the 20-year study period (see Table 3.24). From 1980 to 2000, personal per capita income in Lincoln County increased 7.0% but only slightly exceeded the poverty level ($18,244), Sublette County increased by 6.8%, and Sweetwater County increased 155.9%.

The poverty rate in Wyoming increased over the 20-year study period from 7.9% in 1979 to 11.4% in 1999 (U.S. Census Bureau 1981, 1990, 2000a), while the unemployment rate for Wyoming rose between 1980 (4.0%) and 1990 (5.5%) then decreased to 3.9% by 2000 (see Table 3.24) (Wyoming Department of Employment, Research, and Planning [WDERP] 2002a, 2002b, 2002c). In Lincoln County, the poverty rate decreased slightly from 1979 (11.5%) to 1989 (11.1%) and decreased again to 9.0% by 1999. In Sublette County, it decreased from 9.7% in 1979 to 8.8% in 1989 but, despite the gains in personal income, increased back to 9.7% by 1999. In Sweetwater County, the poverty rate increased from 5.2% in 1979 to 7.4% in 1989 but only slightly increased to 7.8% between 1989 and 1999.

Generally throughout the study area, unemployment rates have increased, ranging from 5.2% in Lincoln County to 3.8% in Sublette County (see Table 3.24).

Data were not collected for LaBarge until the 1990 census. LaBarge has experienced trends similar to the state, with median household income increasing by approximately 55.1% (4% average annual growth [see BLM 2005 for formula used to calculate average annual growth]) from 1990 to 2000 (see Table 3.24). Personal per capita income increased more than 169.3% (10% average annual growth) between 1990 and 2000. Despite the dramatic increase, the per capita income of LaBarge barely exceeds the poverty level (set at $18,244). The poverty rate has significantly decreased--from 24.5% in 1989 to 12.3% in 1999; however, it still exceeds the poverty rate in both the state and county, as well as the other counties in the study area.

Complete information for the potentially affected communities in Sublette County is not available for all study years. Big Piney, Marbleton, and Pinedale have experienced increases in both median household income and personal per capita income since 1980 (see Table 3.24). Marbleton had the highest increase in median household income (22.0%; 2.2% average annual growth) and personal per capita income (111.7%; 8% average annual growth). Despite the increase, the per capita income of Marbleton barely exceeds the poverty level. No personal per capita income is reported for Boulder. The median household income in Boulder in 2000 was only $12,500--68.5% of the poverty level (set at $18,244). The highest reported poverty rates in the three-county study area in 2000 were in Sublette County--Boulder (33.3%), Daniel (24.4%), and Bondurant (19.2%). Although poverty in Sublette County has remained relatively stable, the poverty rates in Marbleton and Pinedale have decreased since 1989.

Rock Springs experienced a decline in median household income (-0.4%) from 1980 to 1990 but experienced an increase (164.9%) from 1990 to 2000, for an overall increase of 164.9% (5.0% average annual growth) over the 20-year study period (see Table 3.24). Personal per capita income increased (150.7%) from 1980 to 1990 and again from 1990 to 2000 (73.1%), for an overall increase of 333.8% (8% average annual growth) over the course of the 20-year study period. Despite the increase in personal income, the poverty level increased from 5.8% in 1979 to 8.5% in 1989 and continued to rise to 9.4% by 1999 in Rock Springs.

Information for Eden and Farson in Sweetwater County was not collected until the 2000 census. However, the median household income in Eden was the highest in the three-county study area ($52,625), and Farson had the lowest poverty level in the three-county study area in 1999 (0.0%) (see Table 3.24).

3.4.2.3 Workforce Age, Gender, and Disabilities

Workforce information was obtained from the U.S. Census Bureau (2000e, 2000f). For the purposes of this report, the civilian labor force is defined as all persons between 16 and 66 years of age (retirement age is 67) in the civilian non-institutional population who either had a job or were looking for a job in the last 12 months and who did not have an employment disability. For the purposes of the last census, employment disability was defined as a condition lasting for 6 months or more that:

- limited the kind or amount of work that he or she could do at a job,
- prevented him or her from working at a job,
- made it difficult to go outside the home alone (for example, to shop or visit a doctor's office), and
- made it difficult to take care of his or her own personal needs such as bathing, dressing, or getting around inside the home.

Based on the age of residents, employment disability information, and unemployment rates in each county, there is a civilian labor force of approximately 1,719 unemployed working-age residents available for employment in the study area (Table 3.25). However, there may be some disconnect between published data and actual available labor. A labor shortage has been reported in all sectors in Sweetwater County, with as many as 600 job vacancies existing in November 2004 (Mast 2004). Additionally, a new Halliburton facility in Rock Springs has reported having difficulty filling the 100 new jobs created by its facility (Mast 2004). Smaller operators are also reported to have difficulties hiring and maintaining crews (personal communication, December 2004, with Roy Allen, Economist, BLM Wyoming State Office, Cheyenne and with Marilyn Filkins, Sublette County Attorney, Pinedale).

3.4.3 Housing

Historic information on housing was obtained from the WDAI (2002a), and projected data were obtained from the Wyoming Business Council (2002d) (Table 3.26). Rental rates and cost as compared to the state were obtained from WDAI (2003b) (Table 3.27). The habitability of vacant residences is unknown, and the acceptability of any individual housing unit is not quantifiable and is subjective for each individual tenant.

Table 3.25 Population and Workforce, 2000.[1]

			County		
Sex and Age	United States	Wyoming	Lincoln	Sublette	Sweetwater
Male					
0-15 years	32,919,334	57,604	1,985	680	4,727
16-66 years	92,539,411	168,540	4,627	2,080	13,168
67 years and over	12,594,818	22,109	763	281	1,072
Total males	138,053,563	248,253	7,375	3,041	18,967
Female					
0-15 years	31,353,445	54,266	1,901	663	4,515
16-66 years	93,508,194	162,400	4,455	1,926	12,533
67 years and over	18,506,704	28,863	842	290	1,598
Total females	143,368,343	245,529	7,198	2,879	18,646
Total all ages	281,421,906	493,782	14,573	5,920	37,613
Total working age	186,047,605	330,940	9,082	4,006	25,701
Persons with disabilities[2]	57,890,659	30,952	633	325	1,942
Total potential workforce	128,156,046	299,988	8,449	3,681	23,759
Unemployment rate	4.0%	3.9%	5.2%	3.8%	4.8%
Number of Persons Available for Employment	5,126,241	11,699	439	139	1,140

1 U.S. Census Bureau (2000e).
2 U.S. Census Bureau (2000f).

Table 3.26 Historic and Projected Housing Availability.

	Wyoming						Lincoln						Sublette						Sweetwater					
					Projected		Historic				Projected		Historic				Projected		Historic				Projected	
Housing Item	1980	1990	2000	2002	2007	2012	1980	1990	2000	2002	2007	2012	1980	1990	2000	2002	2007	2012	1980	1990	2000	2002	2007	2012
Type of Housing[1,2]																								
Vacant	N/A	34,572	30,246	38,804	38,706	39,582	N/A	1,272	1,565	1,349	1,389	1,430	N/A	1,077	1,181	1,155	1,177	1,201	N/A	1,828	1,816	2,075	2,063	2,107
Owner-occupied	N/A	114,544	135,514	139,391	149,399	159,413	N/A	3,310	4,280	4,461	4,869	5,282	N/A	1,281	1,737	1,820	2,055	2,289	N/A	9,552	10,586	10,722	10,960	11,154
Renter-occupied	N/A	54,295	58,094	58,736	60,422	62,098	N/A	826	986	1,024	1,072	1,116	N/A	553	634	652	692	733	N/A	4,065	3,519	3,420	3,168	2,926
Total housing units	188,217	203,411	223,854	236,931	248,527	261,093	4,671	5,408	6,831	6,834	7,330	7,828	2,393	2,911	3,552	3,627	3,924	4,223	15,116	15,445	15,921	16,217	16,191	16,187
Percent of Housing[1]																								
Vacant	N/A	17.0	13.5	16.4	15.6	15.2	N/A	23.5	22.9	19.7	18.9	18.3	N/A	37.0	33.2	31.8	30.0	28.4	N/A	11.8	11.4	12.8	12.7	13.0
Owner-occupied	N/A	56.3	60.5	58.8	60.1	61.1	N/A	61.2	62.7	65.3	66.4	67.5	N/A	44.0	48.9	50.2	52.4	54.2	N/A	61.8	66.5	66.1	67.7	68.9
Renter-occupied	N/A	26.7	26.0	24.8	24.3	23.8	N/A	15.3	14.4	15.0	14.6	14.30	N/A	19.0	17.9	18.0	17.6	17.4	N/A	26.3	22.1	21.1	19.6	18.1
No. of Building Permits[2]	3,845	692	1,582	2,045	--	--	30	3	145	204	--	--	82	37	54	88	--	--	801	56	41	48	--	--

1 Historic data from WDAI (2002a); projected data from Wyoming Business Council (2002d). Reported average availability may not accurately reflect actual availability within particular communities (e.g., Pinedale) that have already been impacted by other projects (e.g., Pinedale/Anticline Project) in the area.

2 Total residential units (i.e., single family units, duplex units, tri- and four-plex units, and multi-family units) (Wyoming Housing Database Partnership 2003).

Table 3.27 Average Rental Rates.[1]

Location	Apartment[2]			House[3]			Mobile Home[4]			Mobile Home Lot[5]		
	Fourth Quarter			Fourth Quarter			Fourth Quarter			Fourth Quarter		
	2001 ($)	2002 ($)	Percent Change	2001 ($)	2002 ($)	Percent Change	2001 ($)	2002 ($)	Percent Change	2001 ($)	2002 ($)	Percent Change
Lincoln	292	332	13.7	400	388	-3.1	315	304	-3.4	158	163	3.2
Sublette	441	534	21.1	613	655	7.0	350	457	30.6	175	165	-5.7
Sweetwater	390	392	0.5	533	516	-3.2	422	422	0.0	201	197	-2.2
Wyoming average	430	443	3.0	599	617	3.0	436	448	2.8	178	183	3.1

1 WDAI (2003b). Reported average rental rates may not accurately reflect actual rental rates within particular communities (e.g., Pinedale) that have already been impacted by other projects (e.g., Pinedale/Anticline Project) in the area.
2 Two-bedroom, unfurnished, excluding gas and electric.
3 Two or three-bedroom, single family, excluding gas and electric.
4 This price reflects total monthly rental expense, including lot rent.
5 Single-wide, including water.

According to the Wyoming Housing Database Partnership [WHDP] (2003), there were 4,579 vacant units available for housing in the study area in 2003, with the vacancy rate ranging from 12.8% in Sweetwater County to 31.8% in Sublette County. Average contract rent ranged from $362/$363 in Lincoln/Sweetwater Counties to $413 in Sublette County. Median monthly mortgage payments were lowest in Sublette County ($847/month) and highest in Sweetwater County ($953/month), although the median house value was lowest in Lincoln County ($95,300) and highest in Sublette County ($112,000) (WHDP 2003).

However, individuals have reported that it was difficult to rent or purchase adequate housing in Sublette County and a surplus apparently does not exist (personal communication, Bill Lanning, BLM, PFO). Blevins et al. (2004) also reported an affordable housing shortage exists in the Pinedale community. No housing is available in Pinedale, Big Piney, or Marbleton (personal communication, May 20, 2004, with Patti Raisch, Pinedale Town Clerk; Vicky Brown, Big Piney Town Clerk; Alice Griggs, Marbleton Town Clerk; and Mary Langford, Sublette County Clerk). According to Ms. Langford, most of the housing impact in the town of Pinedale originates from administrators associated with oil and gas field development, rather than oil and gas field workers. However, according to Sheriff Hank Ruland, up to 40% of the demand on his office results from the in-migration of dislocated Teton County residents who cannot find adequate housing in Jackson Hole (personal communication, May 21, 2004, with Sheriff Hank Ruland, Sublette County Sheriff's Department). Therefore, a large percentage of the housing demand may result from dislocated Teton County residents rather than oil and gas workers.

This view is shared by Cyd Goodrich. Ms. Goodrich stipulates that there is no low-income housing available in the Pinedale community. She holds the opinion that much of the pressure is from higher-middle to lower-upper income families moving out of Teton County and she has never heard anyone express a lack of interest in moving to Pinedale because of oil and gas development. However, most of the affected individuals who encounter difficulty obtaining housing are native residents of Pinedale, especially young or newly married, under-employed couples who simply cannot afford the high rental rates and are not in a position to purchase.

The vacancy rate for rentals/hotels/motels in summer (April-November) is estimated to be 0%, while it is less than 10% the rest of the year and declining (personal communication, December 2004, with Cyd Goodrich, Realtor, Pinedale Properties). Much of the seasonal pressure on housing comes from seasonal, often migrant workers from Canada, who come on work visas. Landlords offer only one-year leases and do not allow subletting, so, although the houses are only used during the drilling season by workers in areas without year-round operations and sit vacant the rest of the year, other workers who are involved in year-round operations have difficulty finding adequate housing. Housing pressures are less in the southern part of the county, because there are no direct roads to the oil and gas fields (personal communication, December 2004, with Cyd Goodrich, Realtor, Pinedale Properties). Additionally, the demand for new housing apparently exceeds the rate of building. A total of 88 new residential building permits were issued in Sublette County in 2002 (WHDP 2003).

In 2004, rent for single family homes ranges from $1,000-$1,500/month, while small apartments in multi-unit facilities range from $850-$1,000/month (personal communication, December 2004, with Cyd Goodrich, Realtor, Pinedale Properties).

3.4.4 Social Traditions

The study area's general heritage is based on ranching and mineral extraction and remains one of least populated and most undeveloped areas in the lower United States, with a population density ranging from 1.2 people/square mile in Sublette County to 3.6 people/square mile in Sweetwater County (see Table 3.23). Landownership is largely public (80% of Sublette County, 79% of Lincoln County, and 72% of Sweetwater County). Oil and gas has played a significant role in the regional economy since the 1920s. Historically, most of the oil and gas activity was limited to the LaBarge area in southwestern Sublette County and neighboring Lincoln County but it now extends over much of the southern portion of the county.

The social characteristics throughout the study area are similar to other small rural western communities and are strongly tied to traditional natural resource-based industries such as agriculture and extractive industries. In addition, study area residents recognize the importance of public lands in providing a natural resource base for economic activities, as well as supporting a particular way of life. Public lands often provide scenic beauty, wildlife habitat, and recreational opportunities. Because public lands comprise 76% of all land within the study area, management decisions can affect lifestyles, as well as the economic base.

Agriculture has provided the historical basis for community development for much of the nineteenth century, and ranching and grazing are viewed as a viable economic activity that provides open space, protection of natural resources, and support of cultural and ecological diversity. Although agricultural activities have become much less important economically in recent years (providing 0.7% of industry income and 4.7% of employment in the study area in 2000), the industry is important for its historic and cultural influence. Moreover, agricultural is viewed as a guardian of resources and an underpinning of cultural resources in the area. Because management decisions made by the federal land managers affect ranching operations beyond public land boundaries, communities are concerned about the social influences these decisions have on local communities.

The oil and gas industry has also played a vital role in the social character of Sublette County and has been an important part of the tax base for Sublette, Sweetwater, and Lincoln Counties for nearly 50 years. In 2000, the oil and gas industry provided 12.8% of industry income and 12.5% of employment in the study area. The area has experienced several boom and bust cycles throughout its history and has realized an increased population tied to this industry. Individuals working in this industry are now active members of local communities and are directly affected by federal land manager decisions.

In spite of the traditional social characteristics, there are indications that the views and beliefs of residents in the study area are changing. Some areas have seen an increase in population, including a combination of retirees and others attracted to this region for the abundance of high-quality air, water, and land resources that offer a rich quality of life and reflect a western wilderness heritage. This new population is not tied to traditional natural resource industries and is more likely to support a conservation-oriented public land management policy.

3.4.5 Quality of Living

Data on quality of living and infrastructure for each county in the study area were obtained from the Wyoming Business Council (2002b, 2002c, 2002d), WDAI (2002b), and personal communications. Due to the remote and unique area encompassed by the JIDPA, the United States in not included in the quality of life analysis, with the exception of crime statistics.

3.4.5.1 Crime

The crime indexes are "100" based, meaning that a value of 100 for a particular level of geography is the average national value. For example, a value of 150 indicates that the area has one and a half times the average risk level. A value of 50 indicates that the area is at half the average risk level.

Wyoming had a low crime index compared to the national average, with the index for personal crimes at 49--about half the national index--and property crimes at 71--about three-fourths the national index. The highest individual crime index for personal crime in Wyoming is for rape (80), which is higher than the index for any of the counties in the study area. The highest crime index for crimes against property is larceny (115)--15% greater than the national average (Wyoming Business Council 2002b).

The overall personal crime index in the study area is less than the national average (ranging from 30 to 60), although murder (133 in Sublette County) exceeds the national average. The crimes against property index is generally lower than the national average (ranging from 33 to 76), with the exception of larceny (155 in Sweetwater County).

Sublette County has implemented an enhanced 911 system as part of community policing efforts and to promote citizen's health and safety (Sublette County Sheriff's Department 2002). A 911 System Health Questionnaire identifies health concerns for local area citizens, which is included as part of a computer system used to assist medical, fire, or law enforcement in meeting the needs of victims in the event of an emergency. Additionally, Sublette County has implemented an innovative Ranch Watch program; child identification and fingerprinting; McGruff (child safety); D.A.R.E.; citizens' academy; county fair dance; Halloween dance; stay-out-of-jail free card (rides home); seminars on drug awareness, shoplifting, and check fraud; and a vacation watch program to aid in the prevention of crime in this largely rural area.

The Sublette County Sheriff's Department staff includes a sheriff, undersheriff, lieutenant, emergency management coordinator, two patrol sergeants, three detectives, a probation/resource officer, a seasonal forest patrol deputy, five patrol deputies for Big Piney/Marbleton, five patrol deputies for Pinedale, four patrol deputies for the county, a detention sergeant and five detention deputies, a communication sergeant and five communication deputies, an office manager, and three secretaries/clerks (Sublette County Sheriff's Department 2002).

The Sublette County Sheriff's office services all of Sublette County and the affected towns within the Sublette County Project-affected area. While calls for service have increased in recent years (from 3,000 in 1995 to 7,000 in 2003), approximately 40% of the increased demand is a result of displaced Jackson Hole residents who have in-migrated to Sublette County in an attempt to find housing; the remaining 60% of the increase results from a combination of Jonah Field workers and tourists (ranging from 11,000 to 14,000 visitors per day during the summer) (personal communication, May 2004, Sheriff Hank Ruland, Sublette County Sheriff's Department, Pinedale, Wyoming). The budget has increased from $1.0 million in 1995 to more than $4.5 million in 2004. The majority of calls for service resulting from Jonah Field development are medical emergencies not involved with criminal action, although some increase in speeding violations can be attributed to Jonah Field workers. According to Sheriff Ruland, oil and gas workers are welcome and contributing members of the community who show that they genuinely care about the community by participating in such activities as community clean-up days. Additionally, recent improvements in the county legal system (new jail, courthouse, equipment, competitive wages, increased staffing [up from 12 officers in 1995 to 26 sheriff's deputies and 21 jail officers in 2003], and vehicles) are a direct result of the tax revenues resulting from natural gas activities in the Jonah Field.

The Sheriff's department and Sublette County would not have been able to sufficiently expand to keep up with the increased demand for services without those revenues (personal communication, May 2004, Sheriff Hank Ruland, Sublette County Sheriff's Department, Pinedale, Wyoming). However, service calls increased from 4,032 in 1995 to 7,347 in 2003 (Royster 2004). According to Sheriff Ruland, the biggest crime problem in Sublette County is methamphetamine. Drug use also leads to increases in domestic violence and bar fights--particularly within the temporary worker demographic. Although there has been an increase in drug use in Sublette County, Ruland does not equate that increase to oil and gas workers--it is a state-wide problem (Royster 2004). Additionally, Ruland recognizes that any increase in population--including visiting hunters and other tourists--result in an increase in drug and alcohol-related calls (Royster 2004).

The majority of law enforcement calls in Sublette County still involve traffic--people speeding or running stop signs. One study indicates that transient workers pose challenges to law enforcement primarily in the form of highway safety and increased substance abuse (Blevins et al. 2204.) However, it is estimated that crime in Sublette and Sweetwater County has increased by 80% since 2000, largely as a result of oil and gas development (personal communication, December 2004, Marilyn Filkins, Sublette County Attorney [formerly Sweetwater Deputy County Attorney], Pinedale). At the end of 2004, the Sublette County Attorney's office had 1,200 open cases and had hired an assistant county attorney to handle only criminal cases. Additionally, she indicated that in 2000-2001, there were one or fewer felony arrests in Sublette County, in 2004 the average is approximately one felony arrest per week and many of those are egregious aggravated assaults. Ms. Filkins also reports gang-like behavior from various drilling and pipeline crews. Increases in felonies and drug-related calls have been reported by the Sweetwater County Sheriff and the Chief of Police in Rock Springs, and these were primarily attributed to oil and gas workers (crime report to Pinedale/Anticline Working Group (PAWG) presented by Jana Weber). Ms. Filkins holds the opinion that Sweetwater County has a higher incident of crime related to methamphetamine than Sublette County.

It should be noted that both Questar (a local oil and gas producer) and EnCana require random drug testing for employees and subcontractors. Additionally, EnCana sponsors training sessions for emergency response personnel and Questar donates money to family violence organizations (Royster 2004). However, one of the smaller local operators is reported to have delayed drug-testing for a year and a half, and when a random drug test was performed, 16 of 18 workers on a drill rig tested positive and were fired (personal communication, December 2004, Marilyn Filkins, Sublette County Attorney [formerly Sweetwater Deputy County Attorney], Pinedale).

3.4.5.2 Infrastructure

County and community profile information was primarily obtained from BLM (1997b) as well as local community websites and other extant information.

Lincoln County

In Lincoln County, LaBarge is the only potentially affected community. It was incorporated in 1973 and is located in Lincoln County on U.S. Highway 189 approximately 75 miles north of Green River and 21 miles south of Big Piney. The town has a mayor/council, one full-time and one part-time policeman, 911 emergency telephone service, and a 15-member volunteer fire department. There is a 6,000-volume library, one day care center, one senior center, four churches, one motel with 36 rooms, and a recreational vehicle (RV) park with six spaces. Medical services are provided by a weekly clinic and by ambulance service, and communications include a weekly newspaper, cable TV, and a post office. Recreational facilities include one ice skating rink, two baseball fields, bike paths, two parks, and a small airport.

Sublette County

Sublette County has three airports; 26 churches; three libraries; five medical facilities (however, the nearest hospitals are in Jackson and Rock Springs, Wyoming); two museums; two newspapers; nine post offices (Big Piney, Bondurant, Boulder, Cora, Daniel, Farson, LaBarge, Marbleton, and Pinedale); and two school districts including three elementary schools, two middle schools, two high schools, and a private school, with higher education available from Western Community College's distance learning program; and utilities/services are provided by one telephone company, two garbage/refuse services, one cable television provider, three natural gas suppliers, one electricity supplier, and one coal company. Citizen organizations are important to Sublette County's infrastructure and include volunteer fire departments, a search-and-rescue organization, and a citizen's recycling program (Sublette.Com 2001; Pinedale Online 2002).

Pinedale

Located approximately 100 miles northwest of Rock Springs and 32 miles north of the JIDPA on U.S. Highway 191, Pinedale is the county seat of Sublette County. The town has a mayor/council government, 911 emergency service, and a volunteer fire department. Police protection for the town is provided through contract with the Sublette County Sheriff's Office. There is a 37,000-volume library, one day care center, one senior center, nine churches, 11 hotels/motels with a total of 162 rooms, and an RV park with 44 spaces. Medical services include a clinic, two doctors, a physician's assistant, one dentist, ambulance service, and a nursing home with 107 rooms. Communications include a weekly newspaper, cable TV, and a post office. There is one golf course, one ice skating rink, bike paths, two parks, and a recreation center, as well as a small airport. It has been reported that there is a shortage of health-care providers in Sublette County (Royster 2004). Some health-care providers may work shifts up to 52 hours straight. The Pinedale Medical Clinic serviced approximately 12,000 patients in 2003--mostly oil and gas workers.

Pinedale has a variety of establishments for overnight lodging. A Best Western and Super 8 are located on the west end of town and offer the most rooms. Several smaller motels are located in the downtown area. The surrounding area has several bed and breakfasts, guest ranches and lodges, and individual cabins available for rent. Tourism in and around Pinedale and in Sublette County in general, is a major business with the primary attraction being the natural resources in the area and the many outdoor activities associated with them, including hunting, fishing, camping, backpacking and hiking, wilderness escapes, horseback riding, mountain biking, golf, wildlife viewing, downhill skiing, cross-country skiing, and snowmobiling. Plans are underway to build another motel in town and several mancamps are currently under discussion by area operators for permitting to alleviate some of the pressures on housing. Several housing developments are also being planned.

Big Piney

Big Piney is located on U.S. Highway 189 about 95 miles north of Green River and 35 miles southwest of Pinedale. The town has a mayor/council government, 911 emergency service, and a voluntary fire department. Police protection is provided by the Sublette County Sheriff's Office. There is a 40,000-volume library, one day care center, six churches, and three motels. Medical services include two doctors, one dentist, and ambulance service. Communications include a weekly newspaper, cable TV, and a post office. There is one ice skating rink, one bike path, three parks, three baseball fields, one swimming pool, and a small airport. Major employers include the oil and gas industry, agriculture, and retail trade and services.

Marbleton

Marbleton is located on U.S. Highway 189 1 mile north of Big Piney. Marbleton has an RV park and picnic grounds, two motels, a coffee shop and restaurant, gas stations, retail shops, a movie theater, a medical clinic, and an airport. Major industries include ranching, oil and gas, and recreation.

Boulder

Boulder is an unincorporated community located on U.S. Highway 191 12 miles south of Pinedale and 85 miles north of Rock Springs. Boulder has a post office and the Boulder Store, which includes a store, gas station, RV park (nine spaces), motel (nine rooms), restaurant, and bar.

Sweetwater County

Sweetwater County is located in the southwestern part of Wyoming with 60 miles of its border touching the states of Utah and Colorado. The county consists of 10,497 square miles. The two largest cities in the county are Rock Springs and Green River.

Rock Springs

Established in 1888 as a mining town, the cultural tradition in Rock Springs emphasizes natural resources as the driving force behind its economy (Rock Springs Chamber of Commerce 2004). Rock Springs is located along Interstate 80 in west-central Sweetwater County and serves as the economic hub of the area. Law enforcement and fire protection services are available, as well as a 911 emergency number. Public education is provided by 11 elementary schools, two junior high schools, one high school, and Western Wyoming Community College (2-year junior college). Community services consist of two libraries (107,000 total volumes), eight day care centers, and 32 churches. Commercial services include two shopping centers, five convention facilities (with a total capacity of 4,660 persons), 31 hotels/motels (1,680 total rooms), an RV park (50 spaces), and several mobile home parks. Medical care is provided by a hospital (100 beds), a nursing home (100 rooms), 33 doctors, 24 dentists, and an ambulance service. Communications consist of two local newspapers (one published in Rock Springs and one in Green River), cable TV, two AM and three FM radio stations, and two post offices.

Recreation resources include 17 baseball fields, 24 tennis courts, six swimming pools, eight soccer fields, a golf course, one ice skating rink, two recreation centers, and 24 parks. Outdoor recreation opportunities available within 30 miles of the city include Flaming Gorge National Recreation Area and various opportunities on BLM-administered lands, including Boar's Tusk, sand dunes, petroglyphs, and the Oregon/California Trails.

Cultural/entertainment attractions include the Red Desert Rodeo, Wild Horse Days, the Sweetwater County Museum, the historical Rock Springs City Hall Museum, the Fine Arts Center, and the Western Wyoming Community College Dinosaur Collection.

Rock Springs is serviced by two commercial airlines providing flights to and from the Rock Springs Airport, two bus lines, four car rental services, and two taxi services.

<u>Eden/Farson</u>

Eden and Farson are two unincorporated communities located on U.S. Highway 191 about 40 miles northwest of Rock Springs and 28 miles southeast of the JIDPA. The communities are governed by Sweetwater County and have a resident sheriff's officer and highway patrolman, a 26-member volunteer fire department, ambulance service, and 911 emergency phone service. There are four churches, two gas stations, two cafes, two bars, and a convenience store. Recreational facilities include a youth center and a county park.

Eden and Farson are not serviced by a doctor, nurse, or dentist, although there is an emergency medical technician service. The nearest medical facility is in Rock Springs. There is one elementary and one secondary school. Bridger Valley Electric supplies energy and three vendors supply propane for heating. Residents have individual wells and septic systems, and solid waste disposal facilities are available. Housing is limited, with ranch homes being the primary type of housing.

3.4.5.3 Cost of Living and Inflation

Cost of living and inflation information was obtained from the Wyoming Cost of Living Index for the fourth quarter of 2002 (WDAI 2003b) (Table 3.28). The Wyoming Cost of Living Index is a summary of price data collected from 27 cities and towns throughout Wyoming over the period of January 8, 9, and 10, 2003. The price data collected are used to build a comparative index and to estimate inflation rates for Wyoming and the five regions of the state.

During this period, Lincoln County ranked 18th in the state with an all items cost of living index of 91, while Sweetwater County was ranked ninth (see Table 3.28). Sublette County was the third most expensive county in the state and had the highest cost of living in the study area with an all items ranking of 105.

Table 3.28 Comparative Cost of Living Index.[1]

Rank	County	All Items	Food	Housing	Apparel	Transportation	Medical	Recreation and Personal Care
1	Teton	139	105	174	121	104	110	111
2	Sheridan	106	107	107	120	100	107	104
3	Sublette	105	96	107	123	101	97	110
4	Campbell	105	100	111	87	99	101	102
5	Laramie	104	107	109	94	98	100	97
6	Johnson	103	105	100	132	100	99	106
7	Albany	102	94	107	103	101	99	96
8	Natrona	99	105	98	103	100	98	96
9	Sweetwater	98	100	95	94	100	99	103
10	Park	97	99	92	107	101	102	101
11	Carbon	94	105	85	91	102	96	107
12	Converse	94	95	90	89	100	98	98
13	Fremont	93	89	91	87	101	99	100
14	Hot Springs	93	98	83	102	102	104	103
15	Uinta	93	92	89	87	100	105	98
16	Goshen	91	93	85	99	99	97	99
17	Platte	91	100	80	107	100	95	100
18	Lincoln	91	90	84	102	100	92	99
19	Big Horn	89	96	77	117	100	95	99
20	Washakie	89	92	78	112	99	101	98
21	Niobrara	88	90	74	104	101	103	106
22	Crook	87	93	76	98	100	93	101
23	Weston	87	89	76	93	101	109	100

[1] Fourth quarter 2002. Prices as of January 8, 9, and 10, 2003 (statewide average = 100) (WDAI 2003b).

Table 3.29 Annual Inflation Rates for the U.S., Wyoming, and Regions.[1]

			Region[2] (All Items %)				
Quarter[3]	U.S. Consumer Price Index (%)	Wyoming (All Items %)	Southeast	Southwest	Central	Northeast	Northwest
4Q96	3.3	4.8	5.2	4.0	5.0	4.2	4.9
2Q97	2.3	2.8	3.6	2.8	3.1	1.0	2.6
4Q97	1.7	2.9	3.3	4.0	1.9	3.0	2.2
2Q98	1.7	1.5	1.3	2.6	0.3	2.1	2.5
4Q98	1.6	2.2	2.7	2.8	1.4	2.0	2.4
2Q99	2.0	2.6	3.8	3.4	1.5	2.6	0.9
4Q99	2.7	3.1	3.6	2.6	2.8	3.4	3.0
2Q00	3.7	4.3	3.9	2.3	4.4	7.4	4.0
4Q00	3.4	3.2	2.8	2.6	3.4	6.9	3.8
2Q01	3.2	4.3	4.1	3.1	5.0	4.8	4.6
4Q01	1.6	3.5	4.9	2.3	2.9	4.0	2.6
2Q02	1.1	2.5	2.6	1.4	2.8	3.1	2.2
4Q02	2.4	3.7	3.0	2.5	5.1	5.1	2.7

1 Source: WDAI (2003b). Note: The 2Q99 inflation calculations mark the first time the WCLI used all 23 counties to calculate the inflation rates. Previously, only 15 counties were used.

2 Regional Composition for Inflation Estimate:
Southeast: Albany, Carbon, Goshen, Laramie, Niobrara, and Platte Counties.
Southwest: Lincoln, Sublette, Sweetwater, and Uinta Counties.
Central: Converse, Fremont, and Natrona Counties.
Northeast: Campbell, Crook, Johnson, Sheridan, and Weston Counties.
Northwest: Big Horn, Hot Springs, Park, Teton, and Washakie Counties.

3 4Q96 = fourth quarter (October, November, December) 1996. Fourth quarter represents the December to December and 2nd Quarter represents the June to June percent change.

The inflation rate represents the percent change in the price level of a standard basket of selected consumer items priced this quarter, compared with the price level of the same goods recorded one year ago. WDAI (2003b) weighted the data by population to more accurately represent the price changes experienced by the majority of consumers in Wyoming (Table 3.29). Nationally, the inflation rate from December 2001 to December 2002 was 2.4% (consumer price index for urban consumers), as reported by the Bureau of Labor Statistics (BLS). Inflation is reported only at the regional level within Wyoming. The study area is in the southwest region.

The Wyoming annual all-items inflation rate for the fourth quarter of 2002 was 3.7% (see Table 3.29), with the medical category experiencing the highest inflation rate for the third consecutive period, increasing 6.0% over the previous period. The southwest region, which includes the study area, had the lowest inflation rate (2.5%) in the state for the fourth quarter of 2002. Because the regional inflation rates are calculated using a smaller sample size than the state-wide all items rate, they may be more volatile over time. Thus, when using the regional inflation rates, it must be noted that they can vary significantly from quarter to quarter.

3.4.5.4 Education

Detailed information on education statistics in the study area is provided in BLM (2005).

3.4.6 Personal Income Trends

The Bureau of Economic Analysis (BEA) reports data adjusted to current dollars using the Consumer Price Index (CPI). CPI data were obtained from the BLS (2003). CPI is a measure of the average change in prices over time in a market basket of goods and services. The estimate for 2003 was based on the change in the CPI from fourth quarter 2001 to fourth quarter 2002, and the base year was chained (i.e., three years were averaged to obtain a base year for the calculation of the CPI; e.g., 1982-1984 = 100). The BLS uses the following formula to make the calculation.

Inflation Factor = (Current Year CPI / Year "X" CPI)

Current Year Dollars = Year "X" Dollars x Inflation Factor

The CPI values and inflation factors used by EPS are listed in Table 3.30. Average wage information was obtained from BEA (2003a) and is summarized in Table 3.31. Personal income trend data were obtained from the BEA (2003b). Table 3.32 shows the components of personal income for 1980, 1990, and 2000 for the counties in the study area and Wyoming. A detailed analysis of personal income trend data is presented in BLM (2005).

3.4.7 Industry and Economy

3.4.7.1 Overview

Gross state product (GSP) is the value added to production by the labor and property located in a state (BEA 2003f). The BEA calculates GSP for a state as the sum of gross state product originating by industry of all industries. This measure of GSP is the state counterpart of the nation's gross domestic product by industry from the national income and product accounts (BEA 2003f). Further detail is provided in BLM (2005).

Table 3.30 CPI and Inflation Factors, 1980-2003.[1]

Year	CPI	Inflation Factor[2]	Year	CPI	Inflation Factor[2]
1980	82.4	2.09	1992	140.3	1.23
1981	90.9	1.89	1993	144.5	1.19
1982	96.5	1.78	1994	148.2	1.16
1983	99.6	1.73	1995	152.4	1.13
1984	103.9	1.66	1996	156.9	1.10
1985	107.6	1.60	1997	160.5	1.07
1986	109.6	1.57	1998	163.0	1.06
1987	113.6	1.52	1999	166.6	1.03
1988	118.3	1.46	2000 [3]	172.2	1.00
1989	124.0	1.39	2001	177.1	0.97
1990	130.7	1.32	2002	179.9	0.96
1991	136.2	1.26	2003 [4]	184.5	0.93

1 Obtained from BLS (2003).
2 Inflation Factor = CPI current year/year "X" CPI.
3 2000 is the current year (base year) for the purposes of this analysis (i.e., inflation factor = 1.00--the year when $1 is worth $1).
4 November 2003 CPI.

Table 3.31 Wages and Job Numbers.

	Average Wage ($)[1,2]			Number of Jobs[3]		
Area	1980	1990	2000	1980	1990	2000
United States	29,254	30,738	34,647	114,231,200	139,426,900	167,283,800
Wyoming	32,004	26,146	26,549	279,650	272,471	328,532
Lincoln	31,618	26,545	25,050	6,591	6,873	8,125
Sublette	27,816	23,260	24,783	2,812	3,076	3,965
Sweetwater	39,568	33,759	33,748	25,503	22,856	24,281

1 The employment estimates used to compute the average wage are a job, not person, count. People holding more than one job are counted in the employment estimates for each job they hold. Source: BEA (2003a).
2 All national, state, and local area dollar estimates are in year 2000 dollars, adjusted for inflation.
3 BEA (2003d).

Table 3.32 Personal Income by Major Source.[1]

							County								
	United States			Wyoming			Lincoln			Sublette			Sweetwater		
Income Item	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
Income Source															
Labor Income (earnings from work)	3,615,178	4,622,364	6,088,880	9,482	7,531	9,006	211	177	187	83	73	87	1,079	834	883
Less: Personal contributions for social insurance[2]	160,890	267,370	357,843	(435)	(444)	(538)	(10)	(11)	(11)	(3)	(4)	(5)	(57)	(57)	(58)
Plus/minus: Adjustment for residence[3]	(949)	(971)	(1,060)	(160)	(16)	(33)	(21)	(7)	(1)	1	3	5	(68)	(77)	(50)
Equals: Net earnings by place of residence	3,453,339	4,354,024	5,729,977	8,887	7,071	8,434	181	159	174	81	72	86	954	700	775
Plus: Dividends, interest, and rent[4]	797,599	1,299,148	1,598,302	1,941	2,513	3,771	42	56	94	29	37	62	110	140	238
Plus: Transfer payments	584,707	783,610	1,070,592	818	1,166	1,600	21	27	40	7	12	17	62	83	104
Total personal income	4,835,646	6,436,782	8,398,871	11,647	10,750	13,805	243	242	308	116	121	165	1,126	923	1,117
Per capita personal income[5]	21,280	25,787	29,760	24,561	23,696	27,941	19,602	19,071	21,041	25,201	24,864	27,741	12,749	18,058	29,811

1 Source: BEA (2003b). All rows except per capita personal income are in millions of year 2000 dollars adjusted for inflation unless otherwise noted. All national, state, and local estimates are in current dollars adjusted for inflation based on U.S. average consumer price index (for urban consumers).

2 Personal contributions for social insurance (e.g., Medicare) are included in earnings by type and industry but they are excluded from personal income.

3 The adjustment for residence is the net inflow/outflow of the earnings of inter-area commuters (i.e., live in Sweetwater County, work in Sublette County, net inflow to Sublette County and net outflow to Sweetwater County).

4 Rental income of persons includes the capital consumption adjustment.

5 Year 2000 dollars, per capita personal income as calculated by the BEA is not the same as personal per capita income reported by the census.

3.4.7.2 Wyoming Industry and Industry Employment

The BEA calculates income and gross state product information at the Standard Industrial Classification (SIC) two-digit level. The data for GSP (Table 3.33) are presented at the simplified one-digit SIC code level for the purposes of this report, with the exceptions of mining (coal, metal, and non-mineral) separated from oil and gas and government separated into federal civilian, federal military, and state and local. Table 3.34 provides employee compensation data in order to make a comparison of state-wide income growth in relation to GSP changes. Detailed analysis of Wyoming industry is presented in BLM (2005).

3.4.7.3 Industry Employment

Data were obtained from BEA regarding total annual employment by industry for the study area and for Wyoming for 1980, 1990, and 2000 to examine trends over the 20-year study period. These data are presented in Table 3.35. More detailed industry employment information for the counties as well as an analysis of industry employment for the State of Wyoming is presented in BLM (2005).

Lincoln County

All employment categories in Lincoln County added 1,534 jobs from 1980 to 2000, an increase of 23.3% (1% average annual growth) (see Table 3.35). Agriculture services, forestry, and fisheries experienced the greatest percentage of job growth (365.6%; 8% average annual growth) during the 20-year study period. The greatest number (-842) and highest percentage (-62.0%; -5% average annual loss) of job losses occurred in mining from 1980 to 2000. The average weekly wages in the private and government sectors in Lincoln County in the first quarter of 2003 were $660 and $495, respectively. Heavy and civil engineering construction had the highest average weekly wage at $1,439, followed by oil and gas at $1,243 and utilities at $1,051 (WDERP 2003a).

Sublette County

Industry employment in Sublette County added 1,153 new jobs from 1980 to 2000, an increase of 41.0% (2% average annual growth) (see Table 3.35). Agriculture services, forestry, and fisheries experienced the greatest percentage of growth (388.9%; 8% average annual growth) during the 20-year study period. The greatest number (-68) and highest percentage (-38.6%; -2% average annual loss) of job losses occurred in transportation, communication, and public utilities from 1980 to 2000. The average weekly wages in the private and government sectors in Sublette County in the first quarter of 2003 were $559 and $529, respectively. Oil and gas had the highest average weekly wage at $1,846, followed by finance/insurance at $964 and federal government at $719 (WDERP 2003a).

Sweetwater County

Industry employment in Sweetwater County lost 1,222 jobs from 1980 to 2000, a decrease of 4.8% (0.2% average annual decrease) (see Table 3.35). Agriculture services, forestry, and fisheries experienced the greatest percentage of growth (291.7%; 7.1% average annual growth) during the 20-year study period. The greatest number (-3,601) and highest percentage of job losses (49.2%; 3.3% average annual loss) occurred in mining from 1980 to 2000. The average

Table 3.33 Wyoming Gross State Product (Millions of Year 2000 Dollars).[1]

	Gross State Product (GSP)						Growth (%)		
			1990		2000				
Industry	GSP	% of GSP	GSP	% of GSP	GSP	% of GSP	1980-1990	1990-2000	1980-2000
Agriculture	619	2.7	510	2.9	468	2.4	-17.6	-8.2	-24.3
Mining (metal, coal, non-metallic)	3,162	14.0	1,920	10.9	1,437	7.5	-39.3	-25.1	-54.6
Oil and gas	6,499	28.8	4,215	23.8	3,089	16.2	-35.2	-26.7	-52.5
Construction	1,601	7.1	573	3.2	1,015	5.3	-64.2	77.1	-36.6
Manufacturing	917	4.1	779	4.4	1,335	7.0	-15.1	71.4	45.5
Transportation, communication, and public utilities	2,236	9.9	2,661	15.0	2,510	13.1	19.0	-5.7	12.2
1980 Wholesale trade	802	3.6	505	2.9	773	4.0	-37.1	53.2	-3.7
Retail trade	1,273	5.6	1,053	6.0	1,403	7.3	-17.3	33.3	10.2
Finance, insurance, and real estate	2,023	9.0	1,648	9.3	2,285	12.0	-18.5	38.6	13.0
Services	1,500	6.7	1,505	8.5	2,202	11.5	0.3	46.4	46.8
Government									
Federal civilian	391	1.7	427	2.4	501	2.6	9.2	17.4	28.2
Federal military	196	0.9	246	1.4	277	1.4	25.4	12.4	41.0
State and local	1,312	5.8	1,650	9.3	1,817	9.5	25.7	10.2	38.4
Total Gross State Product	22,532	100.0	17,690	100.0	19,112	100.0	-21.5	8.0	-15.2

[1] BEA (2003e), millions of year 2000 dollars, adjusted for inflation.

Table 3.34 Compensation of Employees (Millions of Year 2000 Dollars).[1]

	Compensation Paid to Employees from Gross State Product (GSP)[1]						Growth (%)		
	1980		1990		2000				
Industry	Paid	% of Total Paid	Paid	% of Total Paid	Paid	% of Total Paid	1980-1990	1990-2000	1980-2000
Agriculture	148	1.7	100	1.5	132	1.6	-32.5	31.8	-12.4
Mining (metal, coal, non-metallic)	1,220	14.0	655	9.6	518	6.4	-46.3	-20.9	-135.6
Oil and gas	1,014	11.6	426	6.3	580	7.2	-58.0	36.3	-74.8
Construction	997	11.4	402	5.9	642	7.9	-59.7	59.8	-55.3
Manufacturing	422	4.8	364	5.3	461	5.7	-13.9	26.8	8.4
Transportation, communication, and public utilities	932	10.7	780	11.5	762	9.4	-16.3	-2.3	-22.3
Wholesale trade	416	4.8	250	3.7	299	3.7	-39.8	19.4	-39.1
Retail trade	775	8.9	622	9.1	799	9.9	-19.8	28.5	3.0
Finance, insurance, and real estate	255	2.9	237	3.5	308	3.8	-7.0	29.9	17.2
Services	832	9.5	895	13.2	1,393	17.2	7.6	55.7	40.3
Government									
Federal civilian	380	4.4	398	5.9	443	5.5	4.6	11.3	14.1
Federal military	173	2.0	217	3.2	226	2.8	25.3	4.0	23.3
State and local	1,166	13.4	1,455	21.4	1,547	19.1	24.7	6.4	24.6
Total Gross State Product	8,731	100.0	6,798	100.0	8,108	100.0	-22.1	19.3	-7.7

[1] BEA (2003f), millions of year 2000 dollars adjusted for inflation.

Table 3.35 Employment by Industry.[1]

	Number of Jobs											
				Sublette			Sweetwater			Wyoming		
Industry	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
Farm employment	851	733	698	429	402	412	266	220	205	14,504	12,476	12,624
Agriculture services, forestry, fishing, and other	32	77	149	27	83	132	48	81	188	2,016	3,353	5,769
Mining (coal, metal, nonmetal, oil and gas)	1,359	667	517	276	315	325	7,318	4,989	3,717	38,523	20,840	19,387
Construction	575	444	863	388	261	427	3,282	1,533	1,509	25,805	15,782	24,879
Manufacturing	467	614	530	31	(D)[2]	91	494	745	1,649	10,512	11,203	13,583
Transportation, communication, and public utilities	503	568	582	176	145	108	2,208	1,987	1,785	19,169	16,583	17,084
Wholesale trade	196	80	133	25	(D)	55	773	648	615	10,055	7,633	8,812
Lincoln Retail trade	821	1,083	1,389	499	409	603	3,743	3,739	4,447	43,998	47,252	57,824
Finance, insurance, and real estate	287	307	471	147	184	228	693	1,125	1,127	16,334	17,167	21,303
Services	576	1,040	1,278	395	599	905	3,605	3,760	4,749	48,437	61,294	83,161
Federal, civilian	117	146	110	62	91	96	304	262	266	7,539	7,589	7,400
Federal, military	63	75	84	39	28	41	214	228	215	6,335	6,311	6,204
State government	109	136	126	54	74	72	203	278	269	10,988	13,150	13,820
Local government	635	903	1,195	264	364	470	2,352	3,261	3,540	25,435	31,838	36,682
Total full-time and part-time employment	6,591	6,873	8,125	2,812	2,955	3,965	25,503	22,856	24,281	279,650	272,471	328,532

[1] BEA (2003b).
[2] (D) = not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals. BEA does not provide this information.

weekly wages in the private and government sectors in Sweetwater County in the first quarter of 2003 were $744 and $580, respectively (WDERP 2003a). Mining provided 20.0% of total income generated in Sweetwater County and local government provided 14.7% in the first quarter of 2003 (WDERP 2003a).

3.4.7.4 Industry Earnings

Wyoming

Wyoming experienced a loss in total gross earnings for all industries (private non-farm, farm, and government) of 5.0% from 1980 to 2000.

In 1980, total mineral extraction was the largest source of industry earnings in Wyoming (25.0%), and government (federal civilian, military, state, and local government) provided 17.4% of income. Mining (metal, coal, nonmetallic) led the individual categories (13.4% of all income) in 1980, followed by services (12.5%), construction (11.9%), oil and gas extraction (11.6%), and transportation, communication, and public utilities (9.8%) (Table 3.36).

Wyoming's mining and minerals sector contributes more to GSP than any other sector of the economy (Foulke et al. 2001). Minerals (including oil and gas) accounted for 23.7% of Wyoming's GSP, or over $4.5 billion in 2000 (see Table 3.33), and supported approximately 19,387 full-time wage earners, or 5.9% of Wyoming's employment base (see Table 3.35) (BEA 2003e).

In 2000, government led industry income, providing 23.4% of income, followed by services (20.0%), retail trade (9.3%), construction (8.5%), and transportation, communication, and public utilities (8.3%).

In real terms, for the 20-year study period, Wyoming industry income fell in farm; mining; oil and gas; construction; transportation, communication, and public utilities; wholesale trade; and retail trade. The most industry income growth occurred in non-farm agricultural services (156.4%; 4.8% average annual growth) and government (27.5%; 1.2% average annual growth).

Lincoln County

In 1980, total mineral extraction was the greatest source of industry income (36.4% of all income) in Lincoln County (see Table 3.36). In 2000, total government led industry income (23.4%). Total mineral extractions provided 14.2% of industry income. Over the 20-year study period (1980-2000), non-farm agricultural services led industry growth (188.1%; 5.4% average annual growth). Losses occurred in total mineral extraction (-65.4%), and farm income (-60.0%).

Sublette County

In 1980, total mineral extraction provided 20.0% (oil and gas provided 20.0%, mining provided less than 0.1%) of Sublette County industry earnings (see Table 3.36). In 2000, total government provided the most industry income to Sublette County (24.0%). Industry income in Sublette County grew during the 20-year study period from 1980 to 2000 by 4.3% (0.2% annual average growth). Mining (metal, coal, nonmetallic) in Sublette County demonstrated a boom/bust cycle, going from an average annual growth rate of 50.8% from 1980 to 1990 to a declining average

Table 3.36 Earnings by Industry.[1]

				County								
	Wyoming ($)			Lincoln ($)			Sublette ($)			Sweetwater ($)		
Income Item	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
Farm[2]	179,991	191,042	95,760	6,685	5,559	2,675	5,935	8,228	1,969	1,229	1,785	292
Nonfarm agricultural services, forestry, fishing, and other[3]	30,425	50,777	77,999	403	513	1,165	357	677	892	713	726	1,665
Mining (metal, coal, nonmetallic)[4]	1,265,969	637,410	589,053	56,356	28,946	15,921	50	3,043	1,720	322,982	262,370	151,984
Oil and gas extraction[5]	1,102,210	673,330	750,850	20,493	5,747	10,688	16,551	10,934	13,919	116,820	83,967	124,438
Construction	1,131,352	498,755	768,822	23,211	15,296	25,949	15,425	7,686	11,937	177,174	59,118	56,754
Manufacturing[5]	433,727	365,436	478,173	12,825	17,514	12,887	610	1,481	1,135	21,824	34,714	106,835
Transportation and public utilities	924,125	740,282	751,189	24,867	29,076	29,519	8,071	5,503	3,245	109,418	99,300	91,285
Wholesale trade[5]	414,417	250,765	302,921	6,654	2,038	2,289	1,003	773	913	32,990	22,068	20,396
Retail trade	875,953	695,019	840,999	16,725	15,501	16,062	9,143	5,823	8,061	77,068	57,889	66,061
Finance, insurance, and real estate	290,903	247,437	446,611	5,124	4,182	6,131	1,989	1,457	3,932	15,076	13,448	25,631
Services	1,180,316	1,206,898	1,796,451	11,832	14,783	19,792	11,245	10,601	18,032	109,094	73,273	105,933
Federal government, civilian	374,702	382,042	421,904	4,942	6,000	5,538	2,610	4,126	5,566	16,261	14,954	15,720
Military	164,959	206,034	215,018	508	925	1,178	792	357	904	1,735	2,834	3,016
State government	372,796	437,358	435,192	4,017	4,556	4,183	2,102	2,486	2,362	7,881	9,560	9,058
Local government	740,096	947,968	1,035,117	16,685	26,319	32,837	7,057	9,478	11,944	69,143	97,879	104,199
Total Earnings	9,481,940	7,530,552	9,006,059	211,327	176,954	186,814	82,942	70,402	86,531	1,079,406	833,885	883,267

Table 3.36 (continued)

				County								
	Wyoming (%)			Lincoln (%)			Sublette (%)			Sweetwater (%)		
Income Item	1980	1990	2000	1980	1990	2000	1980	1990	2000	1980	1990	2000
Farm[2]	1.90	2.54	1.06	3.16	3.14	1.43	7.16	11.69	2.28	0.11	0.21	0.03
Nonfarm agricultural services, forestry, fishing and other[3]	0.32	0.67	0.87	0.19	0.29	0.62	0.43	0.96	1.03	0.07	0.09	0.19
Mining (metal, coal, nonmetallic)[4]	13.35	8.46	6.54	26.67	16.36	8.52	0.06	4.32	1.99	29.92	31.46	17.21
Oil and gas extraction[5]	11.62	8.94	8.34	9.70	3.25	5.72	19.95	15.53	16.09	10.82	10.07	14.09
Construction	11.93	6.62	8.54	10.98	8.64	13.89	18.60	10.92	13.80	16.41	7.09	6.43
Manufacturing[5]	4.57	4.85	5.31	6.07	9.90	6.90	0.74	2.10	1.31	2.02	4.16	12.10
Transportation and public utilities	9.75	9.83	8.34	11.77	16.43	15.80	9.73	7.82	3.75	10.14	11.91	10.33
Wholesale trade[5]	4.37	3.33	3.36	3.15	1.15	1.23	1.21	1.10	1.06	3.06	2.65	2.31
Retail trade	9.24	9.23	9.34	7.91	8.76	8.60	11.02	8.27	9.32	7.14	6.94	7.48
Finance, insurance, and real estate	3.07	3.29	4.96	2.42	2.36	3.28	2.40	2.07	4.54	1.40	1.61	2.90
Services	12.45	16.03	19.95	5.60	8.35	10.59	13.56	15.06	20.84	10.11	8.79	11.99
Federal government, civilian	3.95	5.07	4.68	2.34	3.39	2.96	3.15	5.86	6.43	1.51	1.79	1.78
Military	1.74	2.74	2.39	0.24	0.52	0.63	0.95	0.51	1.04	0.16	0.34	0.34
State government	3.93	5.81	4.83	1.90	2.57	2.24	2.53	3.53	2.73	0.73	1.15	1.03
Local government	7.81	12.59	11.49	7.90	14.87	17.58	8.51	13.46	13.80	6.41	11.74	11.80
Total Earnings	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

1 Source: BEA (2003b). Thousands of 2000 dollars unless otherwise noted. All state and local area dollar estimates are in current dollars, adjusted for inflation.
2 Farm income consists of proprietors' income; the cash wages, pay-in-kind, and other labor income of hired farm workers; and the salaries of officers of corporate farms.
3 "Other" consists of wage and salary disbursements to U.S. residents employed by international organizations and foreign embassies and consulates in the United States.
4 Calculated by subtracting oil and gas extraction from total mining.
5 Oil and gas extraction for Sublette County in the year 2000 was not disclosed. Therefore, the value shown was estimated for the year 2000 using the constant share of total method based on the average of the shares for 1980 and 1990 and is likely underestimated for 2000 given known increases in this sector during that period. The same method was used to estimate manufacturing and wholesale in Sublette County in 1990 based on the average of the shares for 1980 and 2000.

annual rate of 5.5% from 1990 to 2000; thus, while the industry overall grew by 3,340.0% (19.3% annual average growth) over the 20-year study period, it provided only 2.0% of all Sublette County industry earnings in 2000. Overall, mineral extraction provided a total of 18.1% of all Sublette County industry earnings in 2000 compared to 20.0% in 1980--an average annual loss of 0.3%.

Sweetwater County

In 1980, total mineral extraction provided 40.7% (mining provided 29.9% and oil and gas provided 10.8%) of Sweetwater County industry earnings (see Table 3.36). In 2000, total mineral extraction provided 31.3% (oil and gas provided 14.1% and mining provided 17.2%) of Sweetwater County industry earnings. Total earnings in Sweetwater County fell 18.2% (1.0% annual average loss) over the 20-year study period.

3.4.8 Taxes and Revenues

The minerals industry accounts for a substantial share of revenues to the state and to local governments in Wyoming. Revenues that contributed to the general fund, including those from the minerals industry, from 1980 to 2000 are listed in Table 3.37.

Produced minerals are classified as personal property, and mineral producers pay two types of taxes: (1) the county property (ad valorem) tax on production and (2) the state severance tax. Producers pay county property (ad valorem) taxes on plants, refineries, mining and well head equipment, pipelines, and other facilities used in the mineral production and transportation operations. Mill levies applied against mineral facilities and structures are the same as those applied against all other property in the taxing jurisdiction. Property associated with mineral production is classified as industrial property and thus has a higher assessment ratio than commercial, agricultural, or residential property.

Mineral producers also pay royalties, bonuses, rentals, and fees to the owner of the mineral for the right to obtain a lease and produce the mineral. For minerals owned by the federal government, the federal government receives a share of the revenues from the mineral production, or annual rentals are paid on mineral leases that are not producing. The same is true for minerals owned by the state government. Additionally, the state receives a share of federal royalty payments for federal minerals through a federal revenue-sharing provision.

To obtain a mineral lease from the state or federal government, the lessee must pay a bonus. This "bonus" is the amount that the successful winner of the lease (i.e., highest bidder) pays to acquire the lease. The state retains the entire bonus bid to acquire state leases. One-half of the federal lease bonus proceeds for federal land leases are returned to the state.

A severance tax is an excise tax imposed on the present and continuing privilege of removing, extracting, severing, or producing any mineral in Wyoming. Severance taxes are distributed according to *Wyoming Statute* (W.S.) 39-14-801. Severance distributions to all Wyoming counties and cities and to those counties and cities in the study area are summarized in Table 3.38. Further detail is provided in BLM (2005).

The Permanent Wyoming Mineral Trust Fund (PWMTF) is a fund that holds 25% of all severance taxes currently received by the state, functioning like a savings account for the state.

Table 3.37 Wyoming General Fund Revenues, Fiscal Year Collections by Source.[1]

Fiscal Year	Ad Valorem (Production)	Severance Tax	Sales & Use Tax	PWMTF Income	Pooled Income[2]	Charges-Sales and Services	Franchise Tax	Revenue from Others [3]	Penalties[4]	Federal Aid and Grants	All Other[5,6]	Total[7]
1980	12,907,248	79,282	245,683	25,061	30,410	31,495	15,746	10,131	1,491	9,464	21,444	13,377,455
1981	15,367,554	90,952	267,396	34,650	29,553	31,587	16,067	7,943	2,056	9,826	20,182	15,877,767
1982	14,162,407	201,201	293,965	46,613	37,622	17,129	10,296	13,356	2,304	2,806	21,938	14,809,638
1983	13,737,084	190,796	224,897	78,946	53,131	16,971	15,007	16,229	2,788	442	40,612	14,376,904
1984	13,903,877	181,963	200,116	93,578	48,802	15,005	14,169	13,363	1,976	3,840	29,000	14,505,689
1985	12,532,055	182,560	196,486	108,030	52,254	13,681	14,484	18,681	2,501	3,858	42,055	13,166,647
1986	9,384,099	169,940	196,322	113,788	57,582	17,242	18,627	14,206	1,273	707	26,932	10,000,718
1987	8,934,607	104,407	154,576	112,297	36,053	15,142	30,329	21,040	1,432	1,273	31,046	9,442,200
1988	8,340,254	96,495	150,859	105,738	25,878	14,398	15,197	11,271	1,181	756	22,310	8,784,337
1989	8,435,621	90,777	138,466	98,671	21,377	15,829	14,580	13,149	1,691	1,406	20,005	8,851,573
1990	8,415,025	97,318	134,719	113,515	67,982	13,997	14,336	9,724	3,642	977	22,153	8,893,390
1991	7,653,645	99,741	140,803	119,046	50,717	13,195	16,843	10,913	4,386	3,244	22,080	8,134,614
1992	7,579,071	83,109	142,873	113,807	66,214	16,555	15,162	14,060	5,093	5,504	14,362	8,055,810
1993	7,497,211	78,431	149,419	105,277	31,049	17,424	15,267	10,088	3,938	8,781	12,857	7,929,742
1994	7,240,946	75,800	217,771	99,976	26,045	17,785	14,739	16,551	5,381	9,062	38,561	7,762,616
1995	7,257,937	63,816	236,956	96,731	30,693	18,128	15,593	4,600	10,779	11,944	13,641	7,760,818
1996	7,842,694	67,661	229,365	94,964	29,839	18,286	13,759	4,389	2,203	12,194	15,166	8,330,520
1997	7,983,933	76,075	230,870	98,944	25,997	19,093	14,439	5,577	6,010	12,731	13,225	8,486,894
1998	7,422,008	73,484	247,974	106,994	24,687	19,197	14,073	6,317	7,148	11,153	17,499	7,950,534
1999	8,162,297	60,905	242,616	110,437	26,174	21,017	11,823	7,245	6,070	10,639	20,143	8,679,364
2000	10,542,096	83,616	262,339	117,485	26,192	18,799	13,629	14,830	5,809	8,189	64,712	11,157,696
Total Growth (%) (1980-2000)	-18.32	5.47	6.78	368.79	-13.87	-40.31	-13.45	46.39	289.74	-13.48	201.77	-16.59
Average Annual Growth Rate (%) (1980-2000)	-1.01	0.27	0.33	8.03	-0.74	-2.55	-0.72	1.92	7.04	-0.72	5.68	-0.90

1 Source: Consensus Revenue Estimating Group (2003). In thousands of 2000 dollars, adjusted for inflation.
2 Pooled income revenues earned on water development funds were no longer distributed to the General Fund beginning in FY93.
3 In FY94, this category received an additional $2.9 million in interest on severance tax protests. The rest of the difference in this series between FY94 and FY95 is primarily because revenues from Workers' Compensation ($6.8 million in FY94) and the Retirement System Board's Trust and Agency Fund ($0.8 million in FY94) no longer flowed into the General Fund beginning in FY95. However, the expenditure responsibilities were also shifted away from the General Fund at that time. Consequently, there was no net loss in actual General Fund revenues as a result of these changes.
4 Total revenues in this category in FY95 included $4.1 million in severance tax penalty and interest and interest received during the Generally Accepted Accounting Principals transition period and an additional $2.8 million from an oil audit settlement.
5 This category includes all 1200 series tax revenue except sales and use taxes, inheritance tax (revenue code 1401), license and permit fees (2000 revenue series), property and money use fees (4000 revenue series, excluding investment income), and non-revenue receipts (9000 revenue series). The inheritance tax total for FY94 included $21.0 million in revenue from a single estate settlement, and in FY00 it totaled $45.1 million.
6 Inheritance taxes will provide revenue to the general fund at diminishing rates through FY05. Due to federal legislation, the tax will be completely phased out by FY06.

Table 3.38 Summary of Mineral Severance Taxes Received by Wyoming and Directly Distributed to All Wyoming Counties and Cities and Project-Affected Counties and Cities in the Study Area.

	Distributions (Thousands of $)[1]				
Tax and Distribution Entity	1980	1990	2000	2001	2002
Total Received by Wyoming[2]	219,889	331,196	275,123	434,534	287,457
Amount Distributed to All Counties[2]	--	8,628	8,559	15,171	6,081
Lincoln County[3]	--	--	159	405	231
Sublette County[3]	--	--	61	159	94
Sweetwater County[3]	--	--	489	1,175	595
Amount Distributed to All Cities[2]	--	25,885	21,506	32,136	14,498
LaBarge[4]	--	--	27	53	22
Big Piney[4]	--	--	25	49	21
Marbleton[4]	--	--	35	74	37
Pinedale[4]	--	--	65	140	72
Rock Springs[4]	--	--	1,056	2,121	959

1 In thousands of year 2000 dollars, adjusted for inflation; -- = data not available.
2 Consensus Revenue Estimating Group (2003). Total direct disbursements to cities and counties, not including capital construction or other funds.
3 Lummis et al. (2000, 2001, 2002, 2003). Distributions to counties. Total distributions reported by Lummis et al. do not add to the total reported as revenue received in Consensus Revenue Estimating Group (2003).
4 Lummis et al. (2000, 2001, 2002, 2003). Distributions to towns and cities. Total distributions reported by Lummis et al. do not add to the total reported as revenue received in Consensus Revenue Estimating Group (2003).

The fund balance was $1.9 billion in June 2002 (Lummis et al. 2002). As reported by Lummis et al. during the previous fiscal year, over $74 million in severance taxes were added to the fund. Natural gas alone contributed 46.8% of severance taxes or more than $34.7 million to the PWMTF. Gas, oil, and associated products contributed more than $45.5 million (61.4%) of all severance added to the PWMTF. The principal of the PWMTF is inviolate but may be loaned to political subdivisions. The interest on the PWMTF goes to the state's general fund for the legislature to allocate to current programs.

Royalties

A mineral royalty is the amount of money the owner of the mineral resource receives as a payment or royalty from the mineral producer. Wyoming receives a base royalty of 16.7% of the value of production from state-owned minerals. The federal government receives a royalty of 12.5% of the value of production for minerals produced on federal lands. Fifty percent of federal mineral royalties are returned to the state, and a portion of that is then distributed to counties and cities. Unlike severance taxes, royalties are based on the value of production and byproducts. Gas and oil prices skyrocketed in 2000, bringing with them significant increases in all forms of mineral revenue along with increasing natural gas revenues, which include coalbed methane production. Natural gas prices rose in 2000 due to tighter supplies, lower storage stocks, and market perceptions (Energy Information Administration 2001). In the late 1990s, these sources of income were declining as prices for gas and oil were depressed. With renewed market pressure in late 1999, the value of production increased, as did corresponding taxes. Federal royalties are distributed by the State of Wyoming according to W.S. 9-4-601. Federal royalty distributions to all counties and cities, and those cities in the project-affected area are shown in Table 3.39. State mineral royalties received are presented in Table 3.40.

Payments in Lieu of Taxes (PILT)

The federal government owns and manages 49% of Wyoming lands. Federal lands are not subject to property taxes that support county governments and education. In 1976, Congress authorized federal land management agencies to share income with states and counties and provided a payment in lieu of taxes (PILT) program to help offset lost tax revenue (31 U.S.C. 6901-6907 [*Public Law* 103-397, October 22, 1994; *Public Law* 104-333, November 12, 1996; and *Public Law* 105-83, November 14, 1997]; 43 C.F.R. Part 1880 [65 *Federal Register* 51229-51234, August 23, 2000, effective September 22, 2000]). PILT payments are federal payments to local governments that help offset losses in property taxes due to nontaxable federal lands within their boundaries. PILT payments are administered by the BLM (Coupal et al. 2003).

PILT payments are based on three factors:

eligible federal acres in the county,

federal revenue-sharing going to the county the prior year, and

county population up to the pre-determined ceiling.

Since 1998, PILT payments received by Wyoming have increased by 63.9% (Table 3.41). The three-county study area has experienced a similar increase.

Lincoln County PILT payments increased 74.2%, Sublette County payments increased 58.9%, and Sweetwater County PILT payments increased 58.0% over the past 6 years.

Property Taxes (Ad Valorem Taxes)

The taxable valuation of all mineral production in Wyoming fell 18% from $12.9 billion in 1980 to $10.5 billion in 2000 (-1.1% average annual decline) (Wyoming Department of Revenue 2002). Foulke et al. (2001) believe that mineral revenues will continue to rise and that gas production, particularly, will drive future revenues higher for the foreseeable future. Assessed production values are presented in Table 3.42.

Wyoming Department of Revenue reports indicate that in 2002, natural gas production contributed the greatest proportion of taxable value to the state (34.8%), followed by residential land and improvements (18.5%), mining production (15.9%), and oil production (9.7%) (Table 3.43).

Table 3.39 Summary of Federal Mineral Royalties Received by Wyoming and Directly Distributed to All Counties and Cities and Project-Affected Counties and Cities.[1]

	Royalties Distributions (Thousands of $)[2]				
Tax and Distribution Entity	1980	1990	2000	2001	2002
Total Received by Wyoming[3]	198,742	222,188	309,093	434,676	334,703
Amount Distributed to Counties[3,4]	n/d	1,389	n/d	n/d	n/d
Amount Distributed to Cities[3,4]	--	20,830	19,588	21,678	20,007
LaBarge[5]	--	--	61	60	55
Big Piney[5]	--	--	66	64	55
Marbleton[5]	--	--	86	88	86
Pinedale[5]	--	--	147	152	154
Rock Springs[5]	--	--	1,010	1,002	994

1 Includes coal lease bonuses. FY98 coal revenues include $8.0 million in protest severance taxes that were from prior production years.
2 In thousands of year 2000 dollars, adjusted for inflation; -- = data not available; n/d = no distribution.
3 Consensus Revenue Estimating Group (Consensus Revenue Estimating Group) (2003).
4 Total direct disbursements to cities and counties, not including capital construction or other funds.
5 Lummis et al. (2000, 2001, 2002, 2003). Total distributions reported by Lummis et al. do not add to the total reported as revenue received in Consensus Revenue Estimating Group (2003).

Table 3.40 Summary of State of Wyoming Mineral Royalties.

Fiscal Year	Thousands of $[1]
1980	--
1990	--
2000	27,721
2001	34,099
2002	56,021

1 Historical data for state-owned mineral royalties are not readily available and are generally not included in socioeconomic analyses prepared by Wyoming state agencies. WDAI (2002a).

Table 3.41 Total PILT Payments and Total Acres.[1]

	PILT Payments/Acres					
Location	1998	1999	2000	2001	2002	2003
Wyoming						
Payment ($)	8,118,173	8,208,280	8,318,110	11,828,099	12,392,400	13,304,416
Acres	29,917,112	29,893,541	29,885,632	29,884,922	29,889,764	29,877,970
Lincoln County						
Payment ($)	384,723	406,667	418,646	598,093	617,577	670,171
Acres	1,946,836	1,946,805	1,946,765	1,946,631	1,947,558	1,947,558
Sublette County						
Payment ($)	258,703	247,508	256,483	360,764	376,237	411,150
Acres	2,432,160	2,432,000	2,431,960	2,431,960	2,431,305	2,431,305
Sweetwater County						
Payment ($)	910,456	929,377	949,649	1,281,416	1,333,882	1,438,845
Acres	4,609,862	4,606,891	4,606,891	4,606,888	4,606,888	4,606,799

[1] Coupal et al. (2003) and BLM (2003c), in year 2000 dollars, adjusted for inflation.

Table 3.42 Total State-Assessed Mineral Production Valuations.[1]

	Taxable Valuation (Thousands of $)		
Mineral Type	1980	1990	2000
Oil	4,847,711	2,561,672	1,438,976
Natural Gas	1,402,442	1,057,631	3,365,841
Coal	1,616,744	1,487,154	1,336,116
Trona	290,327	236,359	206,219
All Other Minerals	256,679	52,660	59,909
Total Mineral Taxable Valuation	8,413,904	5,395,476	6,407,060
Other Property	4,493,344	3,019,549	4,135,036
Grand total	12,907,248	8,415,025	10,542,096

[1] Consensus Revenue Estimating Group (2003), thousands of year 2000 dollars, adjusted for inflation.

Table 3.43 Proportionate Taxable Valuation of Various Classes of Property in Wyoming, 1998-2002.

	Proportion of Taxable Value[1] (Ranked Highest to Lowest According to 2002 Proportions)				
Property	1998	1999	2000	2001	2002
Natural gas production	19.2%	18.6%	20.6%	31.9%	34.8%
Residential lands and improvements	19.9%	22.6%	22.0%	18.5%	18.5%
Mining (coal, minerals, and non-minerals)	20.0%	41.6%	19.5%	15.2%	15.9%
Oil production	14.7%	8.8%	11.5%	13.7%	9.7%
Industrial and manufacturing property	8.9%	9.8%	8.7%	7.1%	7.4%
Commercial lands and improvements	1.5%	5.6%	5.2%	4.2%	4.4%
Railroads	1.7%	2.0%	2.2%	1.7%	1.8%
Electric/gas-privately owned	2.5%	2.6%	2.3%	1.6%	1.6%
Commercial personal property	1.5%	1.7%	1.6%	1.3%	1.3%
Agricultural lands	1.9%	2.0%	1.8%	1.3%	1.3%
Natural gas pipelines	0.9%	1.1%	1.1%	0.8%	1.0%
Electric-cooperatives	1.5%	1.1%	1.0%	0.7%	0.6%
Major telecommunications	0.7%	0.7%	0.807%	0.7%	0.6%
Residential personal property	0.6%	0.6%	0.572%	0.4%	0.4%
Liquid pipelines	0.6%	0.7%	0.672%	0.4%	0.4%
Rural telecommunications	0.2%	0.3%	0.232%	0.2%	0.2%
Cellular/reseller telecommunications[2]	<0.1%	0.1%	0.162%	0.1%	0.2%
Airlines	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%
Electric-municipal	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%

[1] Columns may not total to 100% due to rounding. Wyoming Department of Revenue (1998, 1999, 2000, 2001, 2002).
[2] Designated as radio-telephones in 1998.

Sales, Use, and Lodging Tax

Wyoming has had sales and use taxes since 1935. Sales taxes apply to the retail sale of personal property or services within the state. A use tax is levied on any sale of any property outside the state of Wyoming for use, storage, or consumption inside the state of Wyoming.

Wyoming counties, cities, and towns benefit from sales and use tax collections. Each month, the treasurer's office in each county sends the sales tax collections to the Wyoming Department of Revenue, which distributes the money. Currently, two-thirds of the 4% sales tax collections go to the state general fund, and one-third (minus 1% for state administrative purposes) is returned to the cities, towns, and counties. The money returned to the cities and counties is based on where the purchase occurred and the population of the city or county (which is based on the last federal census). Counties that have 1% optional sales taxes or a 1% capital facilities tax keep 100% of the additional 1% collected. The state's share of the sales tax revenue is distributed to the General Fund. Effective tax rates for the study area as of 2002 are listed in Table 3.44.

County sales tax rates can fluctuate from year to year because county option taxes originate and expire at varying times; therefore, only the total state imposed sales tax (4%) will be used for this analysis. State use tax is imposed on purchases made outside a taxing jurisdiction for first use, storage, or other consumption within that jurisdiction (Table 3.44). Thus, the use tax prevents sales tax avoidance or the payment of a lesser tax rate by making purchases outside of the taxing jurisdiction where first use, storage, or other consumption will occur. Wyoming taxing jurisdictions are the State of Wyoming and/or each Wyoming county. Use tax is a complement of sales tax. Effective January 1, 1981, the adoption of an optional sales tax required a change in the use tax rate of equal amount. State use tax is shared between state government and the county of origin on the same distribution basis as sales tax. Therefore, the revised rate and allocation, as mentioned earlier in the sales tax description, applies here as well.

Cities, towns, and counties, by voter approval, may impose a lodging excise tax of up to 4% on all sleeping accommodations for guests staying less than 30 days (see Table 3.44). This tax extends to mobile accommodations such as tents, trailers, and campers, as well. All collections

Table 3.44 Sales, Use, and Lodging Tax Rates by County (Effective April 1, 2003).[1]

Tax Rate	Lincoln	Sublette	Sweetwater
State Sales Tax Rate	4.0%	4.0%	4.0%
General Purpose Option Tax	1.0%	--	1.0%
Specific Purpose Option Tax	--	--	0.5%
Subtotal	5.0%	4.0%	5.5%
Lodging Tax	2.0%[2]	3.0%	2.0%
Total Tax Rate	7.0%	7.0%	7.5%

1 Wyoming Department of Revenue (2003).
2 Note: Lodging tax is imposed only in Afton (i.e., not in a county-wide base).

(less a 2% state administrative cost during the first year the tax is imposed and 1% thereafter) are distributed to the cities, towns, and counties of origin. At least 90% of the tax distributions must be used to promote travel and tourism within the county, city, or town imposing the tax. The amount remaining, not to exceed 10% of the total amount distributed, may be used for general revenue within the governmental entity imposing the tax.

3.4.9 Study Area Taxes and Revenues

3.4.9.1 Availability of Information

Reporting of tax and revenue information has evolved with the development of the internet and the ease of publishing large volumes of information; this evolution has led to an unavailability of certain reports and information that predate 1998 (personal communication, July 8, 2003, with Christie Yurek, Validation Supervisor, Wyoming Department of Revenue, Administrative Services Division).

Oil and gas field operations support employment in many industries. Firms whose primary activity is operating oil and gas wells, exploring for oil and gas, or providing oil and gas field services are included in SIC 13, mining--oil and gas extraction. But many employers in other industries such as wholesale trade and transportation, communications, and public utilities depend on business from oil and gas service companies (WDERP 1999). According to Bullard in WDERP (1999: Table 1 and Map 1), the Sublette and Sweetwater County economies are highly dependent on oil and natural gas extraction (15.2% and 5.8%, respectively), while Lincoln County is moderately dependent (4.2%) on the oil and gas industry.

While it is not possible to determine the proportion of funds each city and county spends on each item of infrastructure and services derived from oil and gas revenues, example budgets for Big Piney, Pinedale, and Sublette County are presented in BLM (2005). Funds received by Sublette County in recent years have been used for capital improvements, such as a new courthouse, jail, land fill, senior centers, and public clinic upgrade, and surpluses have been placed in reserve accounts to develop savings for future requirements (personal communication, May 20, 2004, with Mary Langford, Sublette County Clerk). Funds received in Big Piney in excess of normal operating have also gone to capital improvements (personal communication, May 20, 2004, with Vickie Brown, Big Piney Town Clerk).

3.4.9.2 State Royalties

In total, royalties in Wyoming arising from natural gas production on state lands increased by nearly 62.0% from 1998 to 2002 (Wyoming Office of State Lands and Investments [WOSLI] 2002). Oil royalties rose and fell, but overall grew 5.6% from 1998 to 2002.

In Lincoln County, royalties from natural gas production on state lands fell 21.5% from 1998 to 2002. Oil royalties have risen and fallen, but generally declined in Lincoln County, falling 17.3% from 1998 to 2002. The only other mineral royalty paid to Lincoln County in 2001 and 2002 from state lands was for sand and gravel (WOSLI 2002).

In contrast, Sublette County has experienced significant increases in royalties from natural gas and oil production on state lands. Royalties from natural gas increased by 81.9% from 1998 to 2002. Oil royalties increased even more dramatically (155.9%) from 1998 to 2002. The only other mineral royalty paid to Sublette County in 2001 and 2002 from state lands was for sand and gravel (WOSLI 2002).

Sweetwater County royalties from natural gas production on state lands increased by more than 17.1% from 1998 to 2002. Oil royalties also increased (20.6%; 3.8% average annual growth) in Sweetwater County from 1998 to 2002. Sweetwater County received most of its royalties from (and is the only county in Wyoming to receive royalties from) trona mining but also received royalties from coal (2000, 2001, 2002), limestone (2000), uranium (2002), and sand and gravel (2001, 2002).

3.4.9.3 Ad Valorem Valuation and Taxes Levied

Due to changes in agency reporting methods, information from 1980 and 1990 was only minimally available. Ad valorem valuations for the study area illustrating tax source and allocation are presented in BLM (2005).

3.4.9.4 Sales, Use, and Lodging Tax Collections

Sales, use, and lodging tax collection information is presented for Wyoming and the three-county study area in BLM (2005).

3.4.10 Grazing Economics

3.4.10.1 Grazing Allotments

Table 3.45 summarizes grazing allotment acreages and animal unit months (AUMs) (an AUM is the amount of forage required to sustain one cow and calf for one month) in the JIDPA (see also EIS Section 3.5.2).

3.4.10.2 Value of Grazing

The estimated value of grazing in the JIDPA is summarized in Tables 3.46-3.48. The method used to determine the value of grazing per AUM is from BLM (2003a).

The value of cattle grazing per AUM in Wyoming is shown in Table 3.46. AUM values for grazing cattle were determined from Wyoming Agricultural Statistics Service (2003) values of cattle sold in Wyoming from 1998 to 2002 (presented in Year 2000 dollars, adjusted for inflation) (see Table 3.47). Total cattle sales were divided by the number of cows that calved, which provided a value per cow. The values per cow was then divided by an AUM conversion factor (Workman 1986), resulting in an estimated nominal value per AUM for 2000. The average values of these AUMs are used in the impact analyses presented in EIS Chapter 4.

The JIDPA is entirely within Sublette County. Because there would be no impact on grazing activities in Lincoln or Sweetwater Counties as a result of the proposed project, Sublette County comprises the total study area for grazing analyses. The value of grazing associated with the JIDPA was compared to livestock sales during 1997 for Sublette County. Data on sales were obtained from the 1997 Census of Agriculture published by the National Agricultural Statistical Service (1999). Table 3.48 shows that total agricultural sales in Sublette County exceeded $29 million, more than 95% of which was associated with livestock sales. Grazing activities

Table 3.45 Grazing Allotments and AUMs, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Allotment Name	Allotment Size (acres) Total	Allotment Size (acres) In Project Area	AUMs Total	AUMs In Project Area	Average Acres per AUM
Stud Horse Common	15,590	5,490	1,730	670	8.2
Sand Draw	31,740	20,740	2,324	1,571	13.2
Boundary[1]	31,994	3,630	2,996	363	10.0
Blue Rim Desert	41,273	0[2]	2,826	--	14.6
Unalloted private lands	640	640	-- [3]	-- [3]	-- [3]
Total JIDPA[3]	121,237	30,500	9,876	2,604	11.5

1 Sheep are also approved for grazing on the Boundary allotment.
2 Approximately 35 acres of this allotment would be affected by the Burma Road upgrade.
3 Total does not include unalloted private lands; insufficient data available to calculate AUMs for these lands.

Table 3.46 Estimated Value of Cattle Grazing AUMs in Wyoming, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Year	Value of Cattle Production (Thousands of $)[1]	Number of Cows that have Calved (Thousands of Head)[2]	Value Per Cow[3]	AUM Conversion Factor[4]	Value of Production Per AUM[5] (Year 2000 $)
1997	474,990	870	545.97	16	34.12
1998	423,250	880	480.97	16	30.06
1999	467,253	830	562.96	16	35.18
2000	497,851	830	599.82	16	37.49
2001	527,804	850	620.95	16	38.81
2002	425,776	820	519.24	16	32.45
Average	468,387	842	556.79	--	34.80

1 Thousands of Year 2000 dollars, adjusted for inflation. Source: Wyoming Agricultural Statistics Service (2003:42).
2 Source: Wyoming Agricultural Statistics Service (2003:40).
3 Value per cow = value of cattle production ÷ number of cows that have calved.
4 Workman (1986).
5 Value of production per AUM = value per cow ÷ AUM conversion factor.

Table 3.47 Estimated Value of Grazing Activities on Project-Affected Lands[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

	Value of Grazing Cattle[2] ($)	
Allotment Name	Total	Project-Affected Lands
Stud Horse Common	60,204	23,316
Sand Draw	80,875	54,671
Boundary	104,261	12,632
Blue Rim Desert	98,345	1,218 [3]
Unalloted private lands	1,636 [4]	1,636 [4]
Total JIDPA	343,685	90,619 [3,4]

[1] See Table 3.45.
[2] Cattle grazing was valued at $34.80/AUM (see Table 3.46). Sheep are also approved for grazing on the Boundary allotment, but currently they do not occur on the project-affected portion of the allotment and are not discussed further.
[3] The JIDPA is 30,500 acres; 35 acres in the Blue Rim Desert allotment outside of the project boundary would be disturbed for the Burma Road upgrade (12 miles long x 24 ft wide = 35 acres).
[4] Unalloted private lands within the Sand Draw allotment are not under federal control; therefore, they are not shown in Table 3.44, however, the AUMs (47) are estimated based on the Sand Draw allotment for the purposes of valuation in this table.

Table 3.48 Percentage of Agricultural Sales Attributed to Grazing in the Jonah Field, 1997.

Sales in Sublette County[1]	Value ($)	Percentage
Total Agricultural[2]	$29,191,000	
Value from Livestock[2]	$27,809,000	
Percent from Livestock		95.0%
Sales Attributable to Grazing on the Project Area[2,3]	$90,619	
Percent of all Sublette County Agricultural Sales arising from Grazing on the JIDPA		0.31%
Percent of All Livestock Sales in Sublette County Arising from Grazing on the JIDPA		0.33%

[1] The JIDPA is entirely encompassed within Sublette County; therefore, Lincoln and Sweetwater County sales are unlikely to be affected and are not evaluated.
[2] In year 2000 dollars, adjusted for inflation (National Agriculture Statistics Service 1999).
[3] See Table 3.47.

attributable to the JIDPA could account for $90,619, or up to 0.31% of all agricultural sales and 0.33% of all livestock sales in Sublette County in 1997.

3.4.11 Recreation Economics

Since the JIDPA lies almost entirely within the PFO area, recreation economics are evaluated only within this area. However, some additional demand is likely in other areas (e.g., Lincoln and Sweetwater Counties). See BLM (2005) for more detailed analysis.

3.4.11.1 Nonconsumptive Recreation

Table 3.49 shows the recreational visitor days (RVDs) per activity for the PFO for a 4-year period from 1998 to 2002 (BLM 2003d). (These data are considered to be somewhat inaccurate.) During this time, over 300,000 RVDs are estimated to have occurred annually within the PFO area for a variety of activities. The most popular of these activities were float or raft trips, fishing, camping, and hiking/walking/running. Hunting is addressed separately (Section 3.4.11.2).

3.4.11.2 Hunting

Hunting is also popular within the PFO area. Much of this activity occurs on BLM-managed land since this land provides habitat for many species, including big game, small game, and upland game birds. Pronghorn is the only big game species likely to be hunted in the JIDPA; therefore, the economics of hunting other big game species are not addressed further in this EIS.

The entire JIDPA lies within the Sublette Pronghorn Antelope Herd Unit, which occupies approximately 6.7 million acres (Table 3.50). BLM is responsible for management of 64% of the surface of the Sublette Herd Unit; the USFS is responsible for management of 4% of the surface; 4% is managed by the Bureau of Reclamation; and 26% is in State of Wyoming and private ownership. Pronghorn hunting was estimated from WGFD data since WGFD regulates the sport and keeps data on hunting use by animal and by area throughout Wyoming (Table 3.51).

<u>Furbearers, Small Game, Upland Birds, and Waterfowl</u>

Furbearers likely occur within the JIDPA, which lies within Furbearer Management Area 7 (WGFD 2003b). Weasel, badger, skunk, coyote, red fox, and bobcat are likely to occur and may be hunted/trapped in the vicinity of the project area. WGFD has not collected hunter expenditure information for these species (WGFD 2003d); therefore, they are not addressed further herein.

The JIDPA lies within Small Game Management Area 7 (WGFD 2003b); however, due to habitat limitations, only greater sage-grouse and desert cottontail rabbit are likely to occur and be hunted on the JIDPA (Table 3.52). The WGFD has not collected hunter expenditure information for all small game species that may potentially occur and may occasionally be hunted and trapped on the JIDPA (WGFD 2003d); therefore, impact analysis is provided only for desert cottontail rabbit and greater sage-grouse.

Waterfowl Area 5B encompasses the JIDPA, and ducks and geese may be hunted in the vicinity of the project area. The WGFD has not collected hunter expenditure information for all waterfowl species that may potentially occur and may occasionally be hunted on the JIDPA (WGFD 2003d); therefore, these species are not addressed further herein.

Table 3.49 Estimated Annual Recreational Visitor Days, PFO Area.[1]

Activity	Annual Recreational Visitor Days[2]	Percent of Total Activity
Archery	760	0.24
Backpacking	4,118	1.29
Bicycling–Mountain	5,066	1.58
Bicycling–Road	16	0.01
Camping	35,168	10.99
Climbing–Mountain/Rock	458	0.14
Driving for Pleasure	4,182	1.31
Environmental Education	55	0.02
Fishing	73,227	22.89
Hiking/Walking/Running	30,581	9.56
Horseback Riding	732	0.23
Nature Study	880	0.28
Off-highway vehicles (OHVs) - All-terrain vehicles (ATVs)	1,268	0.40
OHVs – Cars/Trucks/Sport Utility Vehicles	155	0.05
Pack Trips	2,746	0.86
Photography	880	0.28
Picnicking	1,366	0.43
Power Boating	789	0.25
Row/Float/Raft	138,630	43.32
Skiing – Cross-Country	2,123	0.66
Snowmobiling	12,368	3.87
Staging/Comfort Stop	829	0.26
Swimming/Water Play	854	0.27
Viewing Wildlife	2,727	0.85
Total Recreational Visitor Days	319,978	100.00

[1] From BLM (2003d).

3.4.11.3 Value of Recreational Use

Recreational activities (nonconsumptive and hunting) have important economic value both in terms of the satisfaction provided to local residents and visitors and the economic activity it generates for the regional economy. Recreation generates additional spending in the local economy that supports jobs and income. Economic stimulus occurs as non-residents visit the area and spend money in the local economy, which in turn generates additional spending by local residents. It is assumed that if local residents were not participating in recreation, they probably would have spent their money on something else in the region's economy. Thus, expenditures by local residents are seen as a shifting of dollars from one sector to another within the local economy and not a net gain to the region. However, dollars that remain within the community when local residents have satisfactory recreational opportunities are important. Keeping dollars within the local economy helps maintain jobs, thus reducing employment and income fluctuations that may result if those dollars became an outflow from (i.e., are spent outside) the local economy.

Value of Nonconsumptive Recreation

The value of recreation was estimated using the methods developed for the South West Regional Economic Evaluation (University of Wyoming, Agricultural Economics Department [UWAED 1997]) and Jack Morrow Hills Coordinated Activity Plan (BLM 2003a; UWAED 2003). Nonconsumptive recreation was derived from UWAED (1997), and is presented in Year 2000 dollars adjusted for inflation. The estimated value of nonconsumptive recreation in the PFO is summarized in Table 3.53.

Value of Hunting

The method used to determine the value of hunting is based that used by UWAED (1997) updated with 2002 hunting and hunter expenditure data from WGFD (2003a, 2003b, 2003c) and is presented in Year 2000 dollars, adjusted for inflation. The JIDPA is fully encompassed by the Sublette Antelope Herd Unit, and for the purposes of this report it is assumed that pronghorn antelope are evenly hunted across the herd unit because it is not possible to derive from existing data exactly where any individual hunts. This method results in a conservative overestimate of the value of hunting in a particular area because in actual practice, hunting likely does not occur evenly across all areas of a hunt unit. The value of hunting pronghorn antelope on the JIDPA is presented in Tables 3.54 and 3.55.

JIDPA Hunting Value

Because elk, mule deer, and moose are unlikely to occur on the JIDPA, there is no value attributable to the project area for those species. Pronghorn do occur on the JIDPA, and an estimated 61.0 hunter days (0.5% of the Sublette Antelope Herd Unit hunter days) are attributed to the JIDPA. At a value of approximately $381.30/hunter day, approximately $23,244 of hunter expenditures for antelope annually is attributable to hunting on the JIDPA. Approximately 1.0% of hunting in Small Game Management Area 7 for cottontail and greater sage-grouse each are attributable to hunting on the JIDPA. Cottontail account for 26.4 hunter days for a value of approximately $4,569.84 of hunter expenditures attributable to cottontail hunting on the JIDPA. Greater sage-grouse account for 16.3 hunter days for a value of approximately $2,123.78 of hunter expenditures attributable to greater sage-grouse hunting annually on the JIDPA.

Table 3.50 Sublette Antelope Herd Unit Landownership and Management.

		Ownership/Management (acres)		
Herd Unit Name	Total Acres	Federal	State/Private	Disturbed
Sublette Antelope Herd Unit	6,749,440	4,994,586	1,754,854	85,000

Table 3.51 Summary of Pronghorn Hunters and Hunter Days in Wyoming and the Sublette Antelope Herd Unit, 2002.[1]

	Hunters[2]			Hunter Days[2,3]		
Area	Total	Resident	Non-resident	Total	Resident	Non-resident
Wyoming	33,569	15,776	17,793	101,989	51,208	50,781
Sublette Antelope Herd Unit	4,382	2,881	1,501	13,490	9,356	4,134

[1] WGFD (2002; 2003a).
[2] Calculated from Harvest, Hunting Pressure, Hunter Success By Hunt Area 2002 reports for each species. Totals may not match state-wide summary tables.
[3] WGFD defines a "hunter-day" as any day hunting occurred, regardless of actual time spent hunting. These data are based on licensed hunter survey reports.

Table 3.52 Summary of Potentially Project-Affected Small Game and Upland Bird Hunters and Hunter-Days, 2002.[1]

	Total Wyoming		Area 7[2] (Eden)	
Species	Number of Hunters	Hunter Days	Number of Hunters	Hunter Days
Desert cottontail rabbit	5,814	25,566	316	1,981
Greater sage-grouse	2,947	7,164	271	938
Totals	8,761	32,730	587	2,919

[1] WGFD (2003b).
[2] Encompasses the JIDPA in its entirety.

Table 3.53 Value of Nonconsumptive Recreation, PFO Area, 1997.[1]

Recreation Activity	Value per Visitor-Day ($)
General recreation	10.18
Developed camping	15.73
Primitive camping	19.85
Day hiking	33.01
Picnicking	14.32
Sightseeing	16.68
Gathering forest products	15.17
Wilderness recreation	14.45
Big game hunting	77.25
Trout fishing	30.04
Wildlife watching	30.04
Snowmobiling	51.50
Average value per visitor day	27.35

[1] In Year 2000 dollars, adjusted for inflation. Source: UWAED (1997).

3.4.12 Environmental Justice

Less than 5% of the Sublette County population is minority (EPA 2003) and, although 9.7% of the population of Sublette County lives below the poverty level, this is a smaller percentage than for the State of Wyoming (11.4%) (U.S. Census Bureau 2000a). Therefore, Sublette County is neither a minority community nor a low-income community.

3.5 LAND USE

3.5.1 Land Status/Prior Rights

The JIDPA consists of federal surface/federal minerals administered by the BLM (94%/28,580 acres), two sections (1,280 acres) of State of Wyoming surface/mineral, and one section (640 acres) of private surface/federal minerals (see Map 1.1). Current land use includes energy production and development (e.g., natural gas well pads, pipelines, access roads, ware yards, offices), livestock grazing, wildlife habitat, and recreation--primarily hunting. Map 2.1 shows the extent of existing natural gas development in the JIDPA.

Table 3.54 Value of Hunting of Species Potentially Occurring on the Project Area, Wyoming and Study Area, 2002.

Species	Wyoming					Attributable to Potentially Affected Hunt Areas					
	[1,2]			Hunter Expenditures[3] ($)	Average Value/ Hunter-Day ($)	[4]			Hunter Expenditures ($)		
	Total	Resident	Non-resident			Total	Resident	Non-resident	Total	Resident	Non-resident
Antelope	101,989	51,208	50,781	38,888,895	381.30	13,490	9,356	4,134	5,143,737	3,567,443	1,576,294
Cottontail[6]	25,566	NA	NA	4,424,464	173.06	2,516	NA	NA	435,419	--	--
Greater sage-grouse[6]	7,164	NA	NA	933,437	130.30	1,553	NA	NA	202,356	--	--
Hunter-Days											
Total	134,719	51,208	50,781	44,246,796	228.22	17,559	NA	NA	5,781,512	--	--

1 WGFD (2003a, 2003b). Calculated from Harvest, Hunting Pressure, Hunter Success By Hunt Area 2002 reports for each species. Totals may not match state-wide summary tables or WGFD (2003c).

2 WGFD defines a "hunter-day" as any day hunting occurred, regardless of actual time spent hunting. This data is based on licensed hunter survey reports.

3 WGFD (2003c). In year 2000 dollars, adjusted for inflation. WGFD does not distinguish between resident and non-resident expenditures.

Hunter-Days

4 Refer to Table 3.51 and 3.52.

5 Species that may occur infrequently within the affected areas that WGFD does not manage for hunting in the project areas may include bighorn sheep, Rocky Mountain goat, black bear, and mountain lion.

6 WGFD does not separate resident and non-resident hunter days for small and upland game.

Table 3.55 Contribution of JIDPA to Hunting Revenues.[1]

Species	Unit Name	Total Acres	Hunter-Days Attributable to Unit	Average Value/ Hunter-Day ($)	Project Area (acres)	% Acres of Unit in Project Area	Hunter-Days in Project Area	Annual Value Attributable to Hunting on Project Area ($)
Antelope	Sublette Antelope Herd Unit	6,749,440	13,490	381.30	30,500	0.5%	61.0	23,244.00
Cottontail	Small Game Management Area 7	2,906,068	2,516	173.06	30,500	1.0%	26.4	4,569.84
Greater sage-grouse	Small Game Management Area 7	2,906,068	1,553	130.30	30,500	1.0%	16.3	2,123.78
Total	--	n/a[2]	n/a[2]	n/a[2]	n/a[2]	n/a[2]	103.7	29,937.63

[1] In year 2000 dollars, adjusted for inflation.
[2] n/a = column is not additive.

The CIAA for land status/prior rights includes the JIDPA and leases that extend beyond the JIDPA, and it encompasses approximately 35,634 acres (Map 3.21). All of the JIDPA and the CIAA is leased for mineral development. Land use associated with mineral development on the JIDPA is described in Section 3.1.4.1.

3.5.2 Livestock/Grazing Management

The JIDPA includes portions of three grazing allotments--Stud Horse Common, Sand Draw, and Boundary--and the Burma Road Upgrade area includes portions the Blue Rim Desert allotment (Map 3.22 and Table 3.56). Livestock grazing is allocated to two permittees each in the Stud Horse Common and Sand Draw allotments and four permittees in the Blue Rim Desert allotment (personal communication January 6, 2003, with Steve Laster, BLM PFO). The Boundary allotment is allocated to two permittees. There are also approximately 640 acres of private lands (2% of the JIDPA) not included in allotments (see Map 3.22).

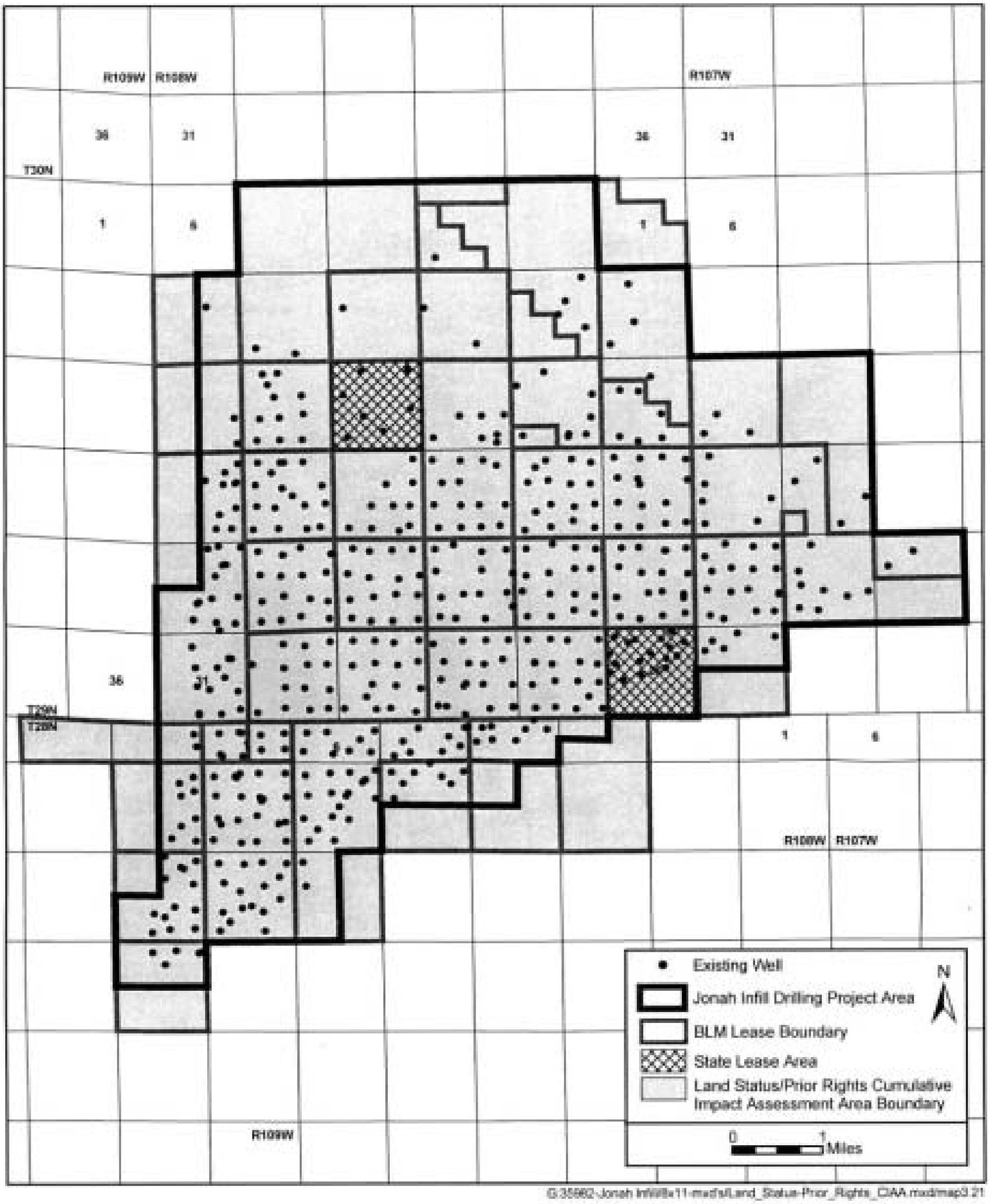
The Stud Horse Common allotment (15,590 total acres) includes 14,309 acres of BLM lands providing 1,730 AUMs (personal communication, January 6, 2003, with Steve Laster, BLM PFO) and 1,280 acres of State of Wyoming lands--an average of 8.2 acres/AUM. Cattle are grazed from May 1 to June 30. The JIDPA includes approximately 5,490 acres of the Stud Horse Common allotment providing approximately 670 AUMs (see Table 3.56).

The Sand Draw allotment (31,740 acres) includes 30,445 acres of BLM lands providing 2,324 AUMs (personal communication, November 2003, with Steve Laster, BLM PFO) and 1,295 acres of State of Wyoming lands. Cattle are grazed from May 1 to June 20 (personal communication, November 2003, with Steve Laster, BLM PFO). The JIDPA includes approximately 20,740 acres of the Sand Draw allotment providing an average of 1,571 AUMs, an average of 13.2 acres/AUM (see Table 3.56).

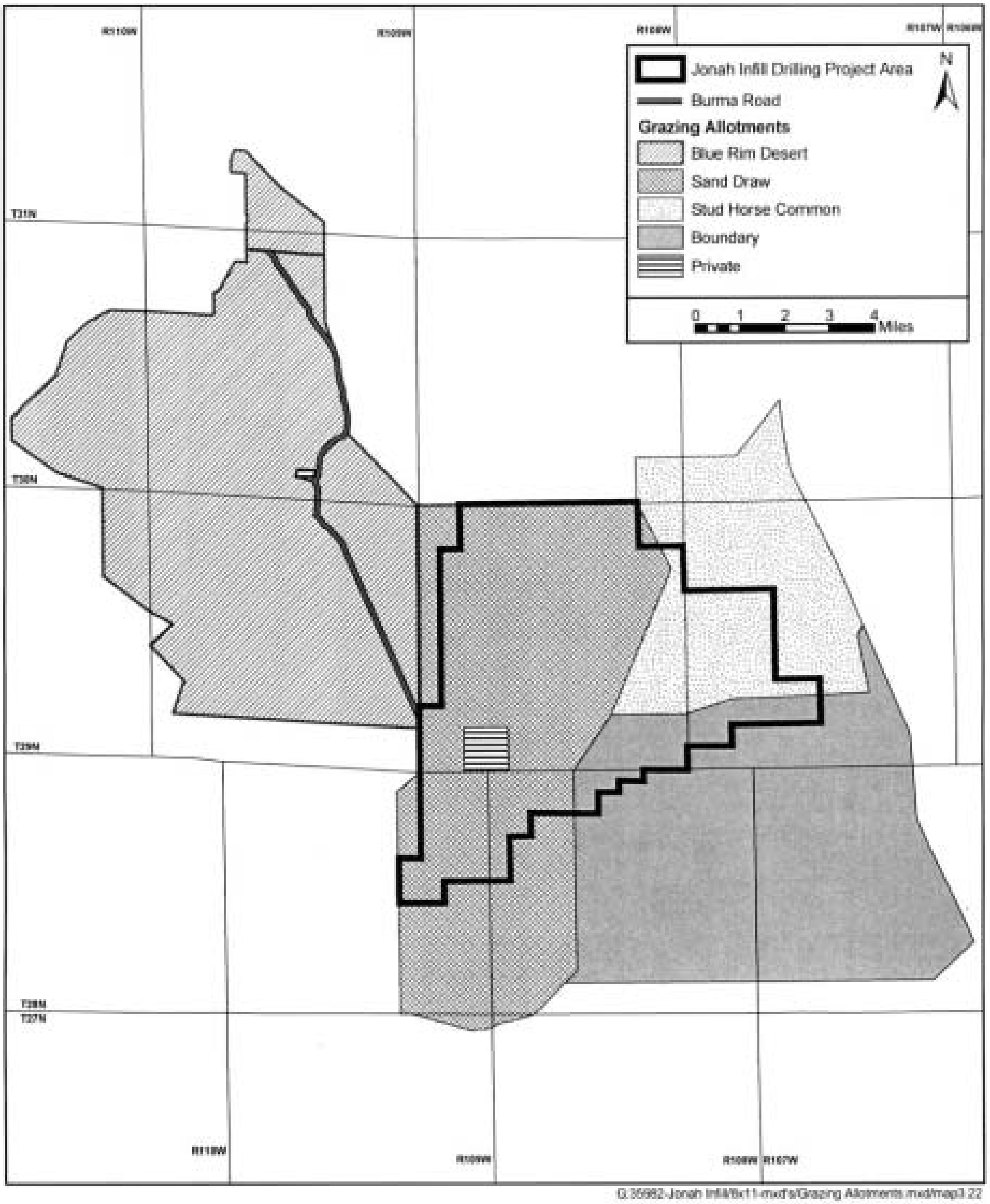
The Boundary allotment (31,994 total acres) includes 29,982 acres of BLM lands (providing 2,996 AUMs), 1,930 acres of state lands, and 82 acres of private land. The allotment is managed for three-pasture deferred rotation/short duration, low-intensity grazing and is approved for yearlong grazing. Sheep and/or cattle are grazed from May to July, with cattle remaining on the allotment until November (personal communication, January, 9, 2004, with Jay D'Ewart, BLM RSFO). The JIDPA includes approximately 3,630 acres of the Boundary allotment providing 363 AUMs, an average 10 acres/AUM (see Table 3.56). Lambing occurs in a portion of the allotment from May 15 to June 15. Sheep grazing and lambing generally do not occur in the JIDPA; therefore, sheep are not discussed further.

The Blue Rim Desert allotment (41,273 total acres) includes 39,467 acres of BLM lands providing 2,826 AUMs (personal communication, January 6, 2004, with Steve Laster, BLM PFO), 1,019 acres of state lands, and 787 acres of private land--an average of 14.6 acres/AUM (see Table 3.56). Cattle are grazed from May 1 to July 6. The proposed Burma Road Upgrade area crosses this allotment.

Economic data for JIDPA livestock grazing is provided in Section 3.4.10. The CIAA for livestock grazing is the four affected grazing allotments that encompass approximately 120,597 acres, of which the 114,203 acres of federal land provide a total of 9,876 permitted AUMs (see Table 3.56, Map 3.22). Based upon WyGISC (2002, 2003) digital data and aerial photographs, approximately 2.3% of the CIAA for livestock grazing (2,777 acres), has been disturbed by well pads, pipelines,



Map 3.21 Land Status/Prior Rights Cumulative Impact Assessment Area Boundary, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.



Map 3.22 Grazing Allotments, Jonah Infill Drilling Project Area and Cumulative Impact Assessment Area, Sublette and Sweetwater Counties, Wyoming, 2004.

Table 3.56 Livestock/Grazing Allotments in the Jonah Infill Drilling Project Area and Cumulative Impact Assessment Area, Sublette County, Wyoming, 2005.

Grazing Allotment	Allotment Size (acres)	Federal Acres in Allotment	Total AUMs	Acres of Allotment in JIDPA	AUMs in JIDPA	Existing Disturbance in Entire Allotment (acres)	Average Federal Acres/AUM
Stud Horse Common	15,590	14,309	1,730	5,490	670	782	8.2
Sand Draw	31,740	30,445	2,324	20,740	1,571	1,147	13.2
Boundary	31,994	29,982	2,996	3,630	363	461	10.0
Blue Rim Desert	41,273	39,467	2,826	n/a [1]	--	359	14.6
No Allotment (Private)	640	--	--	640	--	28	--
Total[1]	120,597	114,203	9,876	30,500	2,604	2,777	11.5[2]

1 n/a = 12 miles of the Burma Road Upgrade Area is in the Blue Rim Desert.
2 Total does not include the "No Allotment"; average federal acres/AUM are not additive.

resource roads, agricultural lands (i.e., hay meadows), and highways. The Sand Draw grazing allotment has the largest amount of existing disturbance with 1,147 acres (3.6% of the allotment) disturbed primarily from existing gas development in the Jonah Natural Gas Field.

3.5.3 Recreation

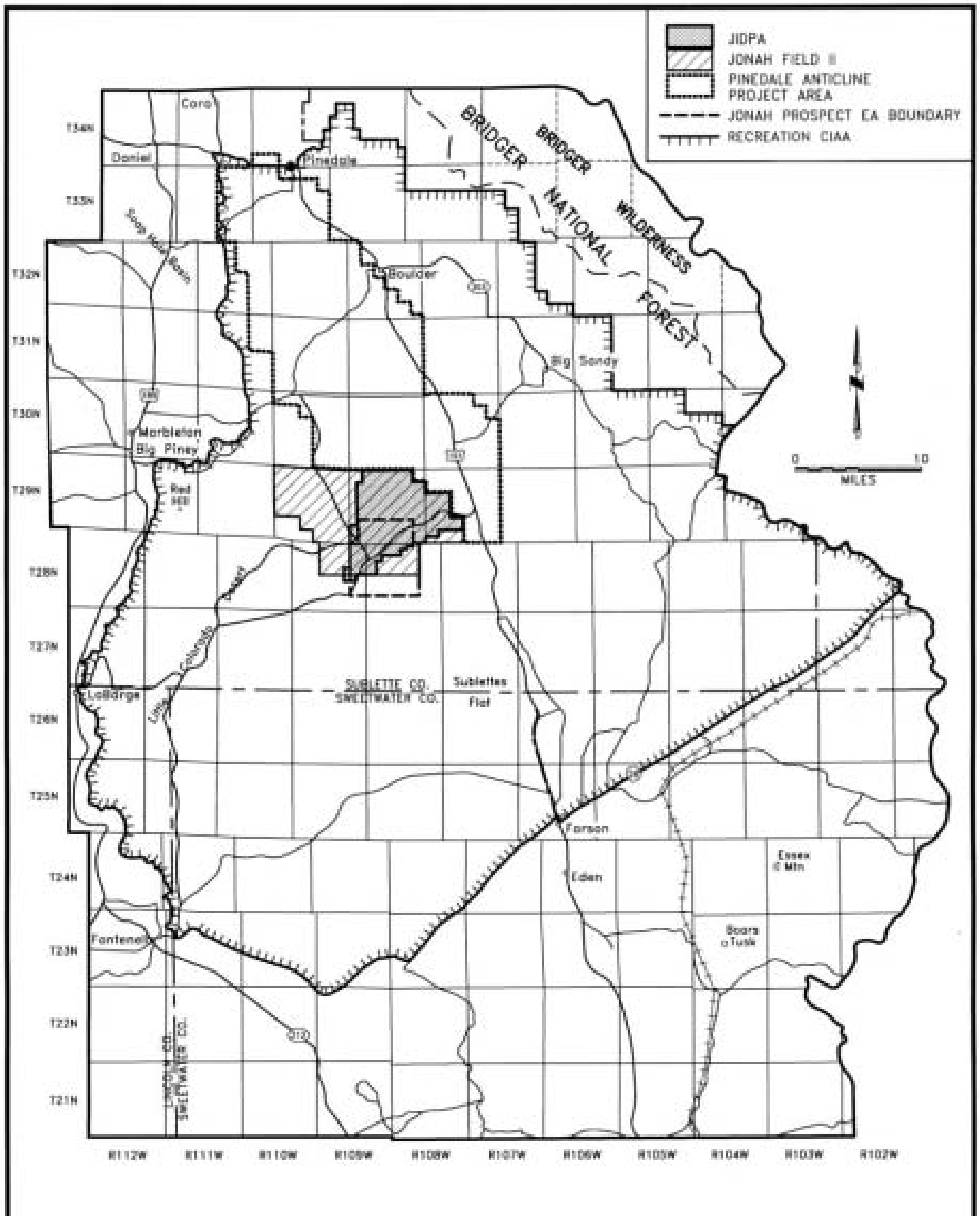
The CIAA for recreation encompasses 1,557,558 acres (2,434 square miles) (Map 3.23). Existing surface disturbance includes approximately 84,331 acres (132 square miles), or 5.4% of the CIAA, and results primarily from agriculture (79%) and road and pipeline ROWs (14%).

Detailed information on recreation and recreation revenues is provided in Section 3.4.11. The following provides some additional information on recreation types and the importance of the various recreation types in the area.

Davis-Peterson Associates, Inc. (1995) estimate that total traveler expenditures in southwestern Wyoming (Carbon, Lincoln, Sublette, Sweetwater, and Uinta Counties) were $282 million in 1994, with Sweetwater County having the most ($98 million) and Sublette County the least ($30 million). Vacationers represented 55% of total traveler expenditures in the five-county region. Data suggest that travel peaked in 1981, declined until 1988, and then grew steadily through 1993 (UWAED 1997). Southwestern Wyoming is an important recreation area for Wyoming residents (UWAED 1997). The 1990 Wyoming State Comprehensive Outdoor Recreation Plan (State of Wyoming 1990), while out of date, reported that southwestern Wyoming, with 20% of the state's population, supported more than 50% of all Wyoming resident OHV and four-wheel drive use, 49% of all resident antelope hunting, 15% of all resident sightseeing, and 17% of all historical site visits and day hiking. Relative to its population (1.1% of state), Sublette County was especially important in terms of OHVs (21.6%), antelope hunting (15.6%), backpacking (18.7%), and camping (11.9%). Statewide, the most popular recreational activities include: wildlife viewing (71%), driving for pleasure (66%), hiking or walking (64%), viewing natural features, such as scenery, flowers (64%), general/other, such as relaxing, escaping crowds, noise (64%), fishing (63%), visiting historic and/or prehistoric sites (54%), and attending fairs or festivals (50%) (Bingaman et al. 2003).

There are no developed recreation areas within the JIDPA; however, BLM-administered lands provide a variety of recreational opportunities including hunting for antelope, greater sage-grouse, and small game. Backpacking, camping, cross-country skiing, snowshoeing, snowmobiling, rock collecting, sightseeing, wildlife viewing and general photography are a few of the nonconsumptive recreational opportunities available in the region, although many of these actions likely no longer occur on the JIDPA due to existing oil and gas development. Total annual recreational visitor days (other than hunting) in the PFO from October 1, 1998, to September 30, 2002, was 319,978 (BLM 2003c). The most popular activities included boating (43%), fishing (23%), camping (11%), and hiking/walking/running (10%). Recreational use data specific to the JIDPA are not available. However, dispersed recreation related to sightseeing and OHV use does likely occur on the JIDPA since the area is designated as suitable for OHV use in the PFO RMP, and recreational hunting is likely the most important recreational activity on the JIDPA.

Since the JIDPA may have importance for recreational hunting by some individuals for the game species that occur in the area (e.g., pronghorn, cottontail rabbit, and greater sage-grouse), a conservative economic analysis of recreational hunting in the JIDPA is provided in Section 3.4.11.2.



Map 3.23 Recreational Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Sublette and Sweetwater Counties, Wyoming, 2004.

While no wilderness or wilderness study areas occur in the JIDPA, the BLM Scab Creek Wilderness Study Area (7,636 acres south of Boulder Lake) and the Bridger Wilderness Area are approximately 20 miles northeast of the area. The Scab Creek, Bridger, Fitzpatrick, and Popo Agie Wilderness provide regional opportunities for remote recreational activities.

3.5.4 Transportation

Surface transportation in the JIDPA is provided by an extensive network of collector and resource roads (see Map 2.1 and Appendix G). The two principle roadways to the JIDPA are State Highway 191, which links the field to Rock Springs and Pinedale, Wyoming, and State Highway 351, which links the field to Big Piney and Marbleton, Wyoming.

The main access to the JIDPA is from the Luman Road, which runs east from the JIDPA to State Highway 191. The Burma and Jonah North Roads, which run north from the JIDPA to connect with State Highway 351 also provide access to the field (see Map 2.1). Further detail on the roads in the JIDPA and associated traffic is discussed in the Transportation Plan (Appendix G).

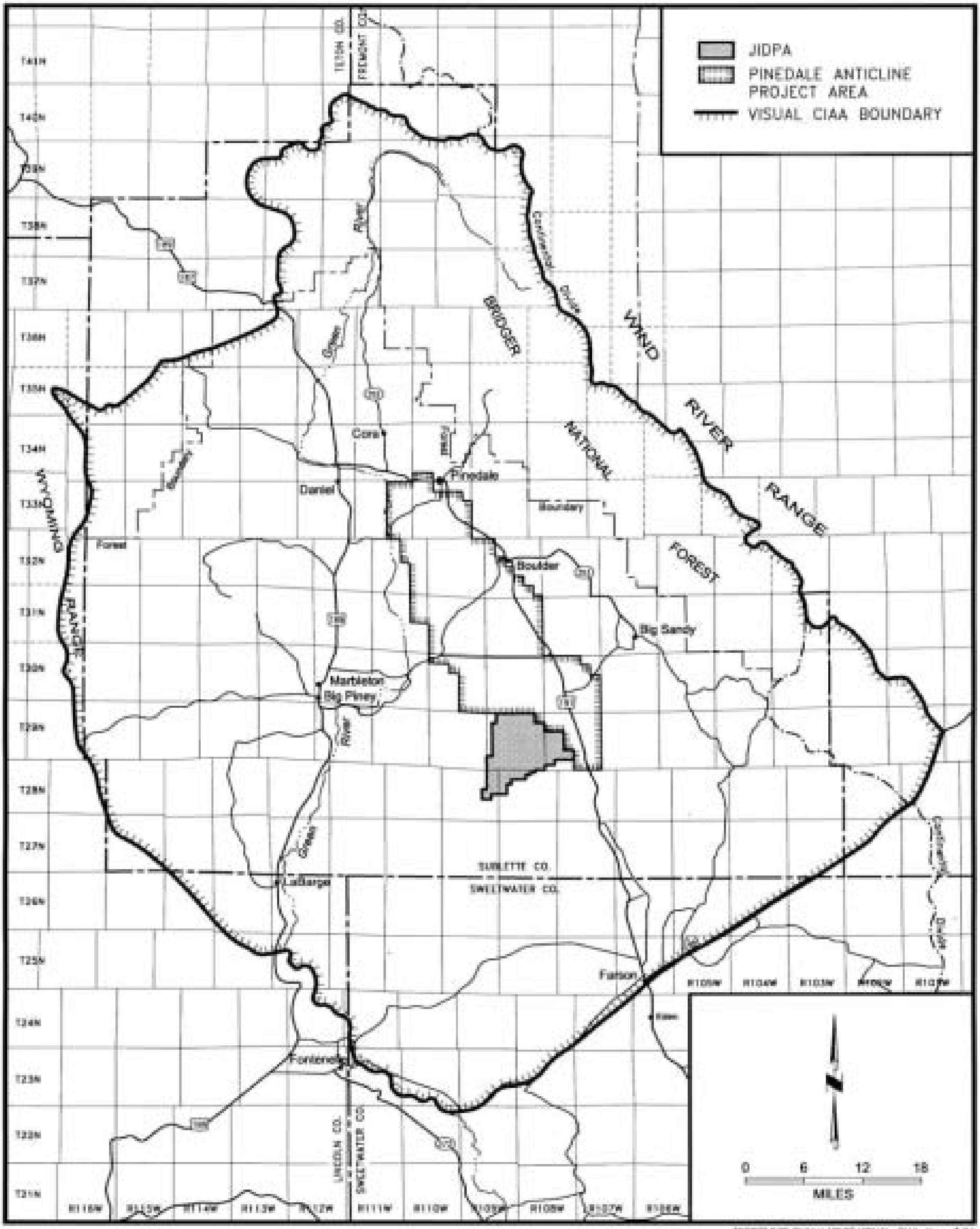
3.6 VISUAL RESOURCES

The CIAA for visual resources encompasses 2,089,363 acres (3,264 square miles) (Map 3.24). Existing surface disturbance includes approximately 138,740 acres (216 square miles) or 6.6% of the CIAA and results primarily from agriculture (83%) and road and pipeline ROWs (12%).

The Visual Resource Management (VRM) System is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM classification combines evaluation of visual quality, visual sensitivity of the area, and view distances. The BLM's PFO was first visually inventoried and classified in 1978. VRM classes are used to identify the degree of acceptable visual change within a characteristic landscape. Classes are based on the physical and sociological characteristics of a given homogeneous area and serve as a management objective. Projects of all types within established VRM class areas will generally be required to conform with objectives and characteristics of the classification, or the project will be modified to meet the VRM class objective. Short-term modifications in portions of visual class areas may be approved if a site-specific environmental analysis determines that impacts would be acceptable.

The entire JIDPA is in a Class IV VRM area. A basic description of the landscape (high desert shrub area with flat to rolling topography containing buttes and ridges) is provided in Sections 3.1.3 (Topography) and 3.2.1 (Vegetation). The landscape today is dominated by oil and gas development features (e.g., roads, well pads). The Class IV designation provides for management activities that may generate major modifications to the existing character of the landscape. Contrasts may attract attention and be a dominant feature of the landscape in terms of scale; however, the change should repeat the basic elements (form, line, color, and texture) inherent in the characteristic landscape. A Class IV VRM designation allows for modification of the landscape to accommodate natural gas production, but also advocates that surface facilities blend with surroundings to lessen the visual impacts.

The connected actions, including the upgrade of the Burma Road and the modification of the Project area boundary to include the north half of Section 23, T28N, R109W, are also in areas designated as VRM Class IV.



Map 3.24 Visual Cumulative Impact Assessment Area, Jonah Infill Drilling Project, Lincoln, Sublette, and Sweetwater Counties, Wyoming, 2005.

A VRM Class III area occurs as a 1-mile corridor surrounding U.S. Highway 191 just east of the JIDPA. A Class III designation provides for moderate changes to the existing landscape, although management activities associated with these changes should not dominate the view of the casual observer. For the most part, the JIDPA is not visible from U.S. Highway 191, a major corridor for tourists. However, current JIDPA developments (e.g., rig structures and production facilities) at higher elevations on Yellow Point Ridge in the southern JIDPA are visible at a distance of about 8 miles from an approximately 8- to 10-mile length of U.S. Highway 191. Additional existing oil and gas development effects visible from the highway include nighttime lights, occasional smoke plumes, and haze events. The only currently identified project feature present in the VRM Class III corridor along U.S. Highway 191 is the existing Luman Road.

3.7 HAZARDOUS MATERIALS

Hazardous materials present in the JIDPA include those used and produced in association with natural gas drilling, completion, and production, and these substances and their current management protocol are discussed in detail in the Hazardous Materials Management Summary (Appendix G).

3.8 COMPENSATORY MITIGATION

No compensatory (off-site) mitigation (CM) projects have been completed or are in progress.

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CHAPTER 4 — ENVIRONMENTAL CONSEQUENCES AND MITIGATION MEASURES

The potential positive and adverse impacts of construction, drilling, completion, operation, maintenance, and reclamation of the proposed project are disclosed for each affected resource under each alternative. An environmental consequence or impact is defined as a modification to the existing environment brought about by development activities. Impacts can be beneficial or adverse, can be a primary result of an action (direct impacts) or a secondary result (indirect impacts), and can be permanent or long-lasting (long-term impacts--more than 5 years) or temporary and short duration (short-term--5-years or less). Impacts can vary in degree from a slightly discernable change to a dramatic change in the environment.

Impacts are quantified whenever possible. Potential significant impacts (as defined in CEQ guidelines 40 C.F.R. 1500-1508--effects that are most substantial and therefore should receive the greatest attention in decision-making) are identified. The use of adjectives (e.g., “moderate,” “low,” “negligible”) has been avoided because this EIS is an analytical document. The magnitude of an impact (i.e., its significance) is based on RMP and state and local land use planning objectives, regulatory standards, scientific and environmental documentation, and professional judgment. Impacts are considered adverse unless identified as beneficial.

Significance criteria were developed to measure the degree to which an impact would affect (positively or negatively) the human and natural environment. Developing significance criteria is difficult for a number of reasons. First, although used extensively throughout the Act, NEPA does not identify what is meant by significant on a resource-by-resource basis. Second, it is often difficult to quantify impacts for some resources. In these cases, significance criteria must be subjective and often rely on the professional opinion of the persons preparing and reviewing the impact analysis. Finally, for the reader, the significance of an impact is often framed in terms of personal experience. For instance, persons who benefit directly from the positive economic impacts of the project are more likely to consider that positive impact more significant than someone who will not receive financial gain. Similarly, someone who recreates in the JIDPA is likely to find conflicts with project-related activities much more severe than someone who recreates elsewhere. Although this document does not predict "worst-case" impacts, it may overestimate impacts from the project. For purposes of this analysis, it is assumed that development would occur throughout the JIDPA. Overestimation is unavoidable for complete disclosure of potential or reasonable foreseeable impacts from the project.

Each resource discussed in this chapter includes a description of the following:

- Impact Significance Criteria. Current resource management goals/objectives are summarized from BLM RMP RODs (BLM 1988b, 1997b), the State of Wyoming land use plan (Wyoming State Land Use Commission [WSLUC] 1979) and the Sublette County comprehensive plan (SCBC and SCPC 2003). In general, the ability of management agencies to achieve or maintain these goals/objectives determines significance (i.e., if plan goals/objectives can no longer be met on the JIDPA or for the planning area, then the potential for a significant impact exists).

For some resources, additional impact significance criteria are provided (e.g., for air resources, various legally mandated thresholds/limits are identified).

- Impacts. The level and duration of impacts anticipated to occur as a result of the No Action Alternative, the Proposed Action, Alternatives A-G, and the Preferred Alternative are described. It is assumed that BLM-identified and Operator-committed practices would be implemented to avoid or minimize adverse impacts (see Chapter 2, and Appendices A and B).
- Cumulative Impacts. These are impacts that result from the incremental impacts of an action added to other past, present, and reasonably foreseeable actions, regardless of who is responsible for such actions. CIAAs for each resource are identified in Table 3.2 and existing disturbance/conditions in these areas are discussed in Chapter 3. Cumulative impact assessment includes past, present, and reasonably foreseeable development (RFD). RFD for this project includes development that has been analyzed and approved under NEPA, including past development in Jonah Field, existing and approved developments in the Pinedale Anticline, and others, as appropriate, as well as other likely surface disturbance (e.g., South Piney Project).
- Unavoidable Adverse Impacts. These are impacts that cannot be completely mitigated.

Mitigation and other environmental protection measures are identified across alternatives in Chapter 2. Detailed descriptions of these measures are provided in Appendix A (BLM Standards), and Appendix B (Operator-committed practices). It is assumed that the application of identified mitigation and protection measures would reduce impact levels; however, the efficacy of many mitigations is unknown. Therefore, no quantitative variation in impact levels based upon the application of variable mitigations is provided.

Alternative-specific mitigation and monitoring measures for the Preferred Alternative are identified in Section 2.14. It is assumed that these measures would impart some level of impact reduction to various resources.

Irreversible and irretrievable commitment of resources and short-term use of the environment versus long-term productivity are discussed in separate sections following the discussions of specific resources (Sections 4.8 and 4.9, respectively).

Considerable natural gas development has already occurred within the JIDPA as approved in past NEPA documents (BLM 1998b, 2000b), and impacts from this past development would continue for approximately 63 years without any further development authorizations. Most impacts associated with this project, therefore, would involve increases in the magnitude and/or duration of impacts previously described in past NEPA documents (BLM 1997a, 2000a). Additionally, preliminary research and monitoring results indicate significant adverse impacts to many area resources have already occurred with existing development and mitigation requirements. Therefore, BLM is proposing to increase on-site mitigation efforts with a particular focus on reclamation, and recommend initiation of CM as appropriate and consistent with BLM policy. All CM efforts would be voluntarily developed and proposed by the Operator, and following approval and authorization by BLM, would become commitments of the Operator.

For most resources, the quicker the project is implemented, the shorter the duration of impacts; therefore, pace of development may have the greatest effect on area resources. For example, the faster the gas is recovered, the sooner the area can be reclaimed.

4.1 PHYSICAL RESOURCES

4.1.1 Climate

An assessment of project impacts to climate is beyond the scope of this analysis and is therefore not discussed further in this EIS.

4.1.2 Air Quality

Direct, indirect, and cumulative air quality impacts were analyzed to predict maximum potential near-field ambient air pollutant concentrations, as well as to determine maximum far-field ambient air pollutant concentrations, visibility (regional haze), and atmospheric deposition (acid rain) impacts. Maximum mid-field (regional community) visibility impacts were also determined, as were maximum in-field (within the JIDPA) concentration impacts.

This air quality impact assessment is based on the best available engineering data and assumptions, meteorology data, and dispersion modeling procedures, as well as professional and scientific judgment. Assumptions representing most likely operating conditions were incorporated into the analysis whenever possible. For example, compression in the field was assumed to operate at 90% of fully permitted capacity. Other parameters for which no reliable most likely operating projections were available were assumed to occur at maximum proposed levels. For example, impact assessments for both the Proposed Action and alternatives assume that all proposed wells would be productive (no dry holes).

Air pollution impacts are limited by state and federal regulations, standards, and implementation plans established under the *Clean Air Act* and administered by the applicable air quality regulatory agency--specifically, the WDEQ/AQD and the EPA. The States of Utah, Colorado, and Idaho have similar jurisdiction over potential air pollutant emissions sources in those states, which can have a cumulative impact when combined with WDEQ/AQD-regulated sources. The applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. The U.S. Congress (through the *Clean Air Act* Section 116) also authorizes local, state, and tribal air quality regulatory agencies to establish air pollution control requirements of equal or greater stringency than federal requirements. Any proposed emissions source is required to undergo a permit review by applicable air quality regulatory agencies (including state, tribal, and/or EPA) before construction can begin. The agencies review the specific air pollutant emission sources proposed and, depending upon the magnitude of emissions and other factors, the air quality regulatory agencies may require additional site-specific air quality analysis and/or additional emission control measures (including a Best Available Control Technology [BACT] analysis and determination) to ensure protection of air quality.

Under FLPMA and the *Clean Air Act*, BLM cannot authorize any activity that does not conform to all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans. An extensive air quality impact assessment technical support document was prepared to analyze potential impacts from the development alternatives, as well as other reasonably foreseeable emission sources. The *Jonah Infill Natural Gas Project Air Quality*

Technical Support Document (TRC Environmental Corporation [TRC EC] 2004) provides additional detail on this air quality evaluation and is available for review at the PFO.

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) prescribe the following management goals/objectives associated with air quality:

- to maintain and, where possible, enhance air quality levels;
- to protect public health and safety and sensitive natural resources;
- to within authority minimize emissions which may add to acid rain, cause violations of air quality standards, or reduce visibility;
- to ensure that industries adhere to federal and state air quality standards; and
- to consider the frequency of atmospheric inversions, meteorology, topography, present ambient air quality, significant deterioration limits, and applicable local, state, and federal laws when evaluating land use proposals and development issues.

The significance criteria for potential air quality impacts include state and federally enforced legal requirements to ensure that air pollutant concentrations will remain within specific allowable levels, as well as adherence to the aforementioned RMP and land use plan goals and objectives. Legal requirements include the NAAQS and WAAQS, which set maximum limits for several air pollutants, and PSD Increments, which limit the incremental increase of certain air pollutants (including NO_2, PM_{10}, and SO_2) above legally defined baseline concentration levels. These standards and increments have been presented in Table 3.7.

Where legal limits have not been established, the BLM uses best available scientific information to identify thresholds of significant adverse impacts. Thresholds or levels of concern have been identified for Hazardous Air Pollution (HAP) exposure, incremental cancer risks, a "just noticeable change" in potential visibility impacts, and potential atmospheric deposition impacts. These thresholds or levels of concern are described later in this chapter.

Air quality impacts from the project would occur from pollutants emitted during construction (due to potential surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well completion and testing, and drilling rig and vehicle engine exhaust) and production (natural gas well-site production equipment, reciprocating pipeline compression engine exhausts, vehicle traffic engine exhausts, and fugitive dust). Pollutants emitted from these activities include PM_{10}, $PM_{2.5}$, NO_X, CO, SO_2, VOC, and HAPs. O_3 may develop from NO_x and VOC emissions. Some amount of unquantified HAPs may also occur from water treatment. The amount of air pollutant emissions during construction and production may, in part, be controlled using the mitigation methods outlined in Section 2.14 and Appendices A and B. Impacts for the Preferred Alternative have been qualitatively estimated. Model runs to quantify the impacts of the Preferred Alternative will be conducted during the DEIS public comment period, and results will be reported in the FEIS. Actual air quality impacts from air pollutants would depend on the amount, duration, location, and emission characteristics of potential emissions sources, as well as meteorological conditions (e.g., wind speed and direction, precipitation, relative humidity).

The assessment of direct project impacts includes a near-field analysis and a far-field analysis, which were completed separately for selected project Alternatives. A summary of near-field and far-field impacts across alternatives is provided in Table 4.1. The near-field analysis assesses direct impacts in the immediate vicinity of project activities resulting from a single phase of construction or production reflective of maximum emissions. The far-field analysis assesses direct impacts from field-wide project emissions at in-field locations within the JIDPA, mid-field locations defined as Class II areas (Wyoming regional communities of Big Piney, Big Sandy, Boulder, Bronx, Cora, Daniel, Farson, LaBarge, Merna, and Pinedale), and at far-field locations (i.e., sensitive Class I and Class II areas) (see Map 3.1). The far-field analysis also assesses regional emission sources located within the model domain illustrated in Map 3.1 to predict cumulative impacts at in-field, mid-field, and far-field locations. While there may be additional gas processing and/or transmission requests due to development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified since they are speculative in nature and would likely require additional WDEQ/AQD permitting if eventually proposed.

Near-field Analysis

The near-field analysis utilized air pollutant emission rates calculated for all phases of construction and production based on WDEQ/AQD guidance in place at the time of the analysis. Impacts were assessed from the phase of single-well pad construction or field production that produced the highest emissions. Near-field analysis for PM_{10}, $PM_{2.5}$, and SO_2 focused on localized impacts from construction and drilling activity at a single well pad and analyzed direct project impacts within the JIDPA using three different well pad configurations to predict maximum impacts that could result from a single pad. A 3.8-acre single-well pad configuration, a 7-acre (two wells per pad) configuration, and a 10.0-acre (10 wells per pad) configuration were analyzed. These three scenarios reflect a range of wells per pad that may be developed under the alternatives. Direct project NO_X, CO, and HAPs impacts were modeled for 3,100- and 1,250-well developments to reflect the maximum range of wells in production under any alternatives. NO_2 and CO impacts analyses included project emissions combined with existing JIDPA wells and non-project existing and proposed compression to better approximate a NAAQS analysis under WDEQ/AQD requirements. Detailed information regarding the modeling methodologies used in the near-field analysis is provided in the *Jonah Infill Natural Gas Project Air Quality Technical Support Document* (TRC EC 2004).

O_3 is formed through a chemical reaction between NO_x, VOCs and ultraviolet light (sunlight) within the atmosphere. The EPA O_3 formation screening methodology (Scheffe 1988) was used to estimate maximum ozone impacts from NO_x and VOC emissions generated from the project. A representative 128-well section with a compressor station was used for this analysis. The maximum quantity of O_3 that could be formed from this project in combination with other existing projects and potential future developments is expected to be less than NAAQS. Further detail on O_3 is provided in the Air Quality Technical Support Document (TRC EC 2004).

Acute (short-term) HAP impacts were modeled by assuming a person would not persistently remain at a location closer than 100 m (328 ft) from a well pad or a compressor station due to site operations safety considerations. Long-term (chronic) health-based HAP impacts and long-term (chronic) cancer risk were modeled using the realistic estimate of long-term exposure, which assumes a person would not be closer than the nearest residence on the New Fork River, located 8 miles from a well pad or compressor site, when averaged over a lifetime. Two estimates of

Table 4.1 Summary of Primary Additional Air Quality Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

IMPACT	NO ACTION	PROPOSED ACTION (3,100 Wells/16,200 Acres Disturbance)	ALTERNATIVE A (3,100 Wells And Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	ALTERNATIVE C (1,250 Wells And Pads)	ALTERNATIVE D (2,220 Wells And Pads)	ALTERNATIVE E (266 New Pads; 16 Total Pads/Section)	ALTERNATIVE F (1,028 New Pads; 32 Total Pads/Section)	ALTERNATIVE G (2,553 New Pads; 64 Total Pads/Section)	PREFERRED ALTERNATIVE (Specific Maximum Disturbance Allowances, Mitigation/Monitoring)
AIR QUALITY										
Increased concentrations of criteria pollutants and Hazardous Air Pollutants (HAPs)	No impact above existing levels; no new developments	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable Prevention of Significant Deterioration (PSD) increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below applicable PSD increments
Visibility (regional haze) at Class I and Sensitive Class II areas (far-field)	No impact above existing levels; no new developments	Potential project impacts would be greater than 1.0 deciview (dv) for a maximum of 10 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 10 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 11 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 8 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than for Alternative C and less than for Alternative A	Potential project impacts would be similar to Alternative B	Potential project impacts would be greater than 1.0 dv for a maximum of 10 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than for Alternative A and less than for Alternative F	Potential project impacts would be similar to Alternative G
Visibility (regional haze) (mid-field communities)	No impact above existing levels; no new developments	Maximum of 23 days per year >1.0 dv	Maximum of 23 days per year >1.0 dv	Maximum of 26 days per year >1.0 dv	Maximum of 17 days per year >1.0 dv	Impacts greater than Alternative C but less than Alternative A	Impacts similar to Alternative B	Maximum of 24 days per year >1.0 dv	Impacts greater than Alternative A but less than Alternative F	Impacts similar to Alternative G
Atmospheric/terrestrial deposition	No impact above existing levels; no new developments	Potential project impacts from sulfur deposition would be less than Deposition Analysis Threshold (DAT) at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.035 kg/ha/yr), Popo Agie Wilderness (0.017 kg/ha/yr), and Wind River Roadless Area (0.010 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.035 kg/ha/yr), Popo Agie Wilderness (0.017 kg/ha/yr), and Wind River Roadless Area (0.010 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.040 kg/ha/yr), Popo Agie Wilderness (0.019 kg/ha/yr), and Wind River Roadless Area (0.011 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.032 kg/ha/yr), Popo Agie Wilderness (0.015 kg/ha/yr), and Wind River Roadless Area (0.009 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT (i.e., 0.005 kg/ha/yr) at all analyzed areas; potential project impacts from nitrogen deposition would be greater than for Alternative C but less than for Alternative A	Potential project impacts would be similar to Alternative B	Potential project impacts from sulfur deposition would be less than DAT (i.e., 0.005 kg/ha/yr) at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT at Bridger Wilderness (0.036 kg/ha/yr), Popo Agie Wilderness (0.017 kg/ha/yr), and Wind River Roadless Area (0.010 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT (i.e., 0.005 kg/ha/yr) at all analyzed areas; potential project impacts from nitrogen deposition would be greater than for Alternative A but less than for Alternative F	Potential project impacts would be similar to Alternative G
Sensitive lake acid neutralization capacity (ANC)	No impact above existing levels; no new developments	Potential project impacts would be less than Level of Acceptable Change (LAC); potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts would be less than LAC	Potential project impacts would be less than LAC; potential cumulative impacts were less than LAC

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 estimated cancer risks were calculated based on EPA (1997) unit risk factors for carcinogenic constituents.

Near-field Impacts Summary

The near-field modeling results for the range of project alternatives are provided in Appendix F, Tables F-1 through F-8. A discussion of these results by alternative is presented in later sections. Maximum predicted concentrations of all criteria pollutants were added to the ambient background pollutant concentrations for comparison to WAAQS and NAAQS. Predicted impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. These tables also present the maximum impacts expressed as a percentage of the NAAQS and WAAQS. Predicted impacts from all project alternatives are less than the applicable WAAQS and NAAQS. Table F-2 also presents a comparison of the maximum predicted NO2 impacts resulting from production activities to the PSD Class II increment for NO_2. Background NO2 concentrations are not added to modeled concentrations for comparison to the PSD Class II Increment for NO_2. Predicted NO_2 impacts from all project alternatives are less than the applicable PSD increment. A comparison of the maximum modeled PM_{10} and SO_2 impacts to PSD Class II increments is not presented since these maximum impacts are associated with emissions from temporary construction activities and as such they do not consume PSD Class II increment (EPA 1990; WDEQ 1993). Production-related emissions of SO_2 and PM_{10} that would be subject to PSD regulations were not modeled for this project. These impacts however, would be required by Wyoming and Federal regulations to be within the applicable PSD increment thresholds. All NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts representative of all project alternatives. For all alternatives, the predicted acute and chronic (long-term) impacts would be below applicable health-based levels for non-cancer compounds. In addition, calculated cancer risks from formaldehyde and benzene are less than the level of acceptable cancer risk of 1×10^{-6} (one in one million) for both the MLE and MEI scenarios except for MEI benzene scenario, which falls at the lower end of the 1×10^{-4} to 1×10^{-6} cancer risk range.

When reviewing predicted near-field impacts, it is important to understand that results reported reflect the maximum pollutant emission rates calculated for the field and the resulting concentrations are combined with monitored background ambient pollutant concentrations. Maximum monitored background air pollutant concentrations were assumed to occur throughout the LOP at all locations in the region year-round. In addition, the maximum predicted air quality impacts from JIDPA emission sources would occur in the vicinity of the JIDPA. Because impacts typically lessen with distance from an emissions source, impacts at locations more distant from the JIDPA would be less than the predicted maximum concentrations. Finally, total air pollutant concentrations for comparison to WAAQS and NAAQS were assumed to be the sum of the maximum modeled concentration and the maximum background concentration. This methodology is used for both long-term and short-term averaging periods. For short-term averaging periods, these maximum concentrations may occur under very different meteorological conditions and may not occur simultaneously.

Far-field Analysis

The far-field analysis utilized the EPA CALMET/CALPUFF modeling system to predict maximum potential air quality impacts at mandatory federal PSD Class I and other sensitive PSD Class II areas, as well as designated acid-sensitive lakes within these areas. The analysis also included an assessment of maximum mid-field (regional community) visibility impacts and air quality impacts at in-field locations within the JIDPA.

The air emissions modeled for project and non-project sources in the far-field analysis are presented in Appendix F Table F-9. Modeling scenarios were developed to approximate a range of project development including the Proposed Action, Alternative A, Alternative B, Alternative C, and Alternative F. These modeling scenarios assumed maximum field emissions that could potentially occur concurrently: during the final year of construction representing the maximum annual construction activity rate combined with nearly full-field production. For comparison purposes, an analysis of the JIDPA in full production, after all construction activities have ceased, is also presented for all alternatives with 3,100 producing wells. Maximum emissions scenarios include production emissions (producing well sites and ancillary equipment) and construction emissions (drilling rigs and pit flaring operations), both occurring continuously over the year. Three well development rates were analyzed--250 wells/year (WDR250), 150 wells/year (WDR150), and 75 wells/year (WDR75). The WDR250 assumes simultaneous operation of 20 drilling rigs and 3 pit flares, WDR150 assumes simultaneous operation of 12 drilling rigs and 2 pit flares, and WDR75 assumes simultaneous operation of 6 drilling rigs and 1 pit flare. Development rates considered both straight and directional drilling operations generally consistent with the various proposed project alternatives. The Proposed Action, Alternative A, and Alternative C scenarios assumed all straight-hole drilling. The Alternative B scenario assumed all directional drilling, and the Alternative F scenario assumes a combination of 50% straight hole drilling and 50% directional drilling operations. The WDR250 scenario model approximates Alternative A and WDR250 approximates the Proposed Action. Details on modeling methodology are presented in the Air Quality Technical Support Document (TRC EC 2004).

Predicted pollutant concentrations were compared to applicable ambient air quality standards and to PSD Class I and Class II increments, and were used to assess potential impacts to AQRVs--visibility (regional haze) and acid deposition--at sensitive PSD Class I and II areas. Ambient background concentrations were added to modeled concentrations for comparison to ambient air quality standards. No ambient background was added to modeled concentrations for comparison to PSD Class I and II Increments. PSD Class I areas and sensitive Class II areas analyzed in the far-field analyses include the following:

- Bridger Wilderness Area (Class I),
- Fitzpatrick Wilderness Area (Class I),
- Popo Agie Wilderness Area (Class II),
- Wind River Roadless Area (Class II),
- Grand Teton National Park (Class I),
- Teton Wilderness Area (Class I) ,

- Yellowstone National Park (Class I), and
- Washakie Wilderness Area (Class I).

Because emissions sources under the Proposed Action and alternatives consist of many small sources spread out over a large area, discrete visible plumes are not likely to impact distant sensitive areas. However, visible plumes may be noticeable within the JIDPA from nearby travel routes and at nearby towns on occasion, especially during flaring upset conditions. Nonetheless, the potential for cumulative visibility impacts (increased regional haze) is a concern.

Regional haze is caused by light scattering and light absorption by fine particles and gases. Potential changes to regional haze are calculated in terms of a perceptible "just noticeable change in visibility" when compared to background conditions, expressed in deciviews (dv). The BLM considers a 1.0-dv change to be a reasonably foreseeable significant adverse impact, although there are no applicable local, state, tribal, or federal regulatory visibility standards. Other federal agencies use a 0.5-dv change as a screening threshold for significance. The USFS and NPS compare direct project impacts to the 0.5-dv level, and those comparisons are included in the Air Quality Technical Support Document (TRC EC 2004).

The NPS, USFS, and USFWS have published the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report* (FLAG 2000) that prescribes a process for assessing impacts of new and existing sources on AQRVs, including visibility. The FLAG Report describes a cumulative impacts analysis of new growth sources (defined as PSD increment-consuming sources) on visibility. If predicted visibility impacts are above a visibility threshold of 1.0 dv for all days, factors such as magnitude of dv change, frequency, seasonal variations, and meteorological conditions may be considered when assessing the significance of predicted impacts.

Potential changes in regional haze at PSD Class I and sensitive PSD Class II areas were estimated by comparing CALPUFF modeled impacts to background visibility conditions in Class I or sensitive Class II area. This comparison was performed using two different representations of background visibility conditions. One method used visibility values provided in the FLAG Report for each Class I area to represent natural background visibility. The second method used estimated background visibility values from an analysis of recent long-term monitored data (1988–2002) from the IMPROVE program. This analysis consisted of estimating visibility parameters for representative Class I areas corresponding to the monitoring period of record quarterly average of the 20% best visibility days.

Potential changes to regional haze resulting from project source emissions were also estimated for nearby communities located in PSD Class II areas (mid-field). Model-predicted concentration impacts within these communities were used to estimate potential impacts to visibility. Background visibility data monitored at the Class I Bridger Wilderness Area, an area more pristine than populated residential areas, were used to estimate potential visibility impairment in these residential areas. These data were used because no visibility monitoring has been conducted in populated areas of the region. Since visibility impacts are calculated as percent increases of modeled concentrations above background values, the use of a more pristine background results in an overestimate of potential visibility impacts.

Seven lakes within the sensitive PSD Class I and Class II Wilderness Areas were identified as being sensitive to acid deposition. These lakes are those for which the most recent and complete data are available and include the following:

- Deep Lake in the Bridger Wilderness Area,
- Black Joe Lake in the Bridger Wilderness Area,
- Hobbs Lake in the Bridger Wilderness Area,
- Lazy Boy Lake in the Bridger Wilderness Area,
- Upper Frozen Lake in the Bridger Wilderness Area,
- Ross Lake in the Fitzpatrick Wilderness Area, and
- Lower Saddlebag Lake in the Popo Agie Wilderness Area.

The NPS (2001) has identified Deposition Analysis Thresholds (DATs) for total nitrogen (N) and sulfur (S) deposition in the western U.S. as 0.005 kilograms per hectare per year (kg/ha-year) for both N and S. The DAT is used as an analysis threshold for evaluating potential impacts from project-related emissions. The USFS (Fox et al. 1989) has defined thresholds below which no adverse impacts from acid deposition are likely; however, the USFS has concerns that these deposition thresholds are set too high. These thresholds (herein referred to as levels of concern), defined as 5 kg/ha-yr for S and 3 kg/ha-yr for N, are used for comparison of potential impacts from cumulative source emissions. The USFS Rocky Mountain Region has also developed a screening method (USFS 2000) that identifies a Limit of Acceptable Change (LAC) in lake chemistry. The LACs are 1) no more than a 10% change in acid-neutralizing capacity (ANC) for lakes with an existing ANC of 25 microequivalents per liter (μeq/l) or greater and 2) no more than a 1-μeq/l change for extremely acid-sensitive lakes where the existing ANC is below 25 μeq/l. Of the seven lakes identified by the USFS as acid-sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid-sensitive.

<u>Far-field Impacts Summary</u>

An overall summary of maximum direct project far-field impacts by alternative is provided in Table 4.1. Pollutant concentrations under all project alternatives would be below applicable ambient air quality standards and PSD increments (see Appendix F, Tables F-10 through F-16). Direct project NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area for various development alternatives, but would be below the SILs at all other sensitive areas.

Direct project visibility impacts from all alternatives were predicted to be above "just noticeable visibility changes" (1.0-dv) threshold at the Bridger Wilderness Area, using both the FLAG and IMPROVE background visibility data (see Appendix F, Tables F-17 and F-18). There were no predicted direct project impacts above the 1.0-dv threshold at any other analyzed sensitive area.

Direct project source emissions under all project alternatives would not result in an increase in ANC above any LAC at the acid-sensitive lakes (see Appendix F, Tables F-19 through F-21). The predicted maximum S deposition impacts from all alternatives are below the 0.005 kg/ha-yr

DAT at all sensitive PSD Class I and Class II areas. Under various alternatives, the maximum predicted N impacts are above the 0.005 kg/ha-yr DAT at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and are below the DAT at all other sensitive areas.

The number of days of direct project visibility impacts within the mid-field (Wyoming regional communities) were predicted to be above the "just noticeable visibility change" (1.0-dv) threshold as shown in Appendix F, Tables F-22 and F-23.

Estimated direct project impacts at in-field locations are below the applicable ambient air quality standards (see Appendix F, Table 2-24).

A presentation of the aforementioned results for each alternative and for cumulative source impacts is presented below.

4.1.2.1 No Action Alternative

<u>Near-field Impacts</u>

No project-related near-field impacts beyond currently approved levels would occur in the JIDPA under the No Action Alternative. As a result, near-field air quality impacts would reflect those analyzed in the Jonah Field II EIS (BLM 1997a, 1998a), and air quality would remain similar to existing levels.

<u>Far-field Impacts</u>

No new project-related development would occur under the No Action Alternative; therefore, no far-field impacts would occur beyond those analyzed in the Jonah Field II EIS (BLM 1997a, 1998a). Air quality would remain similar to existing levels.

4.1.2.2 Proposed Action

<u>Near-field Impacts</u>

The construction or production phase of the Proposed Action that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of the Proposed Action modeled were: PM_{10} and $PM_{2.5}$ using a 3.8-acre pad; SO_2 using straight hole drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 128 wells per section (5.0-acre surface well spacing). These configurations result in the maximum predicted impacts for the Proposed Action.

The maximum predicted impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Proposed Action source emissions are less than the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions representative of the Proposed Action.

Far-field Impacts

Direct impacts from the Proposed Action maximum emissions scenario (the last year of field construction and the full field in production) were modeled as set forth in the *Jonah Infill Natural Gas Project Air Quality Technical Support Document* (TRC EC 2004). The emissions modeled are provided in Appendix F, Table F-1. Appendix F Tables F-10, F-11, F-12, and F-13 present the maximum predicted impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. Appendix F Tables F-14, F-15, and F-16 present the maximum modeled Proposed Action impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to PSD SILs and increments. As shown in these tables, pollutant concentrations resulting from Proposed Action source emissions would be below the applicable ambient air quality standards and PSD increments for both emissions scenarios. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from the Proposed Action were predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area, using both the FLAG and IMPROVE background visibility data. The visibility impacts resulting from direct project source emissions are provided in Appendix F Table F-17 for the FLAG background visibility data, and in Table F-18 for the IMPROVE background visibility data. Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions from the Proposed Action would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). The predicted maximum S deposition impacts (Appendix F Table F-20) from the Proposed Action are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. For the maximum emissions scenario, maximum N impacts (Appendix F Table F-21) are predicted to be above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and below the DAT at all other sensitive areas. The maximum predicted N deposition impacts from the full field in production emissions scenario are above the DAT at the Bridger Wilderness Area and below the DAT at all other sensitive areas. The exceedances of this threshold trigger a management concern but are not necessarily indicative of an adverse impact (NPS 2004).

Mid-field Impacts

Maximum visibility impacts and the estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at nearby Wyoming communities from the Proposed Action source emissions scenarios are shown in Appendix F Table F-22 for the FLAG visibility data and Table F-23 for the IMPROVE visibility data.

In-field Impacts

Appendix F Table F-24 presents the maximum impacts from all Proposed Action source emissions compared to ambient air quality standards estimated to occur within the JIDPA. These project-related impacts are below applicable ambient air quality standards.

4.1.2.3 Alternative A

Near-field Impacts

The construction or production phase of the Alternative A scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative A modeled were: PM_{10} and $PM_{2.5}$ using a 3.8-acre pad; SO_2 using straight hole drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 128 wells per section (5.0-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative A.

The predicted impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparisons of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative A source emissions are less than the applicable WAAQS and NAAQS and PSD increments.

Appendix F Table F-8 and F-9 summarize modeled HAP impacts based on emissions from Alternative A sources.

Far-field Impacts

Direct project concentration impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from Alternative A were estimated at each of the eight Class I and sensitive Class II areas. The emissions modeled for Alternative A scenarios are provided in Appendix F Table F-9. Appendix F Tables F-10, F-11, F-12, and F-13 present the maximum predicted impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. Appendix F Tables F-14, F-15, and F-16 present the maximum modeled Alternative A concentration impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to PSD SILs and increments. As shown in these tables, pollutant concentrations resulting from Alternative A source emissions scenarios are less than the applicable ambient air quality standards and PSD increments for both emissions scenarios. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative A source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each of the three development rate alternatives, using both the FLAG and IMPROVE background visibility data. The visibility impacts resulting from direct project source emissions are provided in Appendix F Table F-17 for the FLAG background visibility data and in Table F-18 for the IMPROVE background visibility data.

Direct project source emissions from Alternative A would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). The predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative A sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. For the development rates WDR250 and WDR150, the predicted N impacts (Appendix F Table F-21) are above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and below the DAT at all other sensitive areas. N impacts from the WDR75 development rate are above the DAT at the Bridger Wilderness and Popo Agie Wilderness and below the DAT at all other sensitive areas.

Mid-field Impacts

The maximum visibility impacts (dv) and estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at nearby Wyoming towns for Alternative A scenarios are shown in Appendix F Tables F-22 for the FLAG visibility data and F-23 for the IMPROVE visibility data.

In-field Impacts

Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, resulting from Alternative A source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The estimated project-related impacts are less than applicable ambient air quality standards.

4.1.2.4 Alternative B

Near-field Impacts

The construction or production phase of Alternative B scenarios that would produce maximum emissions were identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative B modeled were: PM_{10} and $PM_{2.5}$ using a 10.0-acre pad; SO_2 using directional drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 16 well pads per section (40-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative B.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative B source emissions are less than applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative B sources.

Far-field Impacts

Direct project concentration impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were estimated at each of the eight Class I and sensitive Class II areas. The emissions modeled for Alternative B scenarios are provided in Appendix F Table F-9. Appendix F Tables F-10, F-11, F-12, and F-13 present the maximum predicted concentration impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. Appendix F Tables F-14, F-15, and F-16 present the maximum modeled Alternative B impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to PSD SILs and increments. As shown in these tables, pollutant concentrations resulting from all Alternative B source emissions scenarios would be below applicable ambient air quality standards and PSD increments for both emissions scenarios. Potential NO_2 and PM_{10} concentrations may exceed proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative B source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. A summary of these impacts is provided in Appendix F Tables F-17 (FLAG) and F-18 (IMPROVE). Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions from Alternative B would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). Predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative B sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. For the well development rates WDR250 and WDR150, the predicted N impacts (Appendix F Table F-21) are above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and below the DAT at all other sensitive areas. N impacts from the WDR75 development rate are above the DAT at the Bridger Wilderness and Popo Agie Wilderness and below the DAT at all other sensitive areas.

Mid-field Impacts

The maximum visibility impacts (dv) and estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at nearby Wyoming towns from Alternative B scenarios are shown in Appendix F Table F-22 (FLAG) and F-23 (IMPROVE).

In-field Impacts

Model predicted concentrations of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ resulting from Alternative B source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The estimated project-related impacts are below applicable ambient air quality standards.

4.1.2.5 Alternative C

Near-field Impacts

The construction or production phase of the Alternative C scenarios that would produce maximum emissions were identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative C modeled were: PM_{10} and $PM_{2.5}$ using a 3.8-acre pad; SO_2 using straight drilling; and NO_2, CO, and HAP using 1,250 wells developed in the field at 32 well pads per section (20.0-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative C.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative C source emissions are less than the applicable WAAQS and NAAQS standards and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative C sources.

Far-field Impacts

Direct project concentration impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ were estimated at each of the eight Class I and sensitive Class II areas. The emissions modeled for Alternative C scenarios are provided in Appendix F Table F-9. Appendix F Tables F-10, F-11, F-12, and F-13 present the maximum predicted impacts of NO_2, SO_2, PM_{10} and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. Appendix F Table F-14, F-15, and F-16 present the maximum modeled Alternative C impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to PSD SILs and increments. As shown in these tables, pollutant concentrations resulting from all Alternative C source emissions scenarios would be below applicable ambient air quality standards and PSD increments for both emissions scenarios. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative C source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. A summary of these impacts is provided in Appendix F Tables F-17 (FLAG) and F-18 (IMPROVE). Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). The predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative C sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. For the well development rates WDR250 and WDR150, the predicted N impacts (Appendix F Table F-21) are above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and below the DAT at all other sensitive areas. N impacts from the WDR75 development rate are above the DAT at the Bridger Wilderness and Popo Agie Wilderness and below the DAT at all other sensitive areas.

Mid-field Impacts

The maximum visibility impacts (dv) and estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at nearby Wyoming towns from Alternative C scenarios are shown in Appendix F Tables F-22 (FLAG) and F-23 (IMPROVE).

In-field Impacts

Model predicted concentrations of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ resulting from Alternative C source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The estimated project-related impacts are below applicable ambient air quality standards.

4.1.2.6 Alternative D

Near-field Impacts

The construction or production phase of the Alternative D scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative D modeled were: PM_{10} and $PM_{2.5}$ using a 3.8-acre pad; SO_2 using straight hole drilling; and NO_2, CO, and HAP using 2,200 wells developed in the field at 64 well pads per section (10.0-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative D.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative D source emissions are less than the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative D sources.

Far-field Impacts

Direct project concentration impacts of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ would be comparable to those estimated for Alternative A and Alternative C (see Sections 4.1.2.3 and 4.1.2.5, respectively, and Appendix F Tables F-10 through F-16). The estimated project-related impacts at the Class I and sensitive Class II areas are below the applicable ambient air quality standards and PSD increments. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative D source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. Estimated impacts would be slightly less than those presented for Alternative A scenarios but above the impacts presented for Alternative C scenarios (Appendix F Table F-17 and F-18). Visibility impacts at all other sensitive areas are predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). The predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative D sources would be below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. The predicted N deposition impacts (Appendix F Table F-21) would be similar to those presented for Alternative A and Alternative C scenarios (see Sections 4.1.2.3 and 4.1.2.5, respectively), which predict impacts would be above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

Mid-field Impacts

Maximum visibility impacts at nearby Wyoming towns from Alternative D scenarios are predicted to be slightly less than those of Alternative A scenarios but above those presented for Alternative C scenarios, (see Sections 4.1.2.3 and 4.1.2.5, respectively, and Appendix F Tables F-22 and F-23).

<u>In-field Impacts</u>

Predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Alternative D source emissions at locations within the JIDPA would be between those presented for Alternative A and Alternative C (see Sections 4.1.2.3 and 4.1.2.5, respectively, and Appendix F Table F-24). Estimated project-related impacts from Alternative D sources are predicted to be below applicable ambient air quality standards.

4.1.2.7 Alternative E

<u>Near-field Impacts</u>

The construction or production phase of Alternative E scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative E modeled were: PM_{10} and $PM_{2.5}$ using a 10.0-acre pad; SO_2 using directional drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 40 well pads per section (16-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative E.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative E source emissions are less than the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative E sources.

<u>Far-field Impacts</u>

Direct project concentration impacts of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ would be comparable to those estimated for Alternative B (see Section 4.1.2.4, and Appendix F Tables F-10-F-16). Estimated project-related impacts at the Class I and sensitive Class II areas are below the applicable ambient air quality standards and PSD increments. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative E source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. Estimated impacts would be slightly less than those presented for Alternative B scenarios (Appendix F Tables F-17 and F-18). Visibility impacts at all other sensitive areas are predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). The predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative E sources would be below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. Predicted N deposition impacts (Appendix F Table F-21) would be similar to those presented for Alternative B (see Section 4.1.2.4), which predict impacts would be above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

Mid-field Impacts

Maximum visibility impacts at nearby Wyoming towns from Alternative E scenarios are predicted to be slightly lower than those of Alternative B scenarios (see Section 4.1.2.4 and Appendix F Table F-22 and F-23).

In-field Impacts

Predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Alternative E source emissions at locations within the JIDPA would be similar to those presented for Alternative B (see Section 4.1.2.4 and Appendix F Table F-24). The estimated project-related impacts from Alternative E sources are predicted to be below applicable ambient air quality standards.

4.1.2.8 Alternative F

Near-field Impacts

The construction or production phase of Alternative F scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emission configurations representative of Alternative F modeled were: PM_{10} and $PM_{2.5}$ using a 7.0-acre pad; SO_2 using directional drilling; and NO_2, CO, and HAP using 3,100 well pads developed in the field at 32 well pads per section (20.0-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative F.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and a comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative F source emissions would be below the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative F sources.

Far-field Impacts

Direct project concentration impacts of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ were estimated at each of the eight Class I and sensitive Class II areas. The emissions modeled for Alternative F scenarios are provided in Appendix F Table F-9. Appendix F Tables F-10, F-11, F-12, and F-13 present the maximum predicted impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. Appendix F Table F-14, F-15, and F-16 present the maximum modeled Alternative F impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to PSD SILs and increments. As shown in these tables, pollutant concentrations resulting from all Alternative F source emissions scenarios would be below applicable ambient air quality standards and PSD increments for both emissions scenarios. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative F source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. A summary of these impacts is provided in Appendix F Tables F-17 (FLAG) and F-18 (IMPROVE). Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions from Alternative F would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). Predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative F sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. For well development rates WDR250 and WDR150, predicted N impacts (Appendix F Table F-21) are above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area, and below the DAT at all other sensitive areas. N impacts from the WDR75 development rate are above the DAT at the Bridger Wilderness and Popo Agie Wilderness and below the DAT at all other sensitive areas.

Mid-field Impacts

Maximum visibility impacts (dv) and the estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at nearby Wyoming towns from Alternative F scenarios are shown in Appendix F Table F-22 (FLAG) and Table F-23 (IMPROVE).

In-field Impacts

Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Alternative F source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The estimated project-related impacts are below applicable ambient air quality standards.

4.1.2.9 Alternative G

Near-field Impacts

The construction or production phase of the Alternative G scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of Alternative G modeled were: PM_{10} and $PM_{2.5}$ using a 3.8-acre pad; SO_2 using directional drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 64 well pads per section (10.0-acre surface well spacing). These configurations result in the maximum predicted impacts for Alternative G.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and comparison of these impacts to WAAQS and NAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Table F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from Alternative G source emissions are less than the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Alternative G sources.

<u>Far-field Impacts</u>

Direct project concentration impacts of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ would be comparable to those estimated for Alternative A and Alternative C (see Sections 4.1.2.3 and 4.1.2.5, respectively, and Appendix F Tables F-10-F-16). The estimated project-related impacts at Class I and sensitive Class II areas are well below the applicable ambient air quality standards and PSD increments. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Alternative G source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. Estimated impacts would be slightly less than those presented for Alternative A scenarios but above the impacts presented for Alternative C scenarios (Appendix F Table F-17 and F-18). Visibility impacts at all other sensitive areas are predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). Predicted maximum S deposition impacts (Appendix F Table F-20) from Alternative G sources would be below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. Predicted N deposition impacts (Appendix F Table F-21) would be similar to those presented for Alternative A and Alternative F scenarios (see Sections 4.1.2.3 and 4.1.2.8, respectively), which predict impacts would be above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

<u>Mid-field Impacts</u>

Maximum visibility impacts at nearby Wyoming towns from Alternative G scenarios are predicted to be greater than those of Alternative A scenarios, but less than those presented for Alternative F scenarios, (see Sections 4.1.2.3 and 4.1.2.8, respectively, and Appendix F Tables F-22 and F-23).

<u>In-field Impacts</u>

Predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Alternative G source emissions at locations within the JIDPA would be between those presented for Alternative A and Alternative F (see Sections 4.1.2.3 and 4.1.2.8, respectively, and Appendix F Table F-24). Estimated project-related impacts from Alternative G sources are predicted to be below applicable ambient air quality standards.

4.1.2.10 BLM Preferred Alternative

<u>Near-field Impacts</u>

The construction or production phase of the Preferred Alternative scenarios that would produce maximum emissions was identified by pollutant and analyzed. The maximum emissions configurations representative of the Preferred Alternative modeled were: PM_{10} and $PM_{2.5}$ using a 7.0-acre pad; SO_2 using directional drilling; and NO_2, CO, and HAP using 3,100 wells developed in the field at 16 well pads per section (40.0-acre surface well spacing). These configurations result in the maximum predicted impacts for the Preferred Alternative.

Direct project impacts of NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and O_3 and a comparison of those impacts to NAAQS and WAAQS are presented in Appendix F Tables F-1, F-2, F-3, F-4, F-5, and F-6, respectively. Appendix F Tables F-2 also presents a comparison of the maximum predicted NO_2 impacts resulting from production activities to the PSD Class II increment for NO_2. Predicted impacts from the Preferred Alternative source emissions would be below the applicable WAAQS and NAAQS and PSD increments.

Appendix F Tables F-7 and F-8 summarize modeled HAP impacts based on emissions from Preferred Alternative sources.

Far-field Impacts

Direct project impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ would be comparable to those estimated for Alternative G (Section 4.1.2.9, and Appendix F Tables F-10 through F-16). The estimated project-related impacts at the Class I and sensitive Class II areas are below applicable ambient air quality standards and PSD increments. Potential NO_2 and PM_{10} concentrations may exceed the proposed PSD Class I SILs at the Bridger Wilderness Area but would be below the significance levels at all other sensitive areas.

Direct visibility impacts from Preferred Alternative source emissions are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area for each development rate using both the FLAG and IMPROVE background visibility data. Estimated impacts would be comparable to those presented for Alternative G scenarios (Appendix F Tables F-17 and F-18). Visibility impacts at all other sensitive areas are predicted to be below the "just noticeable visibility change" threshold for all days.

Direct project source emissions would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix F Table F-19). Predicted maximum S deposition impacts (Appendix F Table F-20) from Preferred Alternative sources would be below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. Predicted N deposition impacts (Appendix F Table F-21) would be similar to those presented for Alternative G scenarios (see Section 4.1.2.9), which predict impacts would be above the 0.005 kg/ha-yr threshold at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

Mid-field Impacts

Maximum visibility impacts at nearby Wyoming towns from Preferred Alternative scenarios are predicted to be similar to those of Alternative G scenarios (see Section 4.1.2.9 and Appendix F Tables F-22 and F-23).

In-field Impacts

Predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Preferred Alternative source emissions at locations within the JIDPA would be similar to those presented for Alternative G (see Section 4.1.2.9, and Appendix F Table F-24). Estimated project-related impacts from Preferred Alternative sources are predicted to be below applicable ambient air quality standards.

<u>Preferred Alternative Air Quality Mitigation Measures</u>

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.1.2.11 Cumulative Impacts

The CALPUFF model was used to quantify the impacts of NO_X, SO_2, PM_{10}, and $PM_{2.5}$ resulting from project sources, state-permitted sources, RFFA, and RFD located within the model domain (see Map 3.1). Project source emissions are described in Section 4.1.2 and quantified in Appendix F Table F-9. State-permitted sources include NO_X, SO_2 and/or PM_{10}/$PM_{2.5}$ sources that began operation after January 1, 2001, and were permitted before June 20, 2003. Sources permitted within the 18 months prior to January 1, 2001, but not yet operating were included as RFFA. RFD was defined as the undeveloped portion of 1) an approved NEPA project or 2) a proposed NEPA project for which quantified air emissions data were available at the time of the analysis. State-permitted, RFFA, and RFD emissions modeled in the cumulative analysis are quantified in Appendix F Table F-9. RFD projects included in the cumulative analysis are listed in Appendix F Table F-25. RFD projects were analyzed utilizing the maximum production scenario identified for each project. Emissions from field development (the construction phase) of RFD were not analyzed; rather, the combined emissions of all RFD operating at maximum production levels simultaneously was considered a conservative representation of domain-wide emissions. The development phases of individual RFD projects have the potential to cause or contribute to higher localized ambient air impacts than those demonstrated in this analysis. However, because RFD project development rates and schedules vary for each project and are difficult to define with certainty, it was determined that all emission sources operating at maximum production rates was the most reasonable representation of cumulative impacts occurring in the future when based on RFD information available at the time of analysis.

While there may be additional gas processing and/or transmission requirements due to development of this and other natural gas projects regionally and nationally, the potential effects of these developments are not quantified herein since these developments are speculative and would likely require additional WDEQ/AQD permitting if they eventually are proposed. A portion of the Powder River Basin Oil and Gas Development project, located more than 185 miles (>300 km) east-northeast of the JIDPA, is located within the far-field modeling domain defined in Map 3.1. A ratio of total Powder River Basin project field development equal to the geographical portion within the JIDPA far-field modeling domain was included as RFD in this analysis. The Powder River Basin project identified significant project-specific and cumulative impacts in the Bridger Wilderness and other sensitive areas analyzed for this project. Further information on air quality impacts associated with the PRBP may be found in the BLM (2002b).

Recent estimation of NO_X emissions in the Pinedale Anticline Project Area has shown that NO_X emissions are greater than assumed in the Pinedale Anticline EIS (BLM 2004d). Since a quantitative relationship between air emissions and the subsequent potential cumulative impacts to air quality is complex and time consuming, it was not possible to quantify potential impacts of these increased NO_X emissions in this DEIS.

Cumulative impacts were analyzed at each of the eight Class I and sensitive Class II areas, and at mid-field (regional communities) and in-field locations within the JIDPA. Ambient concentrations were estimated at each Class I and sensitive Class II area and at locations within the JIDPA. Acid deposition calculations were performed for each Class I and sensitive Class II area and at acid-sensitive lakes within these areas. Visibility impacts were computed for each Class I and sensitive Class II area and at mid-field (regional communities) locations.

Impacts Summary. The cumulative far-field modeling results for the range of project alternatives are provided in Appendix F Tables F-26 through F-40. These tables present the estimated cumulative impacts resulting from project and regional source emissions. A discussion of the cumulative modeling results for each alternative is presented below.

Appendix F Tables F-26, F-27, F-28, and F-29 present the maximum predicted cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. These maximum predicted concentrations were added to the ambient background pollutant concentrations for comparison to the WAAQS and NAAQS. Appendix F Tables F-30, F-31, and F-32 present the maximum modeled direct project and cumulative source impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to applicable PSD increments. As shown in these tables, cumulative pollutant concentrations from all project alternatives would be below applicable ambient air quality standards and PSD increments.

Estimated cumulative visibility impacts at PSD Class I and sensitive PSD Class II areas resulting from project and regional source emissions are provided in Appendix F Table F-33 for the FLAG background visibility data, and in Appendix F Table F-34 for the IMPROVE background visibility data. As shown in these tables, cumulative visibility impacts from project alternatives were predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area and Wind River Roadless Area using the FLAG background data and at the Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Areas using the IMPROVE background visibility data. There were no predicted impacts above the 1.0-dv threshold at any of the other analyzed sensitive areas.

Appendix F Table F-35 provides a summary of the maximum potential change in ANC at each of the analyzed sensitive lakes for each project alternative. Maximum modeled cumulative deposition impacts are provided in Appendix F Table F-36 (S) and Table F-37 (N). Cumulative emissions from any of the project alternative sources combined with regional sources would not result in an increase in ANC above any LAC at the acid-sensitive lakes. In addition, predicted maximum cumulative S and N deposition impacts from all alternatives are well below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern at all sensitive PSD Class I and Class II areas. Further detail on cumulative S and N deposition impacts is provided in the air quality technical support document (TRC EC 2004).

Modeled cumulative visibility impacts at mid-field Wyoming regional community locations from project and regional source emissions are provided in Appendix F Table F-38 for the FLAG background visibility data and in Table F-39 for the IMPROVE background visibility data. The number of days cumulative visibility impacts were predicted to be above the "just noticeable visibility change" (1.0-dv) threshold are shown in these tables for each project alternative scenario.

Appendix F Table F-40 presents the maximum predicted cumulative impacts for each project alternative at in-field location compared to ambient air quality standards after adding monitored background concentrations. These estimated cumulative impacts are below applicable ambient air quality standards.

No Action Far-field Cumulative Impacts. Modeling was performed for the No Action Alternative to estimate cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from non-project related source emissions consisting of RFD, RFFA, and state-permitted sources. Appendix F Tables F-26, F-27, F-28, and F-29 present the maximum predicted impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. These maximum predicted concentrations were added to the ambient background pollutant concentrations for comparison to the WAAQS and NAAQS. Appendix F Tables F-30, F-31, and F-32 present the maximum modeled cumulative No Action impacts of NO_2, SO_2, and PM_{10}, respectively, for comparison to applicable PSD increments. As shown in these tables, pollutant concentrations from No Action Alternative source emissions scenarios would be well below the applicable ambient air quality standards and PSD increments.

The visibility impacts resulting from cumulative No Action source emissions are provided in Appendix F Table F-33 for the FLAG background visibility data and in Table F-34 for the IMPROVE background visibility data. Impacts are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area using both the FLAG and IMPROVE background visibility data. Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days. Current regional visibility trends are shown in Figures 3.2 through 3.4.

Cumulative acid deposition impacts at the seven sensitive lakes (Appendix F Table F-35) are below the ANC change LACs. In addition, cumulative total N (Appendix F Table F-36) and S deposition (Appendix F Table F-37) are below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

No Action Mid-field Cumulative Impacts. The maximum visibility impacts at nearby Wyoming towns are shown in Appendix F Table F-38 (FLAG) and Table F-39 (IMPROVE). The estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold and the maximum dv change are shown.

No Action In-field Cumulative Impacts. Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from No Action cumulative source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The maximum impacts shown are compared to ambient air quality standards after adding monitored background concentrations. The estimated non-project impacts are below applicable ambient air quality standards.

Proposed Action Far-field Cumulative Impacts. Modeling was performed for the Proposed Action to estimate cumulative impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ from project and non-project related source emissions, consisting of RFD, RFFA, and state-permitted sources. Appendix F Tables F-26, F-27, F-28, and F-29 present the maximum predicted impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively, at the analyzed PSD Class I and sensitive PSD Class II areas. These maximum predicted concentrations were added to the ambient background pollutant concentrations for comparison to the WAAQS and NAAQS. Appendix F Tables F-30, F-31, and F-32 present the maximum modeled cumulative impacts of NO_2, SO_2, and PM_{10}, respectively, from Proposed Action and regional sources for comparison to applicable PSD increments. As shown in these tables, pollutant concentrations from Proposed Action and regional source emissions scenarios would be below applicable ambient air quality standards and PSD increments.

The cumulative visibility impacts for the Proposed Action are provided in Appendix F Table F-33 (FLAG) and in Table F-34 (IMPROVE). Visibility impacts are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area and Wind River Roadless Area using both the FLAG and IMPROVE background visibility data. Visibility impacts at all other sensitive areas were predicted to be below the "just noticeable visibility change" threshold for all days.

Cumulative acid deposition impacts at the seven sensitive lakes (Appendix F Table F-35) are below the ANC change LACs. In addition, cumulative total N (Appendix F Table F-36) and S deposition (Appendix F Table F-37) are well below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

Proposed Action Mid-field Cumulative Impacts. The maximum visibility impacts at nearby Wyoming towns are shown in Appendix F Table F-38 (FLAG) and Table F-39 (IMPROVE). The estimated number of days predicted to be above the "just noticeable visibility change" (1.0-dv) threshold and the maximum dv change are shown.

Proposed Action In-field Cumulative Impacts. Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Proposed Action and regional source emissions at locations within the JIDPA are shown in Appendix F Table F-24. The maximum impacts shown are compared to ambient air quality standards after adding monitored background concentrations.

Cumulative Impacts for Other Project Alternatives. The predicted cumulative impacts from all other project alternatives are well below the applicable ambient air quality standards and PSD Class I increments. Estimated acid deposition impacts at the seven sensitive lakes are below the ANC change LACs. In addition, cumulative total N and S depositions are well below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern. Visibility impacts from the other project alternatives that include increased directional drilling activities have the potential to slightly increase the estimated number of days of visibility impairment. The cumulative far-field modeling results for all project alternatives are summarized in Appendix F Tables F-26 through F-40.

4.1.2.12 Unavoidable Adverse Impacts

Some increase in air pollutant emissions would occur as a result of the Proposed Action and alternatives. Near-field impacts from these emissions are predicted to be below applicable significance thresholds. However, there is a potential for direct and cumulative visibility impacts to exceed visibility levels of concern within PSD Class I Bridger Wilderness Area and deposition thresholds within Bridger Wilderness Area, Popo Agie Wilderness Area, and Wind River Roadless Area.

4.1.3 Topography

Impacts to topography would be considered significant if disturbance permanently inhibited or substantially altered surface drainage patterns (e.g., new head-cutting and/or gully formation inhibiting surface runoff to areas where wetlands or riparian areas depend on it, changes that substantially redirect surface runoff). Project impacts to topography are assumed to be proportional to the volume of surface disturbance (i.e., increased surface disturbance would correspond to an increase in the potential for altered surface drainage patterns). Specific impacts would include changes to the landscape due to cut-and-fill (surface-leveling) activities used to construct well pads, access roads, and other facilities; road and pipeline crossings of channels; and slope and drainage alterations. The landscape and surface drainage alterations associated with this project would require specific mitigation as identified in Appendices A, B, and G.

4.1.3.1 No Action Alternative

Under the No Action Alternative, impacts to topography would be limited to the existing developments for 497 well pads and associated facilities--4,209 acres initially and 1,409 acres for the LOP (see Table 2.3). No significant impacts are anticipated. The duration of impacts would be approximately 63 years (see Table 2.2) and until areas are adequately reclaimed (see Appendix G).

4.1.3.2 The Proposed Action

An estimated maximum of 20,409 acres of disturbance would occur under the Proposed Action (see Table 2.4), 14,369 acres of which would be short-term, because surface disturbance areas not needed for operations would be recontoured and reseeded within 2 to 4 years after disturbance (e.g., portions of well pads and road ROWs and entire pipeline ROW areas). Long-term LOP disturbance is estimated at 6,040 acres and is anticipated to last for 76 years (250 wells developed per year) and until successful reclamation is achieved (see Table 2.2). An approximate 285% increase in new disturbance and 229% increase in LOP disturbance above the No Action would occur under the Proposed Action, impact duration would be extended at least an additional 13 years (76-year LOP), and significant impacts are anticipated.

4.1.3.3 Alternative A

The types of impacts to topography under Alternative A would be similar to that described for the No Action but there would be an additional 16,200 acres of initial disturbance. Impacts may be further amplified if BLM standard stipulations (particularly those regarding steep slopes and drainage channels) are excepted (see Appendix A). Additionally, impacts would occur in some areas that would be avoided under the Proposed Action (i.e., greater sage-grouse lek, raptor nest, and Sand Draw buffers) and, depending upon the rate of development, impacts could last for an additional 29 or more years (75 wells developed per year) plus the time needed for successful reclamation (see Table 2.2). Significant impacts are anticipated.

4.1.3.4 Alternative B

Impacts to topography under Alternative B would be similar to those of the No Action Alternative except that total new initial disturbance would be 3,297 acres more than that required for the No Action Alternative (see Table 2.5). LOP disturbance would be 1,213 acres more than No Action LOP disturbance, and most surface disturbance would occur as expansions at existing disturbance areas. No significant impacts are anticipated. Depending upon the rate of development, the duration of impacts could be 76 (250 new wells per year) to a 105 years (75 new wells per year) plus the time needed for successful reclamation (see Table 2.2).

4.1.3.5 Alternative C

Under Alternative C, impacts to topography would be similar to those of the No Action Alternative, except that Alternative C would result in 6,705 acres of disturbance, 1,990 acres of additional LOP disturbance (see Table 2.6). Impact duration would range from 68 years (250 wells/year) to 80 years (75 wells/year) plus the time needed for successful reclamation (see Table 2.2), and significant impacts are anticipated.

4.1.3.6 Alternative D

Under Alternative D, impacts to topography would be similar to those of the No Action Alternative except that Alternative D would result in 11,581 acres more disturbance, and 3,346 acres of additional LOP disturbance (see Table 2.7). Impact duration would range from 72 years (250 wells/year) to 93 years (75 wells/year) plus the time needed for successful reclamation (see Table 2.2), and significant impacts are anticipated.

4.1.3.7 Alternative E

Under Alternative E, impacts to topography would be similar to those of the No Action Alternative except that Alternative E would result in 6,386 acres additional disturbance and 2,188 acres of additional LOP disturbance compared to the No Action Alternative (see Table 2.8). Impact duration would range from 76 to 105 years plus the time needed for successful reclamation (see Table 2.2). No significant impacts are anticipated.

4.1.3.8 Alternative F

Under Alternative F, impacts to topography would be similar to those of the No Action Alternative except that Alternative F would result in 10,446 acres of additional disturbance and 2,588 acres more LOP disturbance (see Table 2.9). Impact duration would range from 76 to 105 years plus the time needed for successful reclamation (see Table 2.2), and significant impacts are anticipated.

4.1.3.9 Alternative G

Under Alternative G, impacts to topography would be similar to those of the No Action Alternative except that Alternative G would result in 13,989 acres disturbance, 3,999 acres more LOP disturbance (see Table 2.10). Impact duration would range from 76 to 105 years plus the time needed for successful reclamation (see Table 2.2), and significant impacts are anticipated.

4.1.3.10 BLM Preferred Alternative

Under the Preferred Alternative, impacts to topography would be similar to those of the No Action Alternative except that the Preferred Alternative would result in 8,316 acres of additional disturbance and 2,438 acres more LOP disturbance (see Table 2.11). In terms of the amount of disturbance over-and-above that expected for the No Action Alternative, the Preferred Alternative ranks sixth (out of the nine development alternatives), and thus, would result in less potential impacts than for the Proposed Action and Alternatives A, D, F, and G. In terms of duration of impact, the Preferred Alternative is comparable to most of the other alternatives under the 250 well/year development scenario (76-year LOP) since a development rate of 250 wells/year is assumed. Only No Action and Alternatives C and D could result in shorter impact duration (see Table 2.2).

Under the BLM Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Even with the application of these measures, significant impacts may occur to topography for the LOP.

4.1.3.11 Cumulative Impacts

The CIAA for topography includes the combined 10 watersheds that drain the JIDPA, which encompass approximately 210,300 acres. Approximately 1.6% of the CIAA (3,355 acres), has previously been disturbed (see Table 3.11).

RFD (total new initial surface disturbance) for the CIAA outside the JIDPA is estimated at 594 acres, primarily from gas-related development in the Pinedale Anticline Natural Gas Field (see Section 4.1.7). Approximately 38% (228 acres) of the RFD would occur in the Expanded Sand Draw-Alkali Creek Watershed. RFD for the North Alkali Draw watershed is estimated at 168 acres; Southeast New Fork River is estimated at 126 acres; the Big Sandy river is estimated at 54 acres; and the Upper Eighteenmile is estimated at 18 acres.

Maximum cumulative disturbance (i.e., the combined existing, proposed [new initial under Proposed Action and Alternative A], and RFD disturbance) would be 22,953 acres (10.9%) in the combined watersheds. Maximum cumulative disturbance would be greatest in the Expanded Sand Draw-Alkali Creek watershed, and would be primarily attributable to gas development (see Section 4.1.7). The Long Draw watershed that drains 16% of the JIDPA would experience the second greatest amount of cumulative disturbance. The closed basin watersheds--Jonah Gulch and 140401040603--would likely only experience a small increase in cumulative disturbance. Significant cumulative impacts to topography are anticipated under the Proposed Action and Alternatives A, C, D, F, and G.

4.1.3.12 Unavoidable Adverse Impacts

Unavoidable adverse impacts to topography would include long-term changes in landform throughout the JIDPA. Since reclamation activities would be performed such that the reclaimed landscape emulates pre-disturbance conditions, no notable permanent changes (post-LOP) in topography are anticipated. Minor differences from the pre-disturbance condition would be present, but the overall integrity to pre-existing topography would be retained.

4.1.4 Mineral Resources

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and the land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with mineral resources:

- to maintain or enhance opportunities for mineral exploration and development, while protecting other resource values;
- to provide for oil and gas leasing, exploration, and development while protecting other values;

- to provide saleable mineral materials (e.g., sand, gravel) in convenient locations for users, while protecting other resources;

- to consider the conservation and enhancement of natural resources with the economic benefits of resource development;

- to coordinate land use decisions with economic factors and needs;

- to plan land use consistent with the orderly development, use, and conservation of resources while preserving environmental quality; and

- to plan uses that encourage energy conservation.

The primary project impact to mineral resources would be from the depletion of recoverable gas and oil reserves from the Lance Pool and possibly other formations underlying the JIDPA (Table 4.2), and significant impacts are anticipated under most alternatives since these are non-renewable resources. The economic impacts from natural gas and oil recovery are described in Section 4.4.

Since the project (under any alternative) is not anticipated to interfere with the recovery of other minerals (i.e., sand and gravel), these resources would remain available for recovery. Therefore, no impacts to other minerals are anticipated and they are not further discussed.

4.1.4.1 No Action Alternative

Under the No Action Alternative, an estimated 3,366 BCF of natural gas and 31.98 million barrels of oil (MBO) would be recovered. Compared to the Proposed Action, this would leave approximately 4,581 BCF of gas and 43.52 MBO unrecovered.

The No Action Alternative could result in substantial volumes of unrecovered resource. Since large volumes of the resources would remain in place and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.2 The Proposed Action

Implementation of the Proposed Action would result in an estimated total production of natural gas and condensates (oil) from the field of 7,947 BCF and 75.50 MBO, respectively. These amounts represent 4,581 BCF more gas and 43.52 MBO more oil than would be recovered under the No Action Alternative. Since these extracted mineral resources would no longer be available, significant effects to mineral resources would occur.

4.1.4.3 Alternative A

Under Alternative A, impacts to oil and gas reserves would be the recovery of 8,191 BCF of gas and 77.81 MBO (see Table 4.2). These amounts represent an increase in 4,825 BCF of gas and

Table 4.2 Anticipated Gas and Condensate Recovery Volumes for Each Alternative, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Alternative	Approximate Natural Gas Recovered[1] (billion cubic feet [BCF])	Approximate Condensate (Oil) Recovered[1] (MBO)	Recovery Volumes Compared to Proposed Action	
			Gas (BCF)	Oil (MBO)
No Action	3,366	31.98	(4,581)	(43.52)
Proposed Action[2]	7,947	75.50	0	0
Alternative A	8,191	77.81	+244	+2.31
Alternative B[2]	6,124	58.18	(1,823)	(17.32)
Alternative C	6,657	63.24	(1,290)	(12.26)
Alternative D	7,554	71.76	(393)	(3.74)
Alternative E[2]	6,302	59.87	(1,645)	(15.63)
Alternative F[2]	7,186	68.27	(761)	(7.23)
Alternative G[2]	7,876	74.82	(71)	(0.68)
Preferred Alternative[2]	7,876	74.82	(71)	(0.68)

[1] Assumes approximately 10,500 BCF of natural gas and 99.75 MBO of condensate are present beneath the JIDPA.

[2] Does not fully account for losses/unrecovered resources associated with undeveloped wells (assumed to be uneconomic).

45.83 MBO of oil that would be recovered under the No Action Alternative. Since the extracted mineral resources would no longer be available, significant effects to mineral resources and future consumers would occur.

4.1.4.4 Alternative B

Under Alternative B, 6,124 BCF of natural gas and 58.18 MBO would be produced--approximately 2,758 BCF of gas and 26.20 MBO more than would be recovered under the No Action Alternative. Alternative B would leave approximately 1,823 BCF of gas and 17.32 MBO unrecovered. Since considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.5 Alternative C

Under Alternative C, 6,657 BCF of natural gas and 63.24 MBO would be produced--approximately 3,291 BCF of gas and 31.26 MBO of oil more than for the No Action Alternative. Alternative C would leave approximately 1,290 BCF of gas and 12.26 MBO unrecovered. Since considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.6 Alternative D

Under Alternative D, 7,554 BCF of natural gas and 71.76 MBO would be produced--approximately 4,188 BCF of gas and 39.78 MBO of oil more than would be recovered under the No Action Alternative. Alternative D would leave approximately 393 BCF of gas and 3.74 MBO unrecovered. Since considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.7 Alternative E

Under Alternative E, 6,302 BCF of natural gas and 59.87 MBO would be produced--approximately 2,936 BCF of gas and 27.89 MBO of oil more than for the Proposed Action. Alternative E would leave approximately 1,645 BCF of gas and 15.63 MBO unrecovered. Since considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.8 Alternative F

Under Alternative F, 7,186 BCF of natural gas and 68.27 MBO would be produced, approximately 3,820 BCF of gas and 36.29 MBO of oil more than would be produced under the No Action Alternative. Alternative F would leave approximately 761 BCF of gas and 7.23 MBO unrecovered. Since considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.9 Alternative G

Under Alternative G, impacts to oil and gas reserves would approximate those of the Proposed Action (i.e., 7,876 BCF of gas and 74.82 MBO of oil would be produced)--4,510 BCF more gas and 42.84 MBO more oil than for the No Action Alternative. Since these extracted mineral resources would no longer be available, significant effects to mineral resources would occur.

4.1.4.10 BLM Preferred Alternative

Under the Preferred Alternative, impacts to oil and gas reserves would approximate those of Alternative G (i.e., 7,876 BCF of gas and 74.82 MBO of oil would be produced)--4,510 BCF more gas and 42.84 MBO more oil than for the No Action Alternative. Since these extracted mineral resources would no longer be available, significant effects to mineral resources would occur.

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14); however, since most natural gas resources would be recovered and would no longer be available, significant effects would occur.

4.1.4.11 Cumulative Impacts

The CIAA for mineral resources is the composite Jonah Field, which includes the original Jonah Prospect field, the Jonah II project area, and the JIDPA (see Map 3.4). This project is proposed in part to maximize natural gas and condensate recovery from the known reserves in this area. Since no additional development beyond that described herein is anticipated in the CIAA, cumulative impacts to mineral resources would be the same as described for the No Action, Proposed Action, Alternatives A through G, and the BLM Preferred Action.

4.1.4.12 Unavoidable Adverse Impacts

Under the No Action Alternative and Alternatives B through F, there would be less-than-complete recovery of resources, which would either: 1) necessitate developing similar resources elsewhere with possible adverse effects; 2) delay the recovery of these resources until some unknown time in the future; or 3) result in the complete loss of non-recovered energy resources and the associated royalties.

4.1.5 Geologic Hazards

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with geologic hazards:

- to protect the health and safety of the public and the well-being of sensitive natural resources,
- to minimize the loss of life and property from natural hazards, and
- to generate and provide data on development limitations.

Any impacts that would lead to the inability of management agencies to achieve these goals/objectives would be considered a significant impact.

Potential impacts associated with geologic hazards include impacts associated with subsidence, earthquakes, and landslides. The depth of gas reserves in the JIDPA and the lack of underground mines in the area negate the potential for subsidence. There are no known active faults within the JIDPA, and although earthquakes may occur infrequently, all facilities would be designed to withstand the effects of moderate earthquakes. No known landslides occur in the JIDPA, so none of the alternatives would be affected by landslides. With the application of mitigations (see Appendices A and B), impacts are anticipated to be less than significant under all alternatives, and no further alternative-specific impact analyses are discussed.

Under the BLM Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

The CIAA area for geologic hazards includes the composite Jonah field, including the original Jonah Prospect field, the Jonah Field II project area, and the JIDPA (see Map 3.5), and no further development beyond this proposed project is planned for the area. Development in this area is not likely to affect or be affected by geologic hazards. Therefore, cumulative impacts would be the same as described above for the proposed project.

No unavoidable adverse impacts would occur due to geologic hazards.

4.1.6 Paleontological Resources

The PFO and RSFO RMP (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with paleontologic resources:

- to expand the opportunities for scientific study and educational and interpretive uses of paleontologic resources,
- to protect and preserve important paleontologic resources and/or their historic record for future generations, and
- to resolve conflicts between paleontologic resources and other resource uses.

Under all alternatives, direct impacts to paleontological resources would include damage or destruction of fossils and associated data due to field development/surface disturbance for well pads, roads, pipelines, ancillary facilities, etc. For the purpose of this analysis, it is assumed that increases in surface disturbance correspond to an increase in the potential for impacts to paleontological resources. Indirect impacts would include loss from unauthorized collection or vandalism which, in turn, would result in a loss of the opportunity to expand scientific study and educational and interpretive uses of these resources. However, surface-disturbing activities could uncover fossils of significant scientific importance that otherwise would have remained buried and unavailable for scientific study.

The important fossil record of the Green River Basin is well known (Grande 1984; BLM 1992) (see also Table 3.9). The recent discovery of Pleistocene horse bones (tentative identification) during well pad construction in the JIDPA affects potential future paleontological mitigation procedures for the area since Pleistocene paleontologic materials were previously unknown for the JIDPA. Significant fossils likely occur in the JIDPA. To lessen impacts, mitigation measures including avoidance, survey, monitoring, and collection would be used under all alternatives (see also Appendices A and B). In areas of paleontological sensitivity, a determination would be made by the BLM as to whether a survey by a qualified paleontologist is necessary prior to the disturbance.

4.1.6.1 No Action Alternative

Under the No Action Alternative, potential impacts to paleontological resources would be primarily associated with existing surface disturbances (4,209 acres) related to currently approved field development activities. Indirect impacts associated with unauthorized collection or vandalism would continue for the LOP.

4.1.6.2 The Proposed Action

Direct impacts under the Proposed Action would be increased from those of the No Action Alternative since up to 20,409 acres of disturbance would occur--16,200 acres more than for the No Action Alternative. There would be an increase in human activity and it would occur for a longer duration, resulting in more potential for both vandalism and discovery.

4.1.6.3 Alternative A

Potential direct impacts to paleontological resources under Alternative A would be similar to those described for the Proposed Action except that under Alternative A, some disturbance would occur in areas such as along Sand Draw that would be avoided under the Proposed Action. Indirect impacts would be increased from the No Action Alternative due to the increase in human activity, and these indirect impacts would occur for a longer duration, resulting in more potential for both vandalism and discovery (see Table 2.2).

4.1.6.4 Alternative B

Direct and indirect impacts to paleontological resources under Alternative B would be increased from those of the No Action Alternative due to the increase in total surface disturbance of 3,297 acres and the increased human presence. Duration of the impacts would be up to 42 years longer, resulting in more potential for both vandalism and discovery.

4.1.6.5 Alternative C

Under Alternative C, direct impacts to paleontological resources would be increased from those of the No Action Alternative due to the 6,705 acres of additional surface disturbance. Duration of the impacts would be dependent upon the rate of development, but could be up to 17 years longer than for the No Action Alternative. Indirect impacts would be increased from the No Action Alternative due to increased human presence during project development and production.

4.1.6.6 Alternative D

Under Alternative D, direct impacts to paleontological resources would be increased from those of the No Action Alternative due to the 11,581 acres of additional surface disturbance. Duration of the impacts would be dependent upon the rate of development. Indirect impacts would occur for up to 42 years longer than the No Action Alternative, resulting in the potential for increased vandalism and discovery.

4.1.6.7 Alternative E

Under Alternative E, direct impacts to paleontological resources would be increased from those of the No Action Alternative due to the 6,386 acres of additional surface disturbance. Duration of the impacts would be dependent upon the rate of development, and could be up to 42 years longer. Indirect impacts would be increased from the No Action Alternative due to increased human presence during development and production.

4.1.6.8 Alternative F

Under Alternative F, direct impacts to paleontological resources would be increased from those of the No Action Alternative due to the 10,446 acres of additional surface disturbance. Duration of the impacts would be dependent upon the rate of development (see Table 2.2), and could be up to 42 years longer than the No Action Alternative. Indirect impacts would be increased from the No Action Alternative due to increased human presence during development and production.

4.1.6.9 Alternative G

Under Alternative G, impacts to paleontological resources would be increased from those of the No Action Alternative due to the 13,989 acres of additional surface disturbance. Duration of the impacts would be dependent upon the rate of development, and could be up to 42 years longer than the No Action Alternative. Indirect impacts would be increased from the No Action Alternative due to increased human presence during development and production.

4.1.6.10 BLM Preferred Alternative

Under the Preferred Alternative, impacts to paleontologic resources would be increased from those of the No Action Alternative. The Preferred Alternative would result in 8,316 acres of additional surface disturbance and 2,438 acres more LOP disturbance. The Preferred Alternative would have a direct impact duration of approximately 13 years (250 wells/year) longer than the No Action Alternative. In terms of the amount of disturbance over-and-above that expected for the No Action Alternative, the Preferred Alternative ranks sixth out of the nine potential development alternatives and, thus would result in a lower potential for inadvertent loss than the Proposed Action and Alternatives A, D, F, and G. In terms of duration of development (and thus exposure to potential indirect impacts such as vandalism, and, conversely, beneficial discoveries), the Preferred Alternative is comparable to most of the other alternatives under the 250 well/year development scenario; the Preferred Alternative would result in a 4- to 29-year shorter duration of impacts compared to all of the slower development scenarios. Only Alternatives C and D could result in a shorter duration of impact (4 to 8 years). Additionally, the application of alternative-specific management objectives and associated mitigation and monitoring protocol could further reduce impacts.

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.1.6.11 Cumulative Impacts

The CIAA for paleontological resources is a 484.4-square mile area (310,000 acres) surrounding the JIDPA (see Map 3.5). Approximately 1.1% of the CIAA (3,331 acres) has previously been disturbed, much of which is from natural gas well pads, roads, and pipelines in the JIDPA (i.e., currently approved oil and gas development activities). Other activities include oil and gas development in the Pinedale Anticline Field, livestock grazing, and recreation. Livestock grazing and recreation have minimal impacts on paleontological resources, other than the possibility of increasing opportunities for illegal collecting and/or vandalism.

RFD (new surface disturbance) for the portion of the CIAA outside the JIDPA is estimated at 594 acres, primarily from gas-related development in the Pinedale Anticline Natural Gas Field. Maximum cumulative disturbance (i.e., the combined existing, proposed [Proposed Action and Alternative A], and RFD disturbance) would be 20,121 acres (6.4% of the CIAA); other action alternatives would have less surface disturbance and activity and would therefore have a reduced potential for cumulative impacts. Cumulative impacts to paleontological resources would be of the same type as those described for the action alternatives; however, the potential for significant cumulative impacts is unknown since little paleontological inventory or evaluation has been conducted in the JIDPA.

4.1.6.12 Unavoidable Adverse Impacts

Unavoidable adverse impacts to paleontological resources include the fossil resources that may be inadvertently damaged or destroyed by surface-disturbing activities and those potentially lost through illegal collecting and/or vandalism.

4.1.7 Soils

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with soils:

- to stabilize and conserve soils;
- to increase vegetative production;
- to maintain or improve surface and ground water quality;
- to protect, maintain, or improve wetlands, floodplains, and riparian areas;
- to minimize topsoil erosion;
- to maintain or increase highly diverse native plant communities; and
- to consider the suitability of soil composition in all land use decisions.

Impacts to soils would be considered significant if a reduction in soil productivity and/or increased erosion would prevent successful reclamation and/or if disturbance or other activities resulted in a violation of the aforementioned land use objectives. Impacts to soils are assumed to be proportional to the amount of new initial surface disturbance for all alternatives (i.e., increased disturbance would result in a proportionally increased potential for adverse impacts to soils). Under the various alternatives, Operators would implement various management requirements/mitigation measures (see Appendices A and B); therefore, impacts to soils would also be dependent on the effectiveness of this mitigation. Significant impacts to soils are anticipated under all project alternatives.

Direct impacts to soils would include removal of vegetation, exposure of the soil, mixing of soil horizons, loss of topsoil productivity, soil compaction, and increased susceptibility to wind and water erosion. These impacts could, in turn, result in increased runoff, erosion, and sedimentation. Increased surface runoff and erosion would occur primarily in the short-term and would decline in time due to natural stabilization through particle aggregation, soil structure development, and armoring. Short-term control of surface runoff would be dependent on the success and implementation of reclamation and revegetation efforts described in Reclamation Plan and Surface Use Plans and Plans of Development prepared for each APD and/or ROW application, and Storm Water Pollution Prevention Plans (SWPPPs) (see also Appendix G). Following application of reclamation and revegetation procedures, the susceptibility of disturbed areas to soil erosion would be minimized for both the short term and for the LOP. Since the extent of erosion in the JIDPA under any alternative is undefined, the BLM has determined that modeling will be performed to identify potential soil losses. The results of this modeling will be available in the Final EIS.

The potential for contamination of soils due to the accidental discharge would be limited by appropriate project implementation procedures and the remedial measures applied as specified in SPCCPs (see Appendix G).

Most soils in the JIDPA have a naturally high erosion potential and generally have limited rehabilitation potential because of one or more characteristics including thin soils, shallow depth to bedrock, excess salts, excess sand and/or small stones, clayey textures, and excess lime.

Concentrating development actions at larger well pads would have increased site-specific effects on overland flow patterns, ground water infiltration (reduced on compacted areas), and runoff volumes (increased rates and potential erosion and sedimentation). Additionally, if surface disturbance is concentrated in any one watershed, increased potential erosion and runoff-related effects may occur, possibly requiring the need for special treatments to be specified in APD approvals. Estimates of potential new and LOP disturbance associated with the various project alternatives within each project-affected watershed are presented in Tables 4.3 and 4.4 and are discussed under each alternative.

The following analyses show that the Proposed Action and alternatives generally are compatible with existing management goals/objectives; however, significant impacts to soils are anticipated in the short term in and down-channel from the JIDPA. Mitigation measures (see Appendices A and B) would be required under all project alternatives to minimize impacts to soil resources.

4.1.7.1 No Action Alternative

Under the No Action Alternative, there would be no additional activities that would potentially affect soil resources other than those previously approved for the area (BLM 1998b, 2000b)--4,209 acres of new (short-term) and 1,409 acres of LOP disturbance or 13.8% and 4.6% of the JIDPA, respectively. The duration of impacts would be approximately 63 years and until areas are adequately reclaimed.

4.1.7.2 The Proposed Action Alternative

A total of 4,209 acres of new (short-term) and 1,409 acres of LOP disturbance are currently approved (see Table 4.3) and would occur under the No Action Alternative. The Proposed Action would result in an estimated increase of 16,200 acres of new initial disturbance, for a total disturbance of 20,126 acres in the JIDPA (66.0% of the JIDPA), and an additional 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total project-specific existing (i.e. No Action Alternative) and new initial disturbance under the Proposed Action would be 20,409 acres (see Table 4.3). Approximately 70.4% (14,369 acres) of this disturbance would be reclaimed and reseeded as soon as practical after disturbance (see Appendix G). Disturbance would not occur all at once, but would increase as development occurs (for approximately 12 years. Simultaneously, disturbance would decrease in some areas as some disturbed lands are reclaimed. The magnitude of impacts to soil resources would depend on how much disturbance is present at any one time and the rate of reclamation. Approximately 6,040 acres would be disturbed for the LOP--approximately 76 years and until successful reclamation is achieved.

The Expanded Sand Draw-Alkali Creek watershed, which drains 45% of the JIDPA, could experience the greatest level of impacts to soil resources from project-related activities. Under the Proposed Action, potential new disturbance to this watershed could increase from that of the

Table 4.3 Cumulative Acreage of Disturbance in each CIAA Watershed and Including RFD, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Watershed/ Major River Drainage	Total Acreage of Watershed	Acres of Watershed Within JIDPA	Existing Disturbance In CIAA but Outside JIDPA	RFD	No Action[1] New	No Action[1] LOP	No Action[1] Cumulative[10]	Proposed Action and Alternative A[2] (3,100 Wells/Pads) New	LOP	Cumulative[10]	Alternative B[3] (3,100 Wells/497 Pads) New	LOP	Cumulative[10]
Green River/New Fork River													
Expanded Sand Draw-Alkali Creek	22,931	13,725	327	228	1,800	607	2,355	9,057	2,682	9,612	3,250	1,143	3,805
Granite Wash	12,212	1,312	36	0	172	58	208	866	256	902	311	109	347
Reduced Upper Alkali Creek-Green River	26,797	3,782	239	0	496	167	735	2,496	739	2,735	896	315	1,135
Upper Eighteenmile Canyon	35,212	1,958	477	18	257	87	752	1,292	386	1,787	464	163	959
Southeast New Fork River-Blue Rim	11,746	0	23	126	0	0	149	0	0	149	0	0	149
North Alkali Draw	15,911	0	101	168	0	0	269	0	0	269	0	0	269
	124,809	20,777	1,203	540	2,725	919	4,469	13,710	4,059	15,453	4,920	1,731	6,663
Subtotal **Big Sandy River**													
Big Sandy River-Bull Draw	19,760	3,630	217	54	476	160	747	2,395	709	2,666	860	302	1,131
Long Draw	18,521	5,028	281	0	660	222	941	3,318	982	3,599	1,191	419	1,472
Subtotal	38,281	8,658	498	54	1,136	382	1,688	5,713	1,692	6,265	2,050	721	2,603
Closed Basins													
Jonah Gulch	22,652	318	127	0	42	14	169	210	62	337	75	26	202
	24,558	747	122	0	98	33	220	493	146	615	177	62	299
140401040603	47,210	1,065	249	0	140	47	389	703	208	952	252	89	501
Subtotal Total	210,300	30,500	1,950	594	4,001	1,348	6,545	20,126	5,959	22,670	7,223	2,541	9,767
Additional associated disturbance[12]					208	61	208	283	81	283	283	81	283
Grand Total[11]			--	--	4,209	1,409	6,753	20,409	6,040	22,953	7,506	2,622	10,050
Percent disturbance of entire CIAA			0.9	0.3	1.9	0.6	3.2	9.6	2.9	10.9	3.4	1.2	4.8

Table 4.3 (continued)

Watershed/ Major River Drainage	Alternative C[4] (1,250 Wells and Pads) New	LOP	Cumulative[10]	Alternative D[5] (2,220 Wells and Pads) New	LOP	Cumulative[10]	Alternative E[6] (3,100 Wells/266 New Pads) New	LOP	Cumulative[10]
Green River/New Fork River									
Expanded Sand Draw-Alkali Creek	4,784	1,493	5,339	6,978	2,103	7,533	4,640	1,582	5,195
Granite Wash	457	143	493	667	201	703	444	151	480
Reduced Upper Alkali Creek-Green River	1,318	411	1,557	1,923	580	2,162	1,279	436	1,518
Upper Eighteenmile Canyon	682	213	1,177	995	300	1,490	662	226	1,157
Southeast New Fork River-Blue Rim	0	0	149	0	0	176	0	0	149
North Alkali Draw	0	0	269	0	0	281	0	0	269
Subtotal	7,242	2,260	8,985	10,564	3,184	12,307	7,025	2,395	8,768
Big Sandy River									
Big Sandy River-Bull Draw	1,265	395	1,536	1,846	556	2,117	1,227	418	1,498
Long Draw	1,753	547	2,034	2,556	771	2,837	1,700	580	1,981
Subtotal	3,018	942	3,570	4,402	1,327	4,954	2,927	998	3,479
Closed Basins									
Jonah Gulch	111	35	238	162	49	289	108	37	235
140401040603	260	81	382	380	114	502	253	86	375
Subtotal	371	116	620	541	163	790	360	123	610
Total[11]	10,631	3,318	13,175	15,507	4,674	18,051	10,312	3,516	12,857
Additional associated disturbance[12]	283	81	283	283	81	283	283	81	283
Grand Total[11]	10,914	3,399	13,458	15,790	4,755	18,334	10,595	3,597	13,139
Percent disturbance of entire CIAA	5.1	1.6	6.3	7.4	2.2	8.7	4.9	1.7	6.2

Table 4.3 (continued)

6th Order Watershed/ Major River Drainage	Alternative F[7] (3,100 Wells/ 1,028 New Pads) New	LOP	Cumulative[10]	Alternative G[8] (3,100 Wells/ 2,553 New Pads) New	LOP	Cumulative[10]	Preferred Alternative[9] (3,100 Wells/Pads) New	LOP	Cumulative[10]
Green River/New Fork River									
Expanded Sand Draw-Alkali Creek	6,467	1,762	7,022	8,062	2,397	8,617	5,509	1,695	6,064
Granite Wash	618	168	654	771	229	807	527	162	563
Reduced Upper Alkali Creek-Green River	1,782	486	2,021	2,221	661	2,460	1,518	467	1,757
Upper Eighteenmile Canyon	923	251	1,418	1,150	342	1,645	786	242	1,281
Southeast New Fork River-Blue Rim	0	0	149	0	0	149	0	0	149
North Alkali Draw	0	0	269	0	0	269	0	0	269
Subtotal	9,790	2,668	11,533	12,204	3,629	13,947	8,340	2,567	10,083
Big Sandy River									
Big Sandy River-Bull Draw	1,711	466	1,982	2,132	634	2,403	1,458	448	1,729
Long Draw	2,369	646	2,650	2,953	878	3,234	2,018	620	2,299
Subtotal	4,080	1,112	4,632	5,086	1,512	5,638	3,476	1,068	4,028
Closed Basins									
Jonah Gulch	150	41	277	187	56	314	127	39	254
140401040603	352	96	474	439	130	561	299	92	421
Subtotal	502	137	751	626	186	875	426	131	675
Total	14,372	3,916	16,916	17,915	5,327	20,459	12,242	3,766	14,786
Additional associated disturbance[11]	283	81	283	283	81	283	283	81	283
Grand Total [11]	14,655	3,997	17,199	18,198	5,408	20,742	12,525	3,847	15,069
Percent disturbance of entire CIAA	6.8	1.9	8.2	8.5	2.5	9.9	6.0	1.8	7.2

Table 4.3 (continued)

[1] Assumes new and LOP disturbance as currently authorized.
[2] Assumes 20,126 acres of new initial and 5,956 acres of LOP disturbance in the JIDPA.
[3] Assumes 7,223 acres of new initial and 2,541 acres of LOP disturbance in the JIDPA.
[4] Assumes 10,631 acres of new initial and 3,318 acres of LOP disturbance in the JIDPA.
[5] Assumes 15,507 acres of new initial and 4,674 acres of LOP disturbance in the JIDPA.
[6] Assumes 10,312 acres of new initial and 3,516acres of LOP disturbance in the JIDPA.
[7] Assumes 14,372 acres of new initial and 3,916 acres of LOP disturbance in the JIDPA.
[8] Assumes 17,915 acres of new initial and 5,327 acres of LOP disturbance in the JIDPA.
[9] Assumes 12,242 acres of new initial and 3,766 acres of LOP disturbance in the JIDPA.
[10] Cumulative disturbance = New + existing + RFD.
[11] Columns may not total due to rounding error.
[12] Assumes new initial and LOP disturbance associated with selected ancillary facilities which may be constructed outside the JIDPA (e.g. Burma Road upgrade).

Table 4.4 Percent of Watersheds Affected, Including Existing Disturbance, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

Watershed/ Major River Drainage[2]	Total Acreage of Watershed	Percent of Watershed in JIDPA	Percent of Entire Watershed Currently Disturbed[2]	No Action			Proposed Action and Alternative A (3,100 Wells/ Pads)			Alternative B (3,100 Wells/ 497 Pads)			Alternative C (1,250 Wells and Pads)		
				New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative
Green River/New Fork River															
Expanded Sand Draw-Alkali Creek	22,931	59.9	4.2	7.8	2.6	10.3	39.5	11.7	41.9	14.2	5.0	16.6	20.9	6.5	23.3
Granite Wash	12,212	10.7	0.3	1.4	0.5	1.7	7.1	2.1	7.4	2.5	0.9	2.8	3.7	1.2	4.0
Reduced Upper Alkali Creek-Green River	26,797	14.1	1.3	1.9	0.6	2.7	9.3	2.8	10.2	3.3	1.2	4.2	4.9	1.5	5.8
Upper Eighteenmile Canyon	35,212	5.6	1.7	0.7	0.2	2.1	3.7	1.1	5.1	1.3	0.5	2.7	1.9	0.6	3.3
Southeast New Fork River-Blue Rim	11,746	0.0	0.2	--	--	1.3	--	--	1.3	--	--	1.3	--	--	1.3
North Alkali Draw	15,911	0.0	0.6	--	--	1.7	--	--	1.7	--	--	1.7	--	--	1.7
Big Sandy River															
Big Sandy River-Bull Draw	19,760	18.4	1.1	2.4	0.8	3.8	12.1	3.6	13.5	4	1.5	5.7	6.4	2.0	7.8
Long Draw	18,521	27.1	0.7	3.6	1.2	5.1	17.9	5.3	19.5	6.4	2.3	7.9	9.5	3.0	11.0
Closed basins															
Jonah Gulch	22,652	1.4	1.0	0.2	0.1	0.7	0.9	0.3	1.5	0.3	0.1	0.9	0.5	0.2	1.1
140401040603	24,558	3.0	0.7	0.4	0.1	0.9	2.0	0.6	2.5	0.7	0.3	1.2	1.1	0.3	1.6

Table 4.4 (continued)

Watershed/ Major River Drainage[2]	Alternative D (2,220 Wells and Pads)			Alternative E (3,100 Wells/ 266 Pads)			Alternative F (3,100 Wells/ 1,028 New Pads)			Alternative G (3,100 Wells/ 2,553 Pads)			Preferred Alternative (3,100 Wells/ Pads)		
	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative	New[3]	LOP[3]	Cumulative
Green River/New Fork River															
Expanded Sand Draw-Alkali Creek	30.4	9.2	32.9	20.2	6.9	22.7	28.2	7.7	30.6	35.2	10.5	37.6	24.0	7.4	26.4
Granite Wash	5.5	1.7	5.8	3.6	1.2	3.9	5.1	1.4	5.4	6.3	1.9	6.6	4.3	1.3	4.6
Reduced Upper Alkali Creek-Green River	7.2	2.2	8.1	4.8	1.6	5.7	6.6	1.8	7.5	8.3	2.5	9.2	5.6	1.7	6.6
Upper Eighteenmile Canyon	2.8	0.9	4.2	1.9	0.6	3.3	2.6	0.7	4.0	3.3	1.0	4.7	2.2	0.7	3.6
Southeast New Fork River-Blue Rim	--	--	1.3	--	--	1.3	--	--	1.3	--	--	1.3	--	--	1.3
North Alkali Draw	--	--	1.7	--	--	1.7	--	--	1.7	--	--	1.7	--	--	1.7
Big Sandy River															
Big Sandy River-Bull Draw	9.3	2.8	10.7	6.2	2.1	7.6	8.7	2.4	10.0	10.8	3.2	12.2	7.3	2.2	8.7
Long Draw	13.8	4.2	15.5	9.2	3.1	10.7	12.8	3.5	14.3	15.9	4.7	17.5	10.4	3.2	12.4
Closed basins															
Jonah Gulch	0.7	0.2	1.3	0.5	0.2	1.0	0.7	0.2	1.2	0.8	0.2	1.4	0.6	0.2	1.1
140401040603	1.5	0.5	2.0	1.0	0.4	1.5	1.4	0.4	1.9	1.8	0.5	2.3	1.2	0.4	1.7

[1] Percent of watershed affected is calculated using potential acreage affected (refer to Table 4.3) divided by the total watershed acreage multiplied by 100.
[2] As described in Table 3.12.
[3] Provides percent of the watershed within the JIDPA that would be disturbed.

No Action Alternative to 39.5% (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from the Proposed Action would be 2,682 acres (11.7% of the watershed).

No formal estimates of disturbance to the 17 soil map units defined for the JIDPA (see Map 3.6) are provided herein due to the variability and unknown locations for much of the proposed development. Estimates of the types of soils most likely to be disturbed are based on the coarse-scale soil map units (see Map 3.6). The SU05 soil map unit that occurs on 67.2% of the JIDPA (see Table 3.10 and Map 3.6) is anticipated to experience the greatest amount of disturbance--13,525 acres of new disturbance as a result of the Proposed Action. The SU03 unit that occupies 32.5% of the JIDPA could experience 6,541 acres of disturbance. The remaining 60 acres of disturbance could occur in the SU07 soil map unit type.

4.1.7.3 Alternative A

Implementation of Alternative A is anticipated to result in the same types and acreage of impacts and surface disturbance as the Proposed Action (see Tables 4.3 and 4.4) and would result in increased soil impacts and disturbance from these of the No Action Alternative. However, since selected Operator-committed and BLM-required practices would not be implemented (e.g., avoidance of steep slopes and drainage buffers), significant impacts are more likely to occur under this alternative. Development of natural gas resources in these areas could result in significant impacts to soil resources, particularly in the Expanded Sand Draw-Alkali Creek watershed, due to increased erosion and/or sedimentation. As with the Proposed Action, not all areas would be disturbed at the same time, rather, disturbance would accumulate as development occurs. Since the rate of development may vary under Alternative A (i.e., 75, 150, or 250 wells developed/year) the duration of impacts could be extended from the No Action Alternative by an additional 42 years (75 wells/year development rate) and until areas are reclaimed.

4.1.7.4 Alternative B

Implementation of Alternative B would result in an increase of 3,297 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development occurs from approximately 5 to 17 years; all surface disturbance would not be present at any one time. The duration of impacts could be extended from the No Action Alternative by 42 years (75 wells/year development rate).

Under Alternative B, there would be a total of 7,506 acres new disturbance--7,223 acres would occur in the JIDPA (i.e., 23.7% of the JIDPA). Of this total, 4,884 would be short-term and 2,622 acres would be LOP disturbance. Under Alternative B, LOP disturbance to soils within the JIDPA would increase from the No Action Alternative of 4.6% (1,409 acres) to 8.3% (2,541 acres) of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed under Alternative B could increase from that of the No Action to 14.2% of the watershed (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative B would be 1,143 acres (5.0% of the watershed).

It is anticipated that soil map unit SU05 would experience the greatest amount of disturbance (5,044 acres) under this alternative. The SU03 unit could experience 2,439 acres of disturbance. The remaining 23 acres of disturbance could occur in the SU07 soil map unit type.

4.1.7.5 Alternative C

Implementation of Alternative C would result an increase of 6,705 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development occurs; therefore, all surface disturbance would not be present at any one time. The duration of impacts to soils could be extended from the No Action Alternative from 5 to 17 years plus the time needed for successful reclamation.

Under Alternative C, total new surface disturbance in the JIDPA would be 10,631 acres (7,313 and 3,318 acres for short-term and LOP disturbance, respectively) (34.9% of the JIDPA). An additional 283 acres of initial disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore total new disturbance under Alternative C would be 10,914 acres (see Table 4.3). Approximately 68.9% (7,515 acres) of total disturbance would be short-term (i.e., reclaimed and reseeded as soon as practical after disturbance); the remaining 3,399 acres would be disturbed for the LOP. Under Alternative C, LOP disturbance to soils within the JIDPA would increase from the No Action Alternative of 4.6% to 10.9% of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed under Alternative C could increase from that of the No Action Alternative to 20.9%of the watershed (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative C would be 1,493 acres (6.5% of the watershed).

The SU05 soil map unit is anticipated to have approximately 7,144 acres of new disturbance. The SU03 unit could experience 3,455 acres of disturbance. The remaining 32 acres of new disturbance could occur in the SU07 soil map unit type.

4.1.7.6 Alternative D

Implementation of Alternative D would result in an increase of 11,581 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development occurs from approximately 9 to 30 years; therefore, all surface disturbance would not occur at once. Depending in the rate of development, impact duration would be approximately 72 to 93 years, the duration of impacts to soils could be extended from the No Action Alternative by approximately 9 to 30 years plus the time needed for successful reclamation.

Under Alternative D, total new surface disturbance in the JIDPA would be 15,507 acres (10,833 and 4,674 acres for short-term and LOP disturbance, respectively) (50.8% of the JIDPA). An additional 283 acres of new disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under this alternative would be 15,790 acres (see Table 4.3). Approximately 69.9% (11,035 acres) of total disturbance would be short-term (i.e., reclaimed and reseeded as soon as practical after disturbance); the remaining 4,755 acres would be disturbed for the LOP. Under Alternative D, LOP disturbance to soils within the JIDPA would increase from the No Action Alternative of 4.6% to 15.3% of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed under Alternative D could increase from that of the No Action Alternative to 30.4% of the watershed (Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative D would be 2,103 acres (9.2% of the watershed).

The SU05 soil map unit is anticipated to have approximately 10,421 acres of new disturbance. The SU03 unit could experience 5,040 acres of disturbance. The remaining 46 acres of disturbance could occur in the SU07 soil map unit type.

4.1.7.7 Alternative E

Implementation of Alternative E would result in an increase of 6,386 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development progresses, from 12 to 42 years. Depending on the rate of development, impact duration would be approximately 76 to 105 years and could be extended from that of the No Action Alternative by approximately 13 to 42 years plus the time needed for successful reclamation.

Under Alternative E, total surface disturbance in the JIDPA would be 10,312 acres (6,796 and 3,516 acres for short-term and LOP disturbance, respectively) (33.8% of the JIDPA). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new initial disturbance under Alternative E would be 10,595 acres, and 3,597 acres of disturbance would occur for the LOP (see Table 4.3). Under Alternative E, LOP disturbance to soils within the JIDPA would increase from the No Action Alternative of 4.6% to 11.5% of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed from Alternative E could increase from that of the No Action Alternative to 20.3% of the watershed (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative E would be 1,582 acres (6.9% of the watershed).

The SU05 soil map unit is anticipated to have approximately 6,930 acres of new disturbance. The SU03 unit could experience 3,354 acres of disturbance. The remaining 28 acres of new disturbance could occur in the SU07 soil map unit type.

4.1.7.8 Alternative F

Implementation of Alternative F would result in an increase of 10,446 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development progresses from 12 to 42 years. Depending on the rate of development, impact duration would be approximately 76 to 105 years and could be extended from that of the No Action Alternative by approximately 42 years plus the time needed for successful reclamation.

Under Alternative F, total surface disturbance in the JIDPA would be 14,372 acres (10,456 and 3,916 acres for short-term and LOP disturbance, respectively) (47.1% of the JIDPA). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative F would be 14,655 acres, and 3,997 acres of disturbance would occur for the

LOP (see Table 4.3). Under Alternative F, LOP disturbance to soils would increase from the No Action Alternative of 4.6% to 12.8% of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed from Alternative F could increase from that of the No Action Alternative to 28.2% of the watershed (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative F would be 1,762 acres (7.7% of the watershed).

The SU05 soil map unit is anticipated to have approximately 9,658 acres of new disturbance. The SU03 unit could experience 4,671 acres of disturbance. The remaining 43 acres of new disturbance could occur in the SU07 soil map unit type.

4.1.7.9 Alternative G

Implementation of Alternative G would result in an increase of 13,989 acres of new initial surface disturbance from that of the No Action Alternative. Impact potential would increase as development progresses from 12 to 42 years. Depending on the rate of development, impact duration would be approximately 76 to 105 years and could be extended from that of the No Action Alternative by approximately 13 to 42 years plus the time needed for successful reclamation.

Under Alternative G, total surface disturbance in the JIDPA would be 17,915 acres (12,588 and 5,327 acres for short-term and LOP disturbance, respectively) (58.7% of the JIDPA). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative G would be 18,198 acres, and 5,408 acres of disturbance would occur for the LOP (see Table 4.3). Under Alternative G, LOP disturbance to soils from would increase from that of the No Action Alternative of 4.6% to 17.5% of the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related activities. Potential new disturbance to this watershed under Alternative G could increase from that of the No Action Alternative of 4.2% to 35.2% of the watershed (see Tables 4.3 and 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative G would be 2,397 acres (10.5% of the watershed.

The SU05 soil map unit is anticipated to have approximately 12,039 acres of new disturbance. The SU03 unit could experience 5,822 acres of disturbance. The remaining 54 acres of new disturbance could occur in the SU07 soil map unit type.

4.1.7.10 BLM Preferred Alternative

Impacts to soils under the Preferred Alternative would be similar to those described for all other alternatives. Implementation of the Preferred Alternative would result in an estimated 8,316 acres of additional surface disturbance above that of the No Action Alternative, subsequently resulting in an assumed increase in soil impacts. Impact potential would increase as development occurs (for approximately 12 years); therefore, all surface disturbance would not be present at any one time.

Under the Preferred Action Alternative, total new surface disturbance in the JIDPA would be 12,242 acres. An additional 283 acres of initial disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, a total of 12,525 acres would be disturbed under this alternative (see Table 4.3). Approximately 69.2% (8,678 acres) of total disturbance would be short-term (i.e., reclaimed and reseeded as soon as practical after disturbance); the remaining 3,847 acres would be disturbed for the LOP. Under the Preferred Action Alternative, LOP disturbance to soils within the JIDPA would increase from the No Action Alternative of 4.6% to 12.6% of the JIDPA.

Impacts to soil resources resulting from surface disturbance under the Preferred Alternative would be less than those from the Proposed Action and Alternatives A, D, F, and G, where total disturbance is estimated at 20,409 acres, 20,409 acres, 15,790 acres, 14,655 acres, and 18,198 acres, respectively. Additionally, it is anticipated that impacts to soil resources resulting from surface disturbance under the Preferred Alternative would be greater than those from Alternatives B, C, and G, where new disturbance is estimated at 7,506 acres, 10,914 acres, and 10,595 acres, respectively.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to soil resources from project-related surface disturbance. Potential new disturbance to this watershed from the Preferred Alternative could increase from the No Action Alternative to 24.0% of the watershed (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from the Preferred Alternative would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,696 acres (7.4% of watershed) (see Tables 4.3 and 4.4).

Due to the variability and unknown locations for much of the proposed development disturbance, estimates of the types of soils most likely to be disturbed are based on the larger soil map units (see Map 3.6). Under this Alternative, it is anticipated that soil map unit SU05 would experience the greatest amount of disturbance--8,226 acres of new disturbance as a result of this alternative. The SU03 unit could experience 3,978 acres of disturbance. The remaining 38 acres of disturbance could occur in the SU07 soil map unit type.

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.1.7.11 Cumulative Impacts

The CIAA for soil resources is the 10 watersheds that drain the JIDPA, which encompass approximately 210,300 acres. Areas west of Big Sandy River, occurring within the Big Sandy River-Bull Draw watershed are included in the CIAA; however, no project impacts (cumulative or otherwise) would occur in this area. Approximately 1.6% of the CIAA (3,355 acres) has been disturbed by well pads, agricultural lands (i.e., hay meadows), reservoirs, pipelines, roads, and residential areas (i.e., ranches) (see Table 3.11). The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance (992 acres or 4.2% of the watershed), most of which is from existing natural gas development in the Jonah Field.

RFD (total surface disturbance) for the portion of the soil resources CIAA outside the JIDPA is estimated at 594 acres (see Table 4.3), primarily from gas-related development in the Pinedale Anticline Natural Gas Field. Approximately 38% (228 acres) of the RFD would occur in the

Expanded Sand Draw-Alkali Creek Watershed. RFD for the North Alkali Draw watershed is estimated at 168 acres, Southeast New Fork River is estimated at 126 acres, the Big Sandy River-Bull Draw is estimated at 54 acres, and Upper Eighteenmile Canyon is estimated at 18 acres. Maximum cumulative disturbance for the No Action Alternative (i.e., the combined existing and RFD disturbance) would be 6,753 acres (3.2%) in the combined watersheds. The maximum cumulative disturbance for the Proposed Action (i.e., the combined existing, proposed [Proposed Action and Alternative A], and RFD disturbance) would be 22,953 acres (10.9%) in the combined watersheds (see Table 4.3). Under Alternative B, maximum cumulative disturbance would be increased from the No Action to 10,050 acres, 4.8% of the combined watersheds. Under Alternatives C and D, maximum cumulative disturbance would be 13,458 acres and 18,334 acres or 6.3% and 8.7% of the CIAA, respectively. Under Alternative E, maximum cumulative disturbance would be 13,139 acres (6.2%). Under Alternative F, maximum cumulative disturbance would be 17,199 acres or 8.2% of the combined watersheds. Under Alternative G, maximum cumulative disturbance would be 20,742 acres or 9.9% of the combined watersheds. Under the Preferred Alternative, maximum cumulative disturbance would be 15,069 acres (7.2% of the combined watershed)--an increase of 8,316 acres above the No Action Alternative.

Maximum cumulative disturbance would be greatest in the combined watersheds that drain into the Green River, and disturbance would be greatest in the Expanded Sand Draw-Alkali Creek watershed (see Tables 4.3 and 4.4). Gas development would continue to be the primary component of this disturbance. Maximum cumulative disturbance as a result of the No Action Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 2,355 acres (10.3% of the watershed). Maximum cumulative disturbance as a result of the Proposed Action and Alternative A in the Expanded Sand Draw-Alkali Creek watershed is estimated at 9,612 acres (41.9% of the watershed). Maximum cumulative disturbance as a result of the Preferred Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 6,064 acres (26.4% of the watershed). Under other alternatives, maximum cumulative disturbance in the Expanded Sand Draw-Alkali Creek watershed is estimated to range from 3,805 acres (16.6%) under Alternative B to 8,617 acres (37.6%) under Alternative G. The Long Draw watershed that drains 16% of the JIDPA would experience the next greatest amount of cumulative disturbance. The closed basin watersheds--Jonah Gulch and 140401040603--would likely only experience a small percentage of cumulative disturbance to soils.

4.1.7.12 Unavoidable Adverse Impacts

Productivity of some disturbed soils would be reduced due to removal of vegetation, increased soil exposure, mixing of soil horizons, and increased susceptibility to wind and water erosion. Some increased soil loss through erosion would be unavoidable under all of the alternatives.

4.1.8 Surface Water and Ground Water

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with water resources:

- to maintain, improve, and/or protect surface and ground water quality;
- to maintain or improve channel stability and overall watershed conditions;

- to protect, maintain, or improve wetlands, floodplains, riparian areas, and other water resources;
- to conserve water and relate water resources and development to desired land use;
- to support and encourage water quality monitoring programs;
- to establish more watering systems on all grazing lands for livestock, wildlife, and game/non-game birds;
- to encourage strategies that utilize Wyoming's appropriated share of Colorado River waters for beneficial uses;
- to consider potential effects on surface and ground water quality/resources when land uses are planned or proposed, particularly near water courses and lakes;
- to ensure land uses and developments do not accelerate long-term ground water depletion; and
- to comply with water quality standards (e.g., salinity) set forth by the *Colorado River Basin Salinity Control Act*.

Impacts to surface or ground waters would be significant 1) if water quality declined (e.g., from sedimentation, accidental spills, or cross-aquifer mixing) such that existing WDEQ water quality classes (WDEQ 1990) would be downgraded; 2) if water quantities were depleted such that the water rights of ground water or downstream users would be violated; 3) if project-related erosion and runoff into intermittent drainages and subsequently into perennial waters altered the physical characteristics of these waters; 4) if project activities resulted in a violation of RMP objectives within or downstream of the JIDPA; and/or 5) if project activities resulted in a violation of Colorado river Water Quality standards for salinity (723 mg/L salinity below Hoover Dam [Colorado River Basin Salinity Control Forum 2002]).

There would be no depletion of surface waters associated with the project. With successful reclamation (including interim reclamation occurring during the LOP [Appendix G]) and the construction of sediment retention/catchment areas where needed, only minor amounts of project-related runoff sediments are anticipated to reach perennial surface waters. In the absence of successful reclamation and during periods of high runoff, significant sediment loads in runoff waters could potentially occur. No impacts to and/or from flooding are anticipated because areas adjacent to drainages would be avoided.

Potential impacts to surface and/or ground water resulting from the project include increased turbidity, salinity, and sedimentation of surface waters due to runoff and erosion from disturbed areas; accidental spills of petroleum products or other pollutants; discharge of unsuitable quality produced water and/or pipeline test water; and cross-aquifer mixing. Impacts to surface water from development generally would result from increased runoff from disturbed areas, and it is assumed that with increased surface disturbance acreage, there would be a corresponding decrease in water quality (increased sediment loads in runoff waters) and increased runoff rates. Since the sediment and salt loads are unknown under any project alternative, the BLM has determined that modeling will be performed to identify these volumes. The results of this modeling will be available in the Final EIS. Rates of wind and water erosion would increase above natural rates until successful reclamation of disturbed areas is achieved. Short-term control of surface runoff would be dependent on the success of reclamation and revegetation efforts described in site-specific reclamation plans, Surface Use Plans, or Plans of Development prepared for each APD and/or ROW application, and SWPPPs.

Concentrating development actions at larger well pads would have increased site-specific effects on overland flow patterns, ground water infiltration (reduced on compacted areas) and runoff volumes (increased rates and potential erosion and sedimentation). Additionally, if surface disturbance is concentrated in any one watershed, increased potential erosion and runoff-related effects may occur, possibly requiring the need for special treatments to be specified in APD approvals. Estimates of potential new initial and LOP disturbance associated with the Proposed Action and each of the alternatives within each project-affected watershed are presented in Tables 4.3 and 4.4 and discussed under each alternative. Development activities in the JIDPA such as roads and well pads could affect natural overland flow patterns and ground water infiltration. Compacted areas (e.g., roads and well pads) could reduce ground water infiltration and potentially could increase the erosive potential of runoff events by creating a shorter period of runoff and an increased volume of runoff water and contained sediments. While increased sedimentation and salinity volumes are unknown, potential impacts could occur if increases result in the loss of channel stability and a decrease in overall watershed condition. While proper design, construction, and maintenance of proposed facilities would reduce erosion potential, these actions may not entirely compensate for anticipated increased flows.

As noted in Section 3.1.6.2, ground water greater than approximately 2,300 ft below ground surface is relatively fresh, and the aquifer is extensive. Proposed ground water consumption of fresh water would result in the temporary partial depletion of this aquifer. An estimated maximum of 4.9 acre-ft of new ground water would be required to drill and complete each well (Table 4.5), and this water would be obtained from approximately 41 (25 existing, 16 new) water wells drilled to the top 600 ft of the aquifer.

Water wells pumping water out of an aquifer create a cone of depression, where ground water levels are lowered near the pumping wells. The ground water model MODFLOW was used to simulate the cone of depression created by pumping of all Proposed ground water from the existing 25 water wells and to determine the approximate time to full recovery of the aquifer after pumping stops (full recovery is defined as the point in time when drawdown is 1.6 ft or less) (HydroGeo, Inc. 2004). Three development rates were modeled: development of 75 wells per year over 41.3 years, 150 wells per year over 20.7 years, and 250 wells per year over 12.4 years (Table 4.5).

Ground water modeling results (Map 4.1) showed that the cone of depression would extend only about 1.0 mile beyond the boundary of the JIDPA, even for the most rapid rate of maximum development (250 wells per year over 12.4 years) and that drawdown would be no greater than about 10 ft in the JIDPA (HydroGeo, Inc. 2004). The results also showed that the aquifer would fully recover within 1 to 6 years following the cessation of pumping (Table 4.6). Outside the JIDPA, no notable impacts to surface or ground water would occur. Ground water quality would not be impacted as a result of freshwater pumping, since the freshwater aquifers from which proposed waters would be obtained appear to be isolated from deeper, poorer quality waters. None of the alternatives would result in significant aquifer drawdown, and this impact is not discussed further, except to note that rate of development would impact rate of aquifer recovery.

Table 4.5 Summary of Ground Water Pumping Scenarios (3,100 total wells), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Gas Wells/ Year	Water Need per Gas Well (acre-ft/yr)	Water Need for All Gas Wells (acre-ft/yr)	Length of Drilling Program (years)	Number of Pumping Water Wells	Water per Pumping Well (acre-ft/yr)	Water per Pumping Well (gpm)
75	4.9	367.5	41.3	25	14.7	9.1
150	4.9	735.0	20.7	25	29.4	18.2
250	4.9	1,225.0	12.4	25	49.0	30.4

Potential for contamination of the freshwater aquifer is low because the well drilling and casing practices used by the Operators and required by BLM and the WOGCC limit the potential for movement of any materials outside the well casing and across aquifers. Accidental contamination is possible but would be mitigated through a groundwater clean-up program, the scope of which would be determined by the EPA should a reportable incident occur (see Appendix G).

Gas wells are expected to produce 0.5-10.0 bbls of water per day, which would be disposed of as described in Appendix G. The brackish water aquifer(s) that is the source of the produced water is thought to be isolated from the freshwater aquifer described above; thus, water production is not likely to impact the quantity or quality of fresh ground water. Furthermore, because it apparently is isolated, production and disposal or reuse of this water for the project is not likely to impact surface water resources within or outside of the JIDPA.

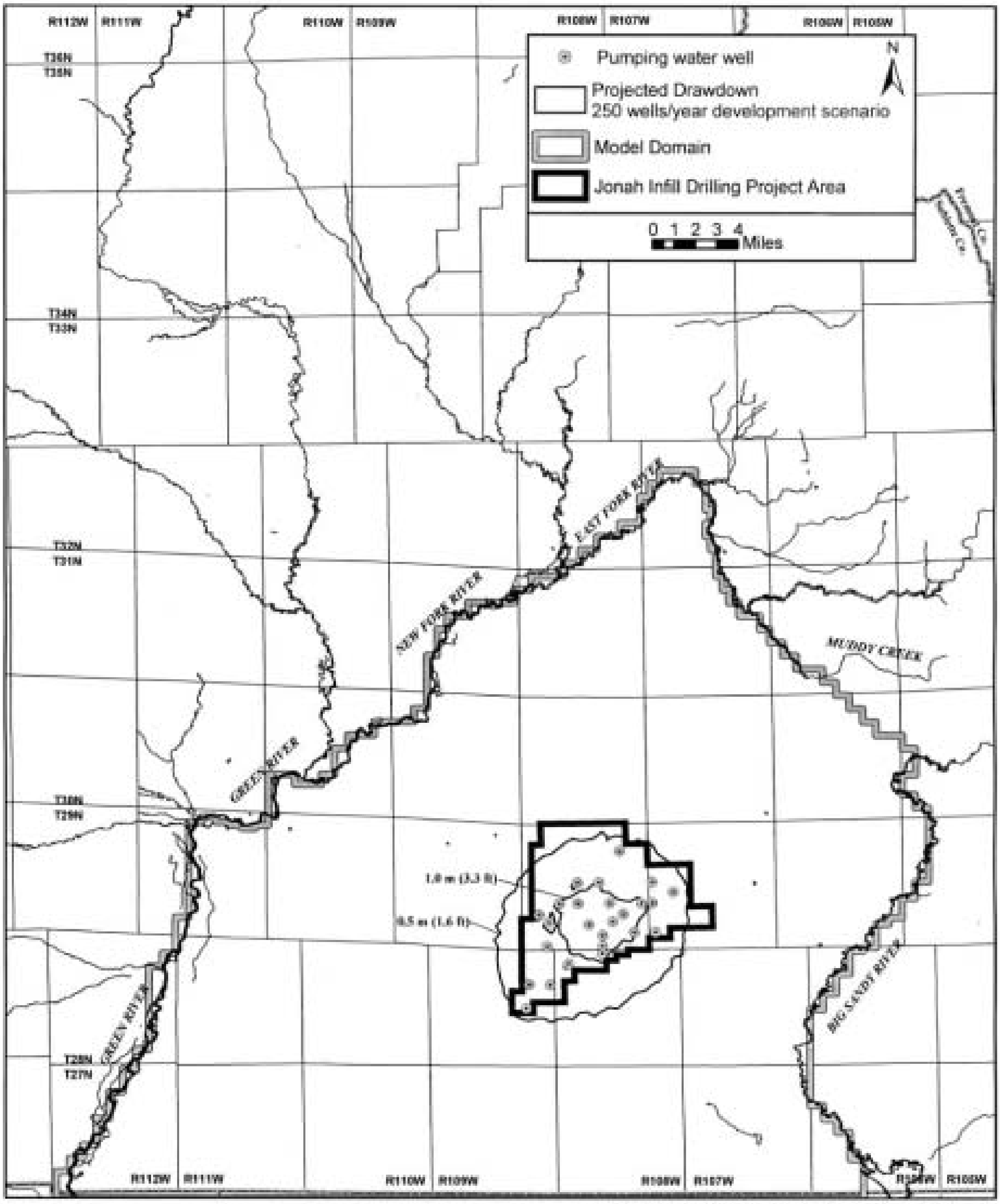
Hydrostatic pipeline testing water that does not meet applicable state and federal surface or ground water standards would not be released on the ground surface. This water may require treatment in a lined treatment pond prior to discharge or may be transported away from well locations to lined evaporation ponds or injector wells for disposal. All disposal and/or reuse of produced and test water would be in accordance with WDEQ rules and regulations and BLM *On-shore Oil and Gas Order No. 7*. Considerable volumes of produced water would be purified and reused for the project (see Appendix G).

Impacts to surface water resources could be significant under any project alternative. Under all alternatives, Operators would be required to implement management requirements and mitigation measures (see Appendices A and B); therefore, impacts to surface water also would be relative to the effectiveness of these additional requirements.

No significant impacts to ground water resources are anticipated under any alternative.

4.1.8.1 No Action Alternative

Under the No Action Alternative, there would be no additional activities that would potentially affect water resources other than those previously approved for the area (BLM 1998b, 2000b)--4,209 acres of new (short-term) and 1,409 acres of LOP disturbance (see Table 2.3) or 13.8% and 4.6% of the JIDPA, respectively. Some ephemeral drainages would remain prone to flooding



Map 4.1 Modeled Cone of Depression for Development of 250 Wells per Year Over 12.4 Years (3,100 total wells), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Table 4.6 Ground Water Recovery Time (3,100 wells), Jonah Infill Drilling Project, 2005.

No. Gas Wells/Year	Years of Pumping	Years to Full Recovery After Pumping Ends	Total Years to Full Recovery
75	41.3	0.5	41.8
150	20.7	4.0	24.7
250	12.4	6.0	18.4

after storm events, and their channels would continue to be subject to erosion at existing rates. The duration of impacts to surface water would be approximately 63 years (see Table 2.2) and until areas are adequately reclaimed. Further ground water pumping would not be conducted, and aquifers would begin recharging immediately. Prior decisions found that the existing project would be unlikely to significantly impact surface or ground water resources (BLM 1998b, 2000b).

4.1.8.2 The Proposed Action

A total of 4,209 acres of new (short-term) and 1,409 acres of LOP disturbance currently is approved in the JIDPA (see Table 4.3). The Proposed Action would result in an estimated additional 16,200 acres of new initial disturbance, for a total of 20,126 acres in the JIDPA (66.0% of the JIDPA) and an additional 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under the Proposed Action would be 20,409 acres (see Table 4.3). Approximately 70.4% (14,369 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would increase as development occurs (for approximately 13 years). The magnitude of surface disturbance would depend on the amount of disturbance present at any one time and the rate of reclamation. The remaining 6,040 acres would be disturbed for the LOP (approximately 76 years and until successful reclamation is achieved); thus, surface water impacts would last 13 years longer than under the No Action Alternative.

Estimates of potential new initial and LOP disturbance acreages associated with the Proposed Action and each of the alternatives within each project-affected watershed are presented in Tables 4.3 and 4.4. The Expanded Sand Draw-Alkali Creek watershed, which drains 45.0% of the JIDPA, would experience the greatest level of impacts to surface water resources from project-related activities. Potential new initial disturbance to this watershed from implementation of the Proposed Action could increase from that of the No Action Alternative to 39.5% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from the Proposed Action would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 2,682 acres (11.7% of the watershed).

Under the Proposed Action, types of impacts to ground water would be similar to those described for the No Action Alternative and, with effective mitigation, it is anticipated that the potential for adverse impacts also would be similar. However, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Under the Proposed Action Alternative, the duration of ground water impacts would be 13 years longer than under the No Action Alternative (i.e., the development phase [see Table 2.2]) plus 6 years required to recharge the aquifer (see Table 4.6).

4.1.8.3 Alternative A

Implementation of Alternative A is anticipated to result in the same types and volumes of water resource impacts as described for the Proposed Action (see Section 4.1.8.2 and Tables 4.3 and 4.4). However, since selected Operator-committed and BLM-required practices (e.g., avoidance of drainage buffers) would not be implemented, significant impacts are more likely to occur under this alternative. Because development of natural gas resources in these areas would not require the use of directional drilling, impacts to surface water resources, particularly sedimentation into Sand Draw, likely would be greater than under the Proposed Action. As with the Proposed Action, areas would not all be disturbed at the same time; rather, disturbance would accumulate as development occurs. Impacts to surface water would depend on the rate of development and would occur throughout the LOP (approximately 76 to 105 years and until successful reclamation is achieved); thus, impacts would last 13 to 42 years longer than under the No Action Alternative.

Implementation of Alternative A is anticipated to result in the same types of impacts to ground water as described for the No Action Alternative (see Tables 4.3 and 4.4); however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. The ground water aquifer recovery rate would depend on the rate of development. Because the rate of development may vary under Alternative A (i.e., 75, 150, or 250 wells developed/year), the duration of ground water impacts would range from 13 to 42 years longer than the No Action Alternative (i.e., the development period) plus up to 6 years required to recharge the aquifer (see Table 4.6).

4.1.8.4 Alternative B

Implementation of Alternative B would result in an estimated additional 3,297 acres of new initial disturbance above that of the No Action Alternative for a total of 7,223 acres in the JIDPA (23.7% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative B would be 7,506 acres (see Table 4.3). Approximately 65.1% (4,884 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 to 42 years). The remaining 2,622 acres would be disturbed for the LOP (approximately 76 to 105 years and until successful reclamation is achieved); thus, surface water impacts would last 13 to 42 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative B could increase from that of the No Action Alternative to 14.2% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative B would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,143 acres (5.0% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative B would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Because the rate of development may vary under Alternative B, the duration of ground water impacts would range from 13 to 42 years longer than the No Action Alternative (i.e., the development period) plus 1 to 6 years required to recharge the aquifer.

4.1.8.5 Alternative C

Implementation of Alternative C would result in an estimated additional 6,705 acres of new initial disturbance above that of the No Action Alternative, for a total of 10,631 acres in the JIDPA (34.9% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative C would be 10,914 acres (see Table 4.3). Approximately 68.9% (7,515 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 to 42 years). The remaining 3,399 acres would be disturbed for the LOP (i.e., approximately 68 to 80 years and until successful reclamation is achieved); thus, surface water impacts would last 5 to 17 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative C could increase from that of the No Action Alternative to 20.9% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative C would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,493 acres (6.5% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative C would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Because the rate of development may vary under Alternative C, the duration of ground water impacts would range from 5 to 17 years longer than the No Action Alternative (i.e., the development period) plus an undetermined number of years (<6) required to recharge the aquifer.

4.1.8.6 Alternative D

Implementation of Alternative D would result in an estimated additional 11,581 acres of new initial disturbance above that of the No Action Alternative, for a total of 15,507 acres in the JIDPA (50.8% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative D would be 15,790 acres (see Table 4.3). Approximately 69.9% (11,035 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 9 to 30 years). The remaining 4,755 acres would be disturbed for the LOP (i.e., approximately 72 to 93 years and until successful reclamation is achieved); thus, surface water impacts would last 9 to 30 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative D could increase from that of the No Action Alternative to 30.4% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative D would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 2,103 acres (9.2% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative D would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Because the rate of development may vary under Alternative D, the duration of ground water impacts would range from 9 to 30 years longer than the No Action Alternative (i.e., the development period) plus an undetermined number of years (<6) required to recharge the aquifer.

4.1.8.7 Alternative E

Implementation of Alternative E would result in an estimated additional 6,386 acres of new initial disturbance above that of the No Action Alternative, for a total of 10,312 acres in the JIDPA (33.8% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative E would be 10,595 acres (see Table 4.3). Approximately 66.0% (6,998 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 to 42 years). The remaining 3,597 acres would be disturbed for the LOP (i.e., approximately 76 to 105 years and until successful reclamation is achieved); thus, surface water impacts would last 13 to 42 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative E could increase from that of the No Action Alternative to 20.2% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative E would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,582 acres (6.9% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative E would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Because the rate of development may vary under Alternative E, the duration of ground water impacts would range from 13 to 42 years (i.e., the development period) longer than the No Action Alternative plus up to 6 years required to recharge the aquifer.

4.1.8.8 Alternative F

Implementation of Alternative F would result in an estimated additional 10,446 acres of new initial disturbance above that of the No Action Alternative, for a total of 14,372 acres in the JIDPA (47.1% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative F would be 14,655 acres (see Table 4.3). Approximately 72.7% (10,658 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 to 42 years). The remaining 3,997 acres would be disturbed for the LOP (i.e., approximately 76 to 105 years and until successful reclamation is achieved); thus, surface water impacts would last 13 to 42 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative F could increase from that of the No Action Alternative to 28.2% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative F would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,762 acres (7.7% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative F would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Slightly larger volumes of fresh water would be needed to drill directional wells than would be needed under the Proposed Action. Because the rate of development may vary under Alternative F, the duration of ground water impacts would range from 13 to 42 years (i.e., the development period) longer than the No Action Alternative plus up to 6 years required to recharge the aquifer.

4.1.8.9 Alternative G

Implementation of Alternative G would result in an estimated additional 13,989 acres of new initial disturbance above that of the No Action Alternative, for a total of 17,915 acres in the JIDPA (58.7% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative G would be 18,198 acres (see Table 4.3). Approximately 70.3% (12,790 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 to 42 years). The remaining 5,408 acres would be disturbed for the LOP (i.e., approximately 76 to 105 years and until successful reclamation is achieved); thus, surface water impacts would last 13 to 42 years longer than under the No Action Alternative, depending on the rate of development.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of Alternative G could increase from that of the No Action Alternative to 35.2% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from Alternative G would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 2,397 acres (10.5% of the watershed) (see Tables 4.3 and 4.4).

Implementation of Alternative G would result in the same types of impacts to ground water as the No Action Alternative; however, more fresh ground water would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Because the rate of development may vary under Alternative G, the duration of ground water impacts would range from 13 to 42 years (i.e., the development period) longer than the No Action Alternative plus up to 6 years required to recharge the aquifer.

4.1.8.10 BLM Preferred Alternative

Implementation of the Preferred Alternative would result in an estimated additional 8,316 acres of new initial disturbance above that of the No Action Alternative, for a total of 12,242 acres in the JIDPA (38.5% of the JIDPA) and 283 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under the Preferred Alternative would be 12,525 acres (see

Table 4.3). Approximately 69.2% (8,678 acres) of this disturbance would be reclaimed as soon as practical after disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 years). The remaining 3,847 acres would be disturbed for the LOP (i.e., approximately 76 years and until successful reclamation is achieved); thus, surface water impacts would last 13 years longer than under the No Action Alternative.

Impacts to surface water resources under the Preferred Alternative would be similar to those described under the Proposed Action and the other alternatives; however, impacts are expected to be proportional the amount of new initial surface disturbance. Potential impacts to surface water from the Preferred Alternative (12,525 acres of new initial disturbance) would likely be less than the Proposed Action and Alternatives A, D, F, and G, where initial disturbance is estimated at 20,409 acres, 20,409 acres, 15,790 acres, 14,655 acres, and 18,198 acres, respectively. Additionally, it is anticipated that potential impacts to surface water under the Preferred Alternative would be greater than impacts to surface water resources as a result of Alternatives B, C, and G, where new disturbance is estimated at 7,506 acres, 10,914 acres, and 10,595 acres, respectively. Impacts are anticipated to be greatest in areas developed with the highest well pad densities (i.e., 48 wells/section).

The Expanded Sand Draw-Alkali Creek watershed would likely experience the greatest level of impacts to surface water resources from project-related activities. Potential new disturbance to this watershed from implementation of the Preferred Alternative could increase from that of the No Action Alternative to 24.0% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from the Preferred Alternative would increase from 607 acres or 2.6% of the watershed (under the No Action Alternative) to 1,695 acres (7.4% of the watershed) (see Tables 4.3 and 4.4).

Implementation of the Preferred Alternative would result in the same types of impacts to ground water as the No Action Alternative. Larger volumes of fresh water would be needed to drill directional wells and more wells would be drilled, so ground water consumption would be greater than for the No Action Alternative and comparable to the Proposed Action and Alternatives A, B, E, F, and G (all with up to 3,100 new wells). Alternatives C and D (1,250 and 2,200 new wells, respectively) would result in less ground water consumption than the Preferred Alternative because fewer wells would be drilled. The duration of ground water impacts would be 13 years (i.e., the development period) longer than the No Action Alternative plus 6 years required to recharge the aquifer.

Under the Preferred Alternative additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.1.8.11 Cumulative Impacts

The CIAA for surface water resources is the 10 watersheds that drain the JIDPA, which encompass approximately 210,300 acres. The overall stability of these watersheds is not anticipated to be significantly affected within the CIAA under any project alternative. Areas west of Big Sandy-occurring within the Bull Draw watershed are included in the CIAA; however, no project impacts would occur in this area. This is the same CIAA for soils and vegetation. Approximately 1.6% of the CIAA (3,355 acres) has been disturbed by well pads, agricultural lands (i.e., hay meadows), reservoirs, pipelines, roads, and residential areas (i.e., ranches) (see

Table 3.11). The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance (992 acres or 4.2% of the watershed), most of which is from existing natural gas development in the Jonah Field.

RFD for the portion of the surface water CIAA outside the JIDPA is estimated at 594 acres, primarily from gas-related development in the Pinedale Anticline Natural Gas Field (see Table 4.3). Approximately 38% (228 acres) of the RFD would occur in the Expanded Sand Draw-Alkali Creek watershed. RFD for the North Alkali Draw watershed is estimated at 168 acres; for the Southeast New Fork River-Blue Rim watershed it is estimated at 126 acres; for the Big Sandy River-Bull Draw watershed it is estimated at 54 acres; and for the Upper Eighteenmile Canyon watershed it is estimated at 18 acres.

Maximum cumulative disturbance for each alternative (i.e., the combined existing, alternative-specific, and RFD disturbance) is shown in Table 4.3. Cumulative impacts would be as described for all alternatives, but increased in volume and duration.

Maximum cumulative disturbance would be greatest in the combined watersheds that drain into the Green River, and disturbance would be greatest in the Expanded Sand Draw-Alkali Creek watershed (see Tables 4.3 and 4.4). Gas development would continue to be the primary component of the disturbance. Maximum cumulative disturbance as a result of the No Action Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 2,355 acres (10.3% of the watershed). Maximum cumulative disturbance as a result of the Proposed Action and Alternative A in the Expanded Sand Draw-Alkali Creek watershed is estimated at 9,612 acres (41.9% of the watershed). Maximum cumulative disturbance as a result of the Preferred Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 6,064 acres (26.4% of the watershed). Under the other alternatives, maximum cumulative disturbance in the Expanded Sand Draw-Alkali Creek watershed is estimated to range from 3,805 acres (16.6%) under Alternative B to 8,617 acres (37.6%) under Alternative G. The Long Draw watershed that drains 16.5% of the JIDPA would experience the next greatest amount of cumulative disturbance. The closed basin watersheds--Jonah Gulch and 140401040603--would likely only experience a small percentage of cumulative disturbance to surface waters.

The CIAA for ground water includes the JIDPA and adjacent drawdown areas (see Map 4.1). Since no actions other than those proposed for this project are anticipated in the area, cumulative impacts to ground water would be of the same type and extent as those described for the No Action and action alternatives.

4.1.8.12 Unavoidable Adverse Impacts

There would be an unavoidable increase in surface disturbance in watersheds within the JIDPA for the LOP that could reduce water quality in ephemeral drainages during runoff events.

Project development would require a maximum of approximately 15,200 acre-ft of fresh water from shallow ground water aquifers.

4.1.9 Noise and Odor

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) do not specify any management goals/objectives specifically associated with noise and odor. However, the BLM's general goal of preserving and maintaining the quality of the environment while coordinating multiple use objectives remains applicable for noise and odor.

Impacts from noise and odor would be considered significant if they resulted in displacement of area residents, the loss of important wildlife features (e.g., greater sage-grouse leks, raptor nests, pronghorn migration corridors), and/or if BLM’s goals of preserving and maintaining the quality of the environment could not be met.

Additional noise sources above and beyond current levels (i.e., the No Action Alternative) would include scraping, grading, and construction of new well pads; drilling, completion, and operation of new wells; Burma Road upgrade activities and associated increases in traffic; construction, maintenance, and traffic associated with new resource roads, gathering pipelines and collector/resource roads; construction/upgrade of ancillary facilities (i.e., water disposal, storage, and compressor station facilities); and exploration activities. Additional odor sources would be associated primarily with wells and exhaust from increased vehicular traffic.

Drilling and flaring operations would produce temporary noise levels of up to 115 dBA at the source, with noise levels of 55 dBA at 3,500 ft from the source (see Section 3.1.7). These activities are expected to be the loudest proposed noise-producing operations and would continue 24 hrs/day at well sites during development periods (see Appendix G). Increased noise levels associated with construction equipment (e.g., scrapers, dozers, trucks, graders, loaders) are expected to be between 70 and 90 dBA at about 50 ft from the source and would attenuate at a rate of approximately 6 dBA with each doubling of distance from the source (Table 4.7). Noise levels associated with production at each well pad would be minimal because no pumping is required. Noise levels associated with compressor stations (between 64 and 86 dBA at compressor stations, between 58 and 75 dBA at approximately 1.0 mile away) would continue at current levels for the LOP. Further noise level data are provided in Section 3.1.7, Figure 3.13, and Table 3.15.

Project noise may be heard 20 or more miles from the area, and although this noise would be barely audible at such distance, it could affect resident and recreating visitor perceptions of solitude. Some area residents have indicated that project noise (especially at night) is pervasive and disruptive and does affect their quality of life.

Under most weather conditions, it is anticipated that project odors would disperse rapidly and would not affect area users greater than 1.0 mile from sources; however, during temperature inversions and at other windless times, odors could be detected at distances greater than 1.0 mile from the JIDPA. This impact would be considered significant and could occur under all project alternatives.

Table 4.7 Estimated Noise Attenuation with Distance from Construction Equipment, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Distance from Source (ft)				
50	100	200	400	800
70 (busy traffic)	64 (conversation)	58 (conversation)	52 (quiet)	46 (library)
90 (endangers hearing)	84 (noisy, factory)	78 (noisy, factory)	72 (busy traffic)	66 (busy traffic, conversation)

It is likely that noise already has contributed to the apparent decrease in wildlife use on and adjacent to the JIDPA (see Section 4.2.2), with observed decreases in raptor nesting activity and productivity, male greater sage-grouse lek attendance and sage-grouse nesting within the JIDPA having been reported over the past several years (TRC Mariah 1999, 2001a, 2001b, 2002, 2004a). Data also suggest that noise may contribute to disturbance and/or departure of greater sage-grouse from area leks (TRC Mariah 2001d, 2003a).

Although project-related noise and odor are not anticipated to pose a human health hazard to persons in the area, they likely would be noticeable to recreationists and other visitors on and in the vicinity of the JIDPA (see Section 4.5.3) and might cause decreased use or diminished enjoyment of the area.

Significant impacts from noise and odor are anticipated within the JIDPA and vicinity under all alternatives.

4.1.9.1 No Action Alternative

Under the No Action Alternative, impacts due to noise and odor would be as identified and approved for existing Jonah Field developments (see Section 3.1.7). Prior decisions found existing project noise and odor impacts to be less than significant (BLM 1998b, 2000b). However, monitoring data collected since those decisions were made indicate that noise associated with existing activities may be contributing to documented decreases in wildlife use on and adjacent to the JIDPA (i.e., may be significant) (TRC Mariah 1999, 2001a, 2001b, 2001d, 2002, 2003a, 2004a).

Once all approved wells are drilled and developed, noise levels would be limited to those needed for production (primarily traffic), compressor stations, and reclamation (farm equipment), and would continue for an estimated 63 years and until all reclamation activities are completed.

4.1.9.2 The Proposed Action

Under the Proposed Action, the nature of impacts due to noise and odor would be similar to those of the No Action Alternative, but levels would be substantially increased as a result of the new wells, well pads, and other proposed project facilities. Increased noise levels associated with construction of new well pads; drilling and completion of new wells; upgrade and/or construction of roads; and other project construction activities would be short-term at any given location but would continue throughout the field development period--12 to 13 years. Noise levels from field traffic and well maintenance actions (which might include some flaring) would occur for an estimated 76 years and until all reclamation activities are completed (i.e., 13 years longer than the No Action Alternative).

Odors present periodically at well and ancillary facility locations and along roadways could offend area users in the vicinity of emission sources. However, odors would be dispersed by wind and are not anticipated to adversely affect the majority of area users.

4.1.9.3 Alternative A

Under Alternative A, noise and odor levels would be similar to those of the Proposed Action. However, potential noise-related impacts to wildlife would be amplified in areas that would have been avoided under the Proposed Action (i.e., greater sage-grouse lek and raptor nest buffers [see Section 4.2.2]), increasing the potential for significant impacts. Odor impacts would be the same as described for the Proposed Action. Since the rate of development may vary under Alternative A (i.e., 75, 150, or 250 wells developed/year), the noise and odor impacts would occur for an estimated 76 to 105 years and until all reclamation activities are completed (i.e., 13 to 42 years longer than under the No Action Alternative).

4.1.9.4 Alternative B

Impacts due to noise and odor under Alternative B would be similar to those described for the Proposed Action except that elevated noise levels during development would be concentrated at the existing 497 wells pads and noise associated with construction of new well pads would not occur. Use of directional drilling would increase the site-specific (per well pad) duration of the noise impacts due to the additional time necessary to drill directional wells and the increased number of wells drilled per pad. Duration of field-wide impacts would be dependent upon the rate of development (76 to 105 years plus the time required to complete reclamation activities, or 13 to 42 years longer than under the No Action Alternative).

4.1.9.5 Alternative C

Under Alternative C, impacts due to increased noise levels and odor would be substantially higher than those for the No Action Alternative but lower than those described for the Proposed Action because 60% fewer well pads would be constructed and 60% fewer wells would be drilled. The duration of elevated noise levels associated with drilling would last from 5 to 17 years depending on the rate of development. Impacts due to odors also would be commensurately reduced from the Proposed Action because fewer wells would be drilled. Duration of field-wide noise and odor impacts would be dependent upon the rate of development (68 to 80 years plus the time required to complete reclamation activities, or 5 to 17 years longer than under the No Action Alternative).

4.1.9.6 Alternative D

Under Alternative D, impacts due to increased noise and odor levels would be substantially higher than those under the No Action Alternative but lower than those under the Proposed

Action because 29% fewer well pads would be constructed and 29% fewer wells would be drilled. The duration of elevated noise levels associated with drilling would last from 12 to 29 years depending on the rate of development. Impacts due to odors also would be commensurately reduced because fewer wells would be drilled. Duration of field-wide noise and odor impacts would be dependent upon the rate of development (72 to 93 years plus the time required to complete reclamation activities, or 9 to 30 years longer than under the No Action Alternative).

4.1.9.7 Alternative E

Impacts due to noise under Alternative E would be substantially higher than those described for the No Action Alternative but lower than those described for the Proposed Action, because elevated noise and odor levels during development would be concentrated at the 497 existing well pads and at 266 new well pads. Use of directional drilling would increase the site-specific (per well pad) duration of the noise impacts due to the additional time necessary to drill directional wells, as well as the increased number of wells per pad. Duration of the field-wide noise and odor impacts would be dependent on the rate of development (76 to 105 years plus the time required to complete reclamation activities, or 13 to 42 years longer than under the No Action Alternative).

4.1.9.8 Alternative F

Impacts due to noise and odor under Alternative F would be substantially higher than those described for the No Action Alternative but slightly lower than those under the Proposed Action because elevated noise and odor levels during development would be concentrated at the existing 497 well pads and at 1,028 new well pads. Use of directional drilling would increase the site-specific (per well pad) duration of the noise impacts due to the additional time necessary to drill directional wells, as well as the increased number of wells per pad. Duration of field-wide noise and odor impacts would be dependent on the rate of development (76 to 105 years plus the time required to complete reclamation work, or 13 to 42 years longer than under the No Action Alternative).

4.1.9.9 Alternative G

Impacts due to noise and odor under Alternative G would be substantially higher than those described under the No Action Alternative but lower than described for the Proposed Action because elevated noise and odor levels would be concentrated at the existing 497 well pads and at 2,553 new well pads. Use of directional drilling would increase the site-specific (per well pad) duration of the noise impacts due to the additional time necessary to drill directional wells, as well as the increased number of wells per pad. Duration of field-wide noise and odor impacts would be dependent on the rate of development (76 to 105 years plus the time required to complete reclamation work, or 13 to 42 years longer than under the No Action Alternative).

4.1.9.10 BLM Preferred Alternative

Impacts due to noise and odor under the Preferred Alternative would be substantially higher than those described under the No Action Alternative but lower than described for other action alternatives because this alternative requires implementation of additional mitigation and monitoring measures/management requirements (see Section 2.14). Implementation of these measures would decrease noise and odor impacts from those described for other action alternatives but impacts associated with noise would still be considered significant within the JIDPA.

Duration of field-wide noise and odor impacts would be dependent on the rate of development (76 years plus the time required to complete reclamation work, or 13 years longer than under the No Action Alternative).

4.1.9.11 Cumulative Impacts

The CIAA area for noise includes the JIDPA plus a 20-mile buffer, whereas the CIAA for odor is the JIDPA and a 2.0-mile buffer. Odors would not likely be detected more than 1.0 mile from the JIDPA and, in most cases, would be confined to the JIDPA because of dispersion. Noise impacts from the project in combination with other existing and proposed noises (most notably those from development in the Pinedale Anticline area) may be heard throughout the CIAA for the LOP. These noise levels could affect the use of some habitat features proximal to the JIDPA by wildlife (see Section 4.2.2) and may affect some recreationists and other visitors through a reduction in the perceived quality of experience throughout the CIAA. In no instance is it anticipated that cumulative noise levels would pose a human health hazard. As with the project alternatives, significant impacts associated with noise and odor are possible and would vary across alternatives depending upon the pace and extent of development. Cumulative impacts are anticipated to be greatest under the Proposed Action and Alternative A and least under the No Action Alternative.

4.1.9.12 Unavoidable Adverse Impacts

All of the action alternatives would result in some additional noise and odors within the JIDPA and in surrounding areas.

4.2 BIOLOGICAL RESOURCES

4.2.1 Vegetation

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with vegetation:

- to maintain or enhance vegetation community health, composition, and diversity to meet watershed, wild horse, and wildlife resource management objectives,
- to provide for plant diversity (desired plant communities) to meet livestock management, watershed, wild horse, and wildlife objectives, and
- to reduce the number and spread of invasive species.

Impacts to plant communities (including wetlands) would be significant if there was a long-term reduction in vegetation productivity, a permanent change in species composition, an increase in invasive non-native species (including noxious weeds), a net loss of wetlands, or a vegetation loss that resulted in a violation of BLM RMP or other land use plan objectives within or outside the JIDPA. Impacts to vegetation and wetland resources are assumed to be proportional to the amount of new initial surface disturbance for all alternatives (i.e., increased surface disturbance would result in a corresponding increase to vegetation impacts).

Impacts to wetlands, waters of the U.S. and riparian areas would be significant if there would be a violation of Section 404 of the *Clean Water Act* or *EOs* 11988 or 11990 and/or if BLM RMP or other land use planning objectives could not be achieved. Since these areas would generally be avoided, there are no perennial streams on the JIDPA, and the project would be developed in compliance with the *Clean Water Act*, no significant impacts to wetlands, waters of the U.S, or riparian areas are anticipated under any alternative.

At the end of the LOP, most, if not all, disturbed areas including roads would be reclaimed and revegetated; however, BLM system roads (e.g., Burma and Luman Roads) would likely remain in an upgraded status.

All potentially disturbed vegetation types are common throughout the JIDPA and on surrounding lands. No uncommon or unique vegetation types would be removed by the project. The estimated disturbance volumes to each of the vegetation type in the JIDPA are provided in Table 4.8.

Impacts associated with the removal of vegetation include loss of wildlife habitat, a reduction in vegetation diversity, potential for increased soil erosion, potential invasion of undesirable plant species (non-native and/or noxious), and loss of livestock forage. Because it would take many years for reclaimed areas to develop the structure and function of self-sustaining vegetation communities (i.e., sagebrush), impacts would persist for an undetermined number of years following reclamation. Reclaimed areas would produce less forage for several years until revegetation is successful, at which time grasses and possibly forbs would likely become more dominant than the existing condition, providing increased forage for some wildlife and livestock (see Section 4.5.2). Shrubs may take 30 to 100 years or longer to reach predisturbance productivity levels and wildlife habitat structures (see also Section 4.2.2). The duration of impacts to vegetation communities would depend on the rate of development (i.e., 75, 150, or 250 wells per year) and the duration of time needed for reclaimed area to reach pre-disturbance conditions.

The following analyses show that the project under all alternatives is generally compatible with BLM management goals/objectives; however, significant impacts are anticipated to vegetation in the JIDPA through loss of habitat, forage, and soil protection, and increased potential for invasive, non-native species invasion under any alternative. For the PFO and RSFO areas as a whole, these significant impacts would not affect BLM's capability to manage vegetation resources pursuant to RMP objectives field-wide. Under all alternatives, specific management requirements and mitigation measures would be implemented; therefore, impacts to vegetation would also be relative to the effectiveness of these additional measures.

4.2.1.1 No Action Alternative

Under the No Action Alternative, there would be no additional activities that would potentially affect vegetation resources other than those previously approved for the area--4,209 acres of new (short-term) and 1,409 acres of LOP disturbance or 13.8% and 4.6% of the JIDPA, respectively. The duration of impacts would be approximately 63 years and until areas are adequately reclaimed. Prior decisions found that the existing project would not be likely to significantly impact vegetation resources (BLM 1998b, 2000b) (see also Section 3.2.1).

4.2.1.2 The Proposed Action

The Proposed Action would result in an estimated increase of 16,200 acres of new initial disturbance. Therefore, total disturbance under the Proposed Action, including existing

Table 4.8 Vegetation Type Disturbance Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Alternative and Disturbance Type	Dense sagebrush	Moderate Density Sagebrush	Scattered/No Sagebrush	Basin Big Sagebrush	Unknown Type (Unmapped Area)	Total (Acres of New Disturbance)
No Action						
New Initial	3,671	375	112	7	44	4,209
LOP	1,229	126	37	2	15	1,409
Proposed Action and Alternative A						
New Initial	14,129	1,445	431	25	170	16,200
LOP	4,039	413	123	7	49	4,631
Alternative B						
New Initial	2,876	294	88	4	35	3,297
LOP	1,058	108	32	2	13	1,213
Alternative C						
New Initial	5,848	598	178	11	70	6,705
LOP	1,736	178	53	2	21	1,990
Alternative D						
New Initial	10,101	1,033	308	17	122	11,581
LOP	2,918	299	89	5	35	3,346
Alternative E						
New Initial	5,570	570	170	9	67	6,386
LOP	1,908	195	58	4	23	2,188
Alternative F						
New Initial	9,111	932	278	15	110	10,446
LOP	2,257	231	69	4	27	2,588
Alternative G						
New Initial	12,201	1,248	372	21	147	13,989
LOP	3,448	357	106	6	42	3,999
Preferred Alternative						
New Initial	7,253	742	221	13	87	8,316
LOP	2,127	218	65	3	25	2,436
Total Acreage in JIDPA	26,601	2,721	811	47	320	30,500

disturbance, would be 20,409 acres (see Table 4.3). Of these 20,409 acres, 14,369 acres (70.4%) would be reclaimed and revegetated as soon as possible after disturbance. Not all disturbance would occur at one time but would accumulate as development occurs (for approximately 12 years). The magnitude of surface disturbance would depend on how much disturbance is present at any one time, as well as the rate of reclamation. Approximately 6,040 acres of vegetation would be removed for the LOP (i.e., 76 years and until adequate reclamation is achieved).

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to vegetation resources from project-related activities. Potential new disturbance to this watershed from the Proposed Action could increase from the existing 4.2% to 39.5% (see Table 4.4). Estimated LOP disturbance to the Expanded Sand Draw-Alkali Creek watershed from the Proposed Action could increase to 2,682 acres (11.7% of the watershed).

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands, waters of the U.S, and/or riparian areas would occur as a result of increased sediment deposition in these areas.

4.2.1.3 Alternative A

Implementation of Alternative A is anticipated to result in the same types and volumes of vegetation impacts as the Proposed Action Alternative and would result in an increase in vegetation impacts from the No Action Alternative. However, under this Alternative, selected Operator-committed and BLM-required practices would not be implemented (i.e., avoidance of various buffers); therefore, impacts to vegetation, including wetlands, and waters of the U.S. particularly in the Sand Draw area would likely be greater than under the Proposed Action. Depending upon the rate of development (i.e., 75, 150, or 250 wells developed per year), the duration of vegetation impacts could be extended by an additional 42 years from that of the No Action Alternative (75 wells/year).

4.2.1.4 Alternative B

Implementation of Alternative B would result in an increase of 3,297 acres of new surface disturbance from that of the No Action Alternative, thereby increasing the potential of impacts to vegetation. There would be a total of 7,506 acres new disturbance (4,884 and 2,622 acres of short-term and LOP disturbance, respectively) under Alternative B. Approximately 65% (4,879 acres) of this disturbance would be reclaimed and reseeded as soon as practical after disturbance. An estimated 2,622 acres of total LOP disturbance, of which 2,541 acres would occur in the JIDPA, would be required for Alternative B. LOP disturbance to vegetation from this Alternative would increase from the No Action Alternative to 8.3% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively. Depending upon the rate of development (i.e., 75, 150, or 250 wells developed per year), the duration of vegetation impacts could be extended by an additional 42 years from that of the No Action Alternative (75 wells/year).

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands, and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.5 Alternative C

Implementation of Alternative C would result in an increase of 6,705 acres of new surface disturbance from that of the No Action Alternative, thereby increasing potential impacts to vegetation resources. The duration of impacts to vegetation would depend on the rate of development, and the rate of reclamation, which could be from 68 years (250 wells/year) to 80 years (75 wells/year) plus the time needed for successful reclamation.

Under Alternative C, total new surface disturbance in the JIDPA would be 10,631 acres (7,313 acres and 3,318 acres for short-term and LOP disturbance, respectively). An additional 283 acres of new disturbance (81 acres for the LOP) would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative C would be 10,914 acres (see Table 4.3). Approximately 69% (7,515 acres) of this disturbance would be reclaimed and reseeded as soon as practical after disturbance; the remaining 3,399 acres would be disturbed for the LOP. LOP disturbance to vegetation from this alternative would increase from the No Action Alternative to 10.9% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively.

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.6 Alternative D

Implementation of Alternative D would result in an increase of 11,581 acres of new surface disturbance from that of the No Action Alternative, thereby increasing impacts to vegetation resources. Surface disturbance would accumulate as development occurs from 12 to 29 years. The duration of impacts to vegetation would depend on the rate of development and the rate of reclamation, which could be from 72 years (250 wells/year) to 93 years (75 wells/year) plus the time needed for successful reclamation.

Under Alternative D, total new surface disturbance in the JIDPA would be 15,507 acres (10,833 acres and 4,674 acres for short-term and LOP disturbance, respectively). An additional 283 acres of new initial disturbance (81 acres for the LOP) would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under this Alternative would be 15,790 acres (see Table 4.3). Approximately 70% (11,035 acres) of total disturbance would be short-term (i.e., reclaimed and reseeded as soon as practical after disturbance); the remaining 4,755 acres would be disturbed for the LOP. LOP disturbance to vegetation from Alternative D would increase from the No Action Alternative to 15.3% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively.

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands, waters of the U.S, and/or riparian areas would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.7 Alternative E

Implementation of Alternative E would result in an increase of 6,386 acres of new surface disturbance from that of the No Action Alternative, thereby increasing impacts to vegetation as more well pads (estimated at 266 new well pads) and roads would be constructed. Surface disturbance would accumulate as development occurs from 12 to 42 years. The duration of impacts to vegetation would depend on the rate of development and the rate of reclamation, which could be from 76 years (250 wells/year) to 105 years (75 wells/year) plus the time needed for successful reclamation.

Under Alternative E, total surface disturbance in the JIDPA would be 10,312 acres (6,796 acres and 3,516 acres for short-term and LOP disturbance, respectively). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative E would be 10,595 acres (see Table 4.3). LOP disturbance to vegetation from Alternative E would increase from the No Action Alternative to 11.5% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively.
Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.8 Alternative F

Implementation of Alternative F would result in an increase of 10,446 acres of new surface disturbance from that of the No Action Alternative; thereby increasing impacts to vegetation as more well pads (estimated at 1,028 new pads) and roads would be built. Surface disturbance would accumulate as development occurs from 12 to 42 years. The duration of impacts to vegetation would depend on the rate of development and the rate of reclamation, which could be from 76 years (250 wells/year) to 105 years (75 wells/year) plus the time needed for successful reclamation.

Under Alternative F, total surface disturbance in the JIDPA would be 14,372 acres (10,456 acres and 3,916 acres for short-term and LOP disturbance, respectively). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative F would be 14,655 acres (see Table 4.3). LOP disturbance to vegetation from Alternative F would increase from the No Action Alternative to 12.8% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively.

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.9 Alternative G

Implementation of Alternative G would result in an increase of 13,989 acres of new surface disturbance from that of the No Action Alternative; thereby increasing impacts to vegetation since more well pads (estimated at 2,553 new pads) and roads would be built. Surface disturbance would accumulate as development occurs from 12 to 42 years. The duration of impacts to vegetation would depend on the rate of development and rate of reclamation, which could be from 76 years (250 wells/year) to 105 years (75 wells/year) plus the time needed for successful reclamation.

Under Alternative G, total surface disturbance in the JIDPA would be 17,915 acres (12,588 acres and 5,327 acres for short-term and LOP disturbance, respectively). An additional 283 acres of new disturbance and 81 acres LOP disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under Alternative G would be 18,198 acres (see Table 4.3). LOP disturbance to vegetation from Alternative G would increase from the No Action Alternative to 17.5% of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.3 and 4.4, respectively.

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

4.2.1.10 BLM Preferred Alternative

Implementation of the Preferred Alternative would result an increase of an estimated 8,316 acres of surface disturbance from that of the No Action Alternative, resulting in an assumed increase in vegetation impacts. Surface disturbance would accumulate as development occurs (for approximately 12 years).

Under the Preferred Alternative, total new initial surface disturbance in the JIDPA would be 12,242 acres. An additional 283 acres of initial disturbance would be required for ancillary facilities that may be constructed outside the JIDPA; therefore, total new disturbance under this Alternative would be 12,525 acres (see Table 4.3). Approximately 69.2% (8,678 acres) of total disturbance would be short-term (i.e., reclaimed and reseeded as soon as practical after disturbance); the remaining 3,847 acres would be disturbed for the LOP. New initial disturbance to vegetation in the JIDPA under this Alternative would increase from No Action to 12,242 acres (40.1% of the JIDPA). LOP disturbance to vegetation from the Preferred Alternative would increase from the No Action Alternative to 12.6 % of the JIDPA.

Habitat suitable to the invasion of noxious weeds and other undesirable plant species would be created as a result of removal of existing vegetation.

Direct impacts to wetlands and waters of the U.S. would occur temporarily only as a result of road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 ft of wetlands or open water or within 100 ft of ephemeral or intermittent channels. Indirect impacts to wetlands and waters of the U.S. would occur as a result of increased sediment deposition in these areas.

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.2.1.11 Cumulative Impacts

The CIAA for vegetation including wetlands and waters of the U.S. are the 10 watersheds that drain the JIDPA which encompass approximately 210,300 acres. Areas west of Big Sandy River occurring within the Big Sandy River-Bull Draw watershed are included in the CIAA; however, no project impacts would occur in this area. Approximately 1.6% of the CIAA (3,355 acres) has had native vegetation removed primarily as a result of well pads, agricultural lands (i.e., hay meadows), reservoirs, pipelines, roads, and residential areas (i.e., ranches). The Expanded Sand Draw-Alkali Creek watershed has the largest amount of existing disturbance, of which most is from existing natural gas development in the Jonah Natural Gas Field.

RFD (vegetation disturbance) for the portion of the vegetation CIAA outside the JIDPA is estimated at 594 acres (see Table 4.3), primarily from gas-related development in the Pinedale Anticline Natural Gas Field. Approximately 38% (228 acres) of the RFD would occur in the Expanded Sand Draw-Alkali Creek Watershed. RFD for the North Alkali Draw watershed is estimated at 168 acres; for the Southeast New Fork River is estimated at 126 acres; for the Big Sandy River-Bull Draw is estimated at 54 acres; and for the Upper Eighteenmile Canyon is estimated at 18 acres.

Maximum cumulative disturbance for the No Action Alternative (i.e., the combined existing and RFD disturbance) would be 6,753 acres (3.2%) in the combined watersheds (see Table 4.3). The maximum cumulative disturbance for the Proposed Action (i.e., the combined existing, proposed

[Proposed Action and Alternative A], and RFD disturbance) would be 22,953 acres (10.9%) in the combined watersheds (see Table 4.3). Under Alternative B, maximum cumulative disturbance would be increased from the No Action to 10,050 acres, 4.8% of the combined watersheds. Under Alternatives C and D, maximum cumulative disturbance would be 13,458 acres and 18,334 acres or 6.3% and 8.7% of the CIAA, respectively. Under Alternative E, maximum cumulative disturbance would be 13,139 acres (6.2%). Under Alternative F, maximum cumulative disturbance would be 17,199 acres or 8.2% of the combined watersheds. Under Alternative G, maximum cumulative disturbance would be 20,742 acres or 9.9% of the combined watersheds. Under the Preferred Alternative, maximum cumulative disturbance would be 15,069 acres (7.2% of the combined watershed), an increase of 8,316 acres above the No Action Alternative.

Maximum cumulative disturbance would be greatest in the combined watersheds that drain into the Green River, and disturbance would be greatest in the Expanded Sand Draw-Alkali Creek watershed (see Tables 4.3 and 4.4).

The Wyoming sagebrush vegetation type, the primary vegetation type in the JIDPA and CIAA (see Tables 3.16 and 3.17 and Maps 3.11 and 3.12), would experience the greatest amount of cumulative disturbance regardless of development alternative. Disturbance to Wyoming sagebrush vegetation communities would remain greatest in the Expanded Sand Draw-Alkali Creek watershed, where gas development would continue to be the primary component of the disturbance. Maximum cumulative disturbance to vegetation as a result of the No Action Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 2,355 acres (10.3% of the watershed). Maximum cumulative disturbance to vegetation as a result of the Proposed Action and Alternative A in the Expanded Sand Draw-Alkali Creek watershed is estimated at 9,612 acres (41.9% of the watershed). Maximum cumulative disturbance to vegetation as a result of the Preferred Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 6,064 acres (26.4% of the watershed). Under other Alternatives, maximum cumulative disturbance in the Expanded Sand Draw-Alkali Creek watershed is estimated to range from 3,805 acres (16.6%) under Alternative B to 8,617 acres (37.6%) under Alternative G. The Long Draw watershed that drains 16% of the JIDPA would experience the next greatest amount of maximum cumulative disturbance. The closed basin watersheds--Jonah Gulch and 140401040603 would likely only experience a small percentage of cumulative disturbance to vegetation resources.

Within the CIAA, riparian and wetland habitats are primarily found along drainages and dispersed at ponds and reservoirs. Existing adverse impacts include some roads within these habitats, livestock grazing, and recreational use. Wetlands, waters of the U.S., and riparian areas would be avoided where possible by this and most other proposed projects in the area, so there are not anticipated to be any significant direct impacts to these resources. Indirect impacts to wetland and riparian areas would be limited to increased sediment deposition (see Section 4.1.8). A beneficial impact to riparian habitat would occur with planned improvements in grazing management. No permanent cumulative impacts are anticipated since all future development activities would comply with Section 404 of the *Clean Water Act* and EO 11990.

4.2.1.12 Unavoidable Adverse Impacts

The proposed project would temporarily remove from 13.8% (No Action, 4,209 acres) to 66.0% (Proposed Action and Alternative A, 20,409 acres) of the vegetation and would provide areas conducive to the invasion of noxious weeds and invasive species.

Since wetlands, WUS, and riparian areas would generally be avoided and any disturbance of these areas would be promptly reclaimed, no long-term unavoidable adverse impacts to these resources are anticipated.

4.2.2 Wildlife and Fisheries

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with wildlife and fisheries:

- to maintain, improve, or enhance the biological diversity of all plant and wildlife species while ensuring healthy ecosystems;
- to restore disturbed or altered habitat with the objective to attain desired native plant communities, while providing for wildlife needs and soil stability;
- to conserve and develop recreational resources for the benefit of present and future generations;
- to consider wildlife migration corridors, crucial winter ranges, and other important habitats when evaluating land use proposals;
- to support and maintain healthy wildlife populations as an appropriate and desired land use;
- to establish more watering systems on all grazing lands for livestock, wildlife, and game/non-game birds; and
- to minimize conflicts between wildlife and domestic pets.

Impacts to wildlife and fisheries would be considered significant if any project action would compromise the ability to meet the above management objectives, and significant impacts to most wildlife species on the JIDPA are anticipated under all project alternatives. Specific impacts which would be considered significant include, but would not be limited to, the physical loss or the abandonment of important wildlife features (e.g., greater sage-grouse leks, greater sage-grouse winter concentration areas, raptor nests and nesting and foraging territories, pronghorn migration corridors), diminished wildlife diversity in the JIDPA, and degradation of crucial winter ranges and/or other important wildlife habitats. For the PFO and RSFO areas as a whole, significant impacts to wildlife on and adjacent to the JIDPA would not be to such a degree that they would affect BLM's capability to manage these resources pursuant to RMP objectives field officewide.

In general, impacts to wildlife would result from 1) the direct loss of habitat due to removal of vegetation; 2) displacement of wildlife due to disturbance and/or noise from project-related activities including construction, drilling, traffic, and human presence (indirect habitat loss); 3) habitat fragmentation; 4) direct mortality due to construction activities and/or animal/vehicle collisions; 5) potential increased poaching and harassment as a result of increased access and human presence; 6) impediments to pronghorn antelope migration; 7) loss of habitat function (most notably for greater sage-grouse breeding, nesting, brood-rearing, and wintering); 8) loss of suitable raptor nesting areas and/or existing territories; and 9) a decrease in species diversity. No impacts to fisheries in the Big Sandy, New Fork, and Green Rivers are anticipated under any alternative due to the distance of the project from live surface waters, the absence of surface water depletion, and the application of appropriate mitigation. Thus, impacts to fisheries are not discussed further in this section.

Exploration and development activities may cause severely fragmented habitats, and habitat treatments may not be an effective mitigation to offset the impacts of initial and long-term disturbance or loss of habitat function. When sagebrush habitats are degraded, vegetation reestablishment may take many years. Wyoming big sagebrush may require between 30 and 40 years to become established and may take 90 to 110 years to achieve desirable habitat characteristics (e.g., canopy height, coverage, and area). Therefore, habitat functionality, particularly for nesting species, on disturbed areas may not be achieved for 90 to 110 years. However, with successful reclamation, a mosaic of sagebrush successional stages, which is desirable for most sagebrush obligate species would be available in the JIDPA within a shorter time frame.

The Wilderness Society (2002) defines habitat fragmentation by quoting Noss and Csuti (1994); "Fragmentation of habitat can be defined as the decrease in the size of habitat patches and interior habitat and the increase in distance between patches." When large blocks of habitat are separated into small patches, the resulting fragmentation of the habitat may limit the ability of some animals to move, resulting in the use of inferior or unsuitable habitat. The Wilderness Society (2002) suggests that landscape analysis is a proven way to identify habitat fragmentation.

This EIS quantifies habitat fragmentation using GIS technology to draw buffers of various widths around roads, pipeline ROWs, well pads, and other project-related disturbance. The areas outside those buffers (i.e., those greater than a designated distance from project features and/or activities) are considered core areas. Core areas, by their definition, are the habitat patches most removed from project disturbances and, in general, they are likely to have a higher comparative value to wildlife species in the JIDPA than non-core areas, all other factors being equal. By producing habitat fragmentation models of the JIDPA using various buffers (i.e., 0.5 mile, 0.25 mile, 0.125 mile, and 0.063 mile) from existing and/or proposed project disturbance at various well densities (16, 32, and 64 wells per 640-acre section), an estimated total acreage and the number and average size of core areas within the JIDPA under a variety of development scenarios has been analyzed. The modeling results are provided in Tables 4.9 and 4.10 and Maps 4.2 through 4.5. Although it is suspected that some species in the area (e.g., greater sage-grouse, pronghorn antelope) are sensitive to varying degrees of fragmentation, insufficient scientific research has been conducted to determine what level of fragmentation is critical for individual populations or species.

Impacts specific to species or groups of species are described in the following sections. Significant impacts are anticipated under all alternatives (including the No Action Alternative), but would vary in degree as discussed in Sections 4.2.2.1 through 4.2.2.11. Existing and BLM-proposed mitigations for many wildlife species may be inadequate to reduce impacts to less than significant levels in the JIDPA.

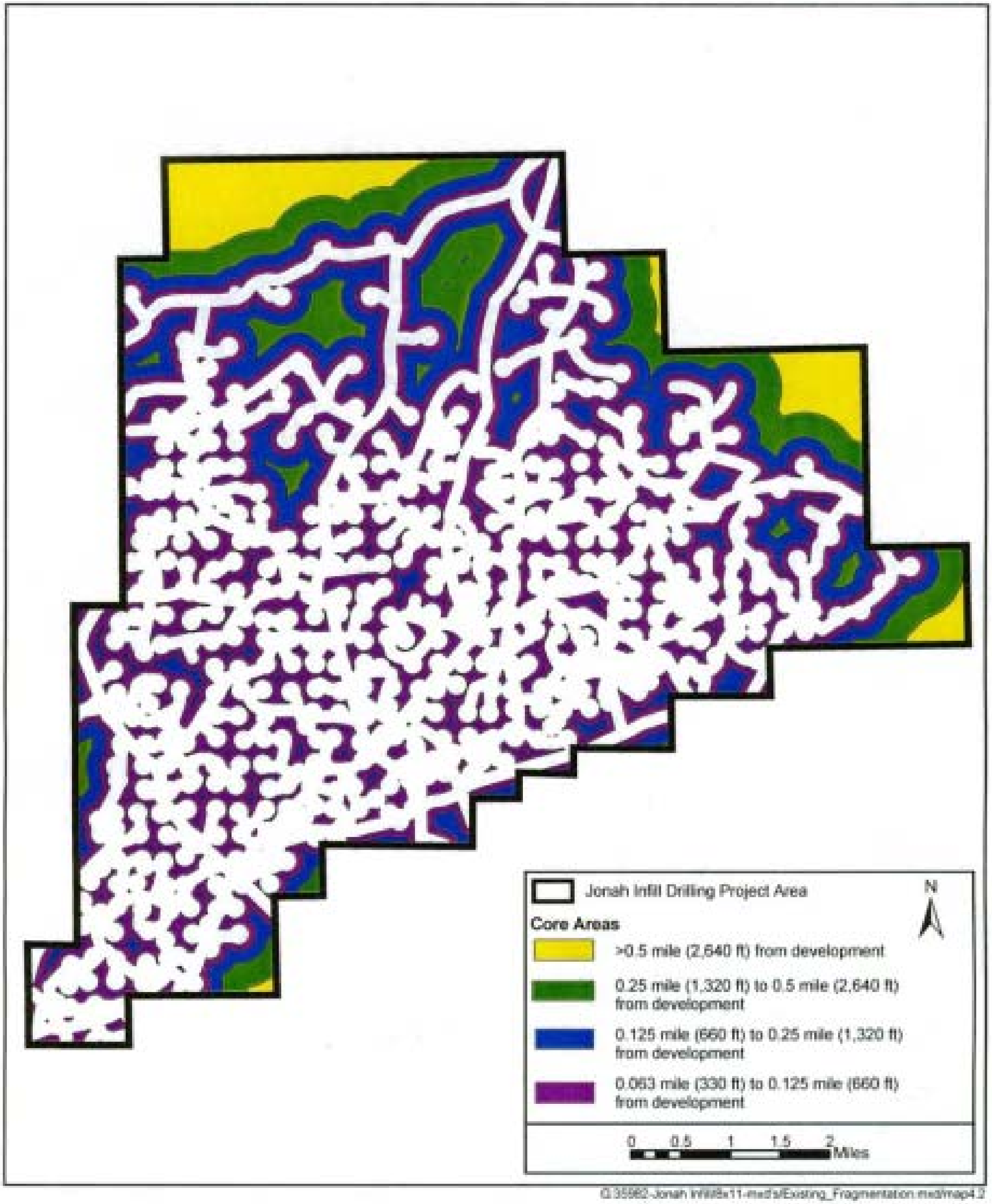
Table 4.9 Percent of the JIDPA Contained Within Core Areas for Existing Conditions and Selected Action Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

	Percent of JIDPA in Core Areas (%)			
Disturbance Buffer	Existing Conditions (No Action)	16 Wells/Section (Alternative E)	32 Wells/Section (Alternative F)	64 Wells/Section (Alternative G)
0.063 mile	45.3	28.6	10.1	2.1
0.125 mile	24.3	2.7	1.0	0.8
0.25 mile	12.6	0.2	0.04	0.02
0.5 mile	5.2	0	0	0

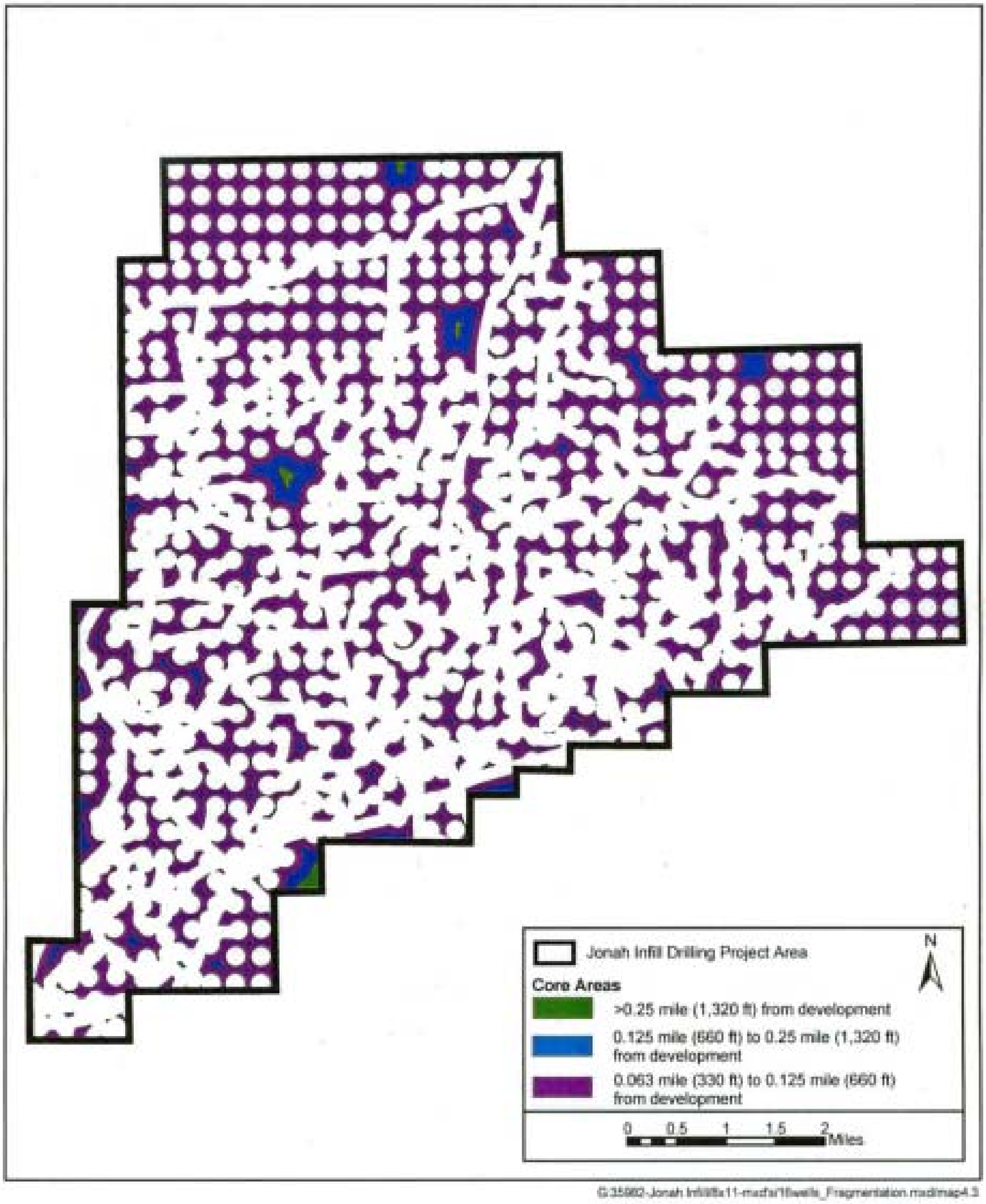
[1] Core areas are those areas within the JIDPA and outside the disturbance buffer (i.e., greater than a designated distance from Project-related disturbance).

Table 4.10 Number and Mean Size of Core Areas in the JIDPA for Existing Conditions and Selected Action Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

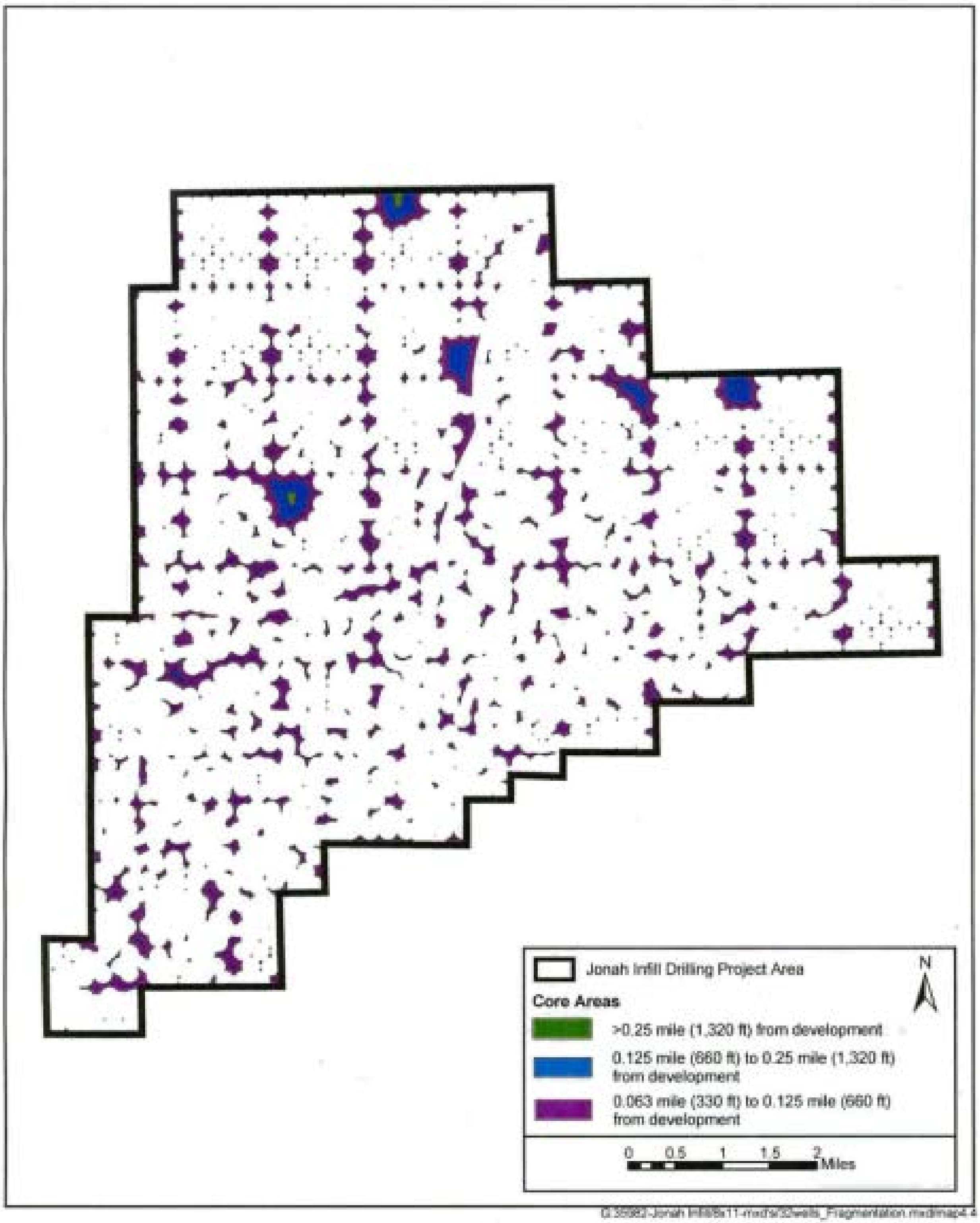
	Number/Mean Size of Core Areas (acres)			
Disturbance Buffer	Existing Conditions (No Action)	16 Wells/Section (Alternative E)	32 Wells/Section (Alternative F)	64 Wells/Section (Alternative G)
0.063 mile	164/84	205/42	616/5	93/7
0.125 mile	119/62	237/3	64/5	7/33
0.25 mile	18/214	6/10	3/5	2/3
0.5 mile	7/226	0	0	0



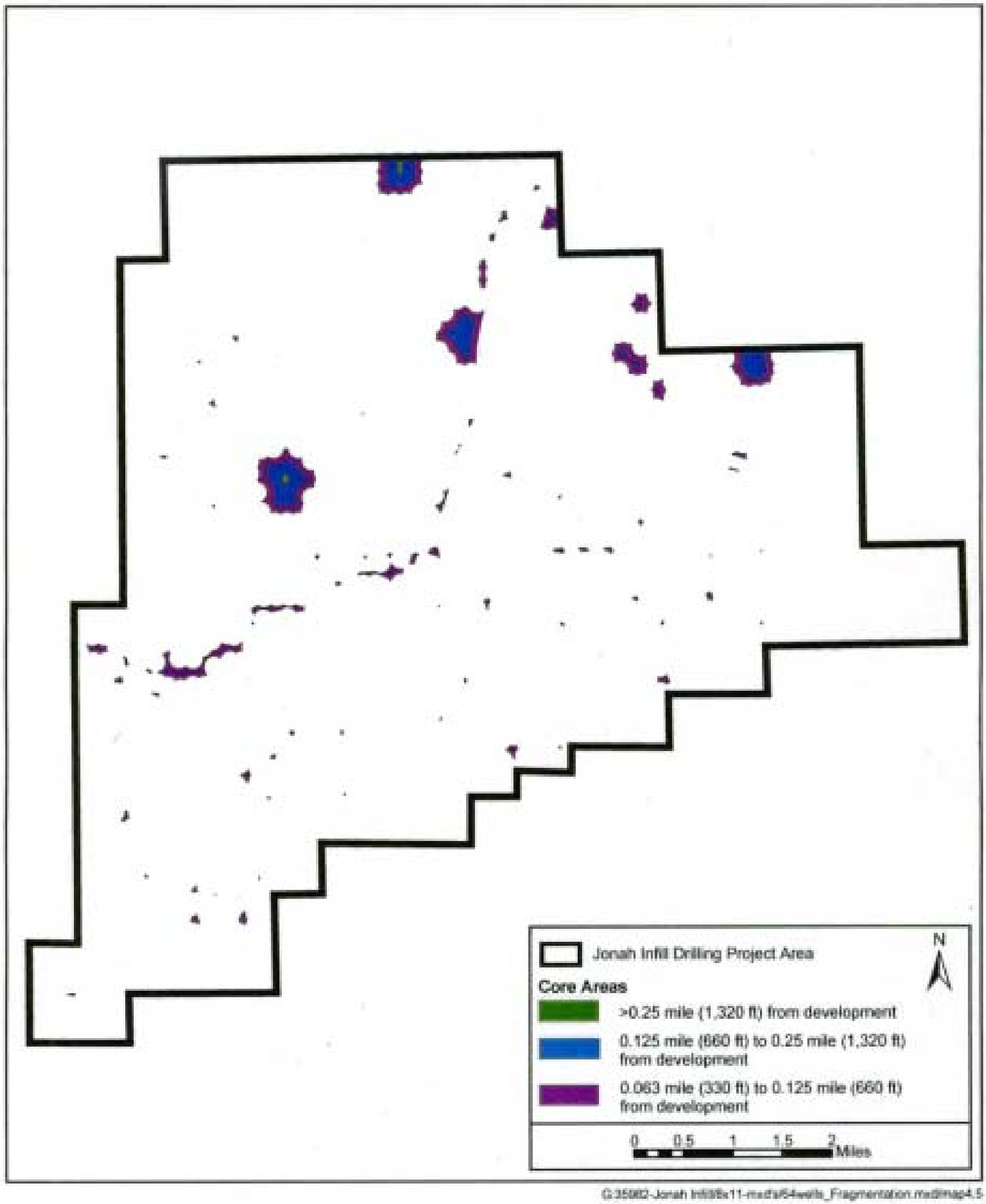
Map 4.2 Existing Wildlife Habitat Fragmentation (No Action), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 4.3 Wildlife Habitat Fragmentation Expected Under Development at 16 Wells per Section (Alternative E), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 4.4 Wildlife Habitat Fragmentation Expected Under Development at 32 Wells per Section (Alternative F), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.



Map 4.5 Wildlife Habitat Fragmentation Expected Under Development at 64 Wells per Section (Alternative G), Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Pronghorn Antelope

Surface disturbance (both short-term and LOP) would result in a direct loss of spring/summer/fall pronghorn habitat within the Sublette Herd Unit. This represents up to 0.7% of the 4,697 square miles of spring/summer/fall habitat for the herd and up to 0.4% of the total acreage of the 7,938 square miles of occupied habitat (the amount would depend on the alternative). No crucial pronghorn habitats would be disturbed as a result of the proposed project. Approximately 65-73% (depending on the alternative) of the disturbed areas would be reclaimed and revegetated shortly after disturbance. This short-term disturbance would occur within spring/summer/fall habitat and would be spread over the development period and scattered throughout the JIDPA. The remaining 27-35% of the disturbance would result in the removal of spring/summer/fall habitat on the Sublette Herd for the LOP and until successful reclamation and revegetation is achieved. Reclaimed and revegetated areas would produce less forage for a period of years until revegetation is successful, at which time grasses and possibly forbs would become more dominant. Shrubs likely would take 30 to 40 years or more to become established but may take 90 to 110 years to reach predisturbance productivity and structure levels. In the interim, habitat function for sagebrush obligate species such as pronghorn would be compromised to varying degrees.

In addition to the direct loss of habitat, disturbance from drilling activities (including noise, increased traffic volume, and human presence) would affect utilization of habitats adjacent to development areas. Displacement likely would be about 0.5 mile (Gusey 1986; Guenzel 1987; Easterly et al. 1991). However, as noise and human presence are reduced, pronghorn likely would increase their use of these areas (e.g., during production operations), although probably not to the same extent as prior to disturbance. Although methodologies for documenting animal displacement or changes in distribution are fairly straightforward, those for documenting population-level impacts (i.e., survival, reproduction) are extremely complex. Thus, little information is available concerning how human-related disturbances impact reproduction and survival of ungulates (Western EcoSystems Technology Inc. [West] 2003).

Because the Jonah Infill Project would disturb pronghorn spring/summer/fall range, it is reasonable to assume that the project would have some adverse impacts to pronghorn populations as a result of direct habitat removal and a reduction in habitat function on areas adjacent to development activities. However, specific quantitative estimates of such impacts are not possible because the requisite research has not been done. Lindzey (2002), commenting on impacts to big game from oil and gas development, said:

> Changes resulting from energy development, undoubtedly, will influence wildlife populations, yet little [research] is available to support inferences about the degree of population-level effects or the best way to address possible impacts. Understanding the population-level effects of disturbances, such as those realized during energy exploration and development require more than the short-term, observational studies biologists now have to rely on.

Reeve (1984) found that pronghorn habituated to increased traffic volumes and heavy machinery as long as traffic moved in a predictable manner. Reaction of pronghorn to roads is not well understood; however, pronghorn are often seen adjacent to road ROWs, including busy interstate highways. It is likely that pronghorn movement is more affected by fences along ROWs than by the activity (traffic) on the ROW. However, increased mortality from vehicle/animal collisions is a potential direct impact that may occur due to increased traffic on the JIDPA for the LOP, and the provision of access to big game range may increase legal and illegal pronghorn harvest. On the other hand, some people may be deterred from poaching because of the increased number of vehicles and humans in the area and the subsequent likelihood of being observed by other area visitors.

Pronghorn are known to move through the JIDPA on their way to and from crucial habitats (see Map 3.13), and some of these movements are likely to be hindered under most, if not all, of the development alternatives. The existing migration corridor between U.S. Highway 191 and the JIDPA boundary is at least 1.0 mile wide and would remain undisturbed (excluding the existing and unfenced Luman, Jonah North, and Rim Roads).

Furbearers, Small Game, and Other Mammals

Impacts to furbearers, small game, and other mammals would include the direct loss of habitat due to surface disturbance. Total proposed surface disturbance represents up to 67% of the JIDPA (depending on the alternative), and some unknown portion of the undisturbed habitat likely would suffer a reduction in use because of its proximity to human activity (noise, traffic, etc.). The degree of loss of habitat function would, to some extent, depend on each species' ability to adapt to disturbance. In addition, some smaller, less mobile animals like mice, voles, and ground squirrels are likely to be killed during construction operations.

Some additional poaching and increased mortality from animal/vehicle collisions is likely due to the increased road and traffic volume associated with project activities. The ability of the lands within the JIDPA to support furbearers, small game, and other mammals likely would decrease from current levels due to habitat loss and human disturbance. Increased human activity would displace some species from areas near project features which, when coupled with direct habitat loss, would further fragment habitats. Populations would continue to fluctuate and impacts would be masked by natural variations in weather, incidence of disease, and other natural factors. project-related disturbance to rare habitats (e.g., wetlands) would be avoided where practical (no other rare habitats are currently known to occur on the JIDPA).

Raptors

Existing seasonal and spatial restrictions at active raptor nests are intended to prevent adverse impacts (e.g., frightened adults, overexposure of eggs or young to heat or cold, missed feedings, premature fledging, and increased predation) to breeding, nesting, and brood-rearing raptors. However, no restrictions are in place to prevent development within the seasonal buffer zone outside of the nesting season except for the 825-ft or 1,000-ft no surface occupancy (NSO) buffers, and project facilities and roads constructed outside of the nesting season could result in disturbance to nesting activities in subsequent years. Tolerance to disturbance varies among raptor species and among individuals of the same species. In general, ferruginous hawks are among the most sensitive species to human disturbance. In some instances, raptor nest disturbance and the associated decrease in reproductive success may be avoided if project facilities are located outside of the line-of-sight of active raptor nests and/or if other raptor protection measures are effective. However, if suitable nesting habitat as identified during pre-development surveys is determined to be unoccupied by raptors, development may be allowed in these areas potentially precluding the future use of these areas by nesting raptors. The potential for adverse impacts to raptors would be greatest during project development, when human activity levels are highest; it is anticipated that impacts would decrease somewhat during the production phase of the project.

Reduction in raptor prey species also is likely to occur as a result of the surface disturbance of up to two-thirds of the JIDPA (the amount of disturbance would depend on the alternative). This habitat loss and the associated decrease in available prey base would reduce the quality of raptor foraging habitat within the JIDPA and may increase the size of foraging territory necessary to support an individual and/or decrease the number of foraging raptors the area can support.

Throughout the LOP, it is likely that raptor productivity (especially that of ferruginous hawks) would be negatively impacted by project-related activities. Increased human activity associated with the proposed project is likely to result in fewer nest initiations, increased nest site abandonment and/or reproductive failure, and decreased productivity of successful nests.

Game Birds

Continued disturbance of breeding, nesting, brood-rearing, and wintering greater sage-grouse and their habitats would occur and would increase from that currently occurring in the JIDPA as a result of increased habitat removal and noise and disturbance from traffic and human presence. The currently identified 0.25-mile active lek buffer and other seasonal avoidance measures may be inadequate to protect breeding, nesting, brood-rearing, and wintering grouse from noise or other impacts within the JIDPA (e.g., individuals flushed from leks, failure of females to breed, lek and nest abandonment, avoidance of all habitat areas), which could result in reduced breeding initiation, reproductive success, and survival. The locations of known leks (see Map 3.19) on and adjacent to the JIDPA are assumed to represent optimal lek habitat. Impacts to leks and other important habitats (nesting, winter) may be serious enough to cause abandonment of the area. Even if alternate lek sites are established or existing leks at alternate locations are used, it is assumed that less than optimal conditions would prevail, resulting in decreased breeding success. Furthermore, the loss of nesting, brood-rearing, and wintering areas may be equally, if not more, important to grouse survival. As with raptor nests, site-specific situations vary, and the success in reducing impacts using standard mitigation measures (e.g., NSO buffers and seasonal timing restrictions) is variable.

Most impacts to greater sage-grouse in the JIDPA have likely already occurred due to existing developments, and the area may no longer be suitable for sage-grouse use. Further habitat loss and disturbance would occur under all action alternatives. Recovery of habitat functionality for greater sage-grouse may take over 100 years. However, it is anticipated that a mosaic of sagebrush habitat age classes would be available on the JIDPA within a shorter time frame.

In areas where 40% of greater sage-grouse nesting, early brood-rearing, and/or winter habitat has been lost or severely degraded within the range of a population, Connelly et al. (2000) suggest that the management emphasis should focus on protecting any remaining sagebrush that is in any way suitable for these functions. Disturbance to remaining suitable greater sage-grouse nesting, early brood-rearing, and winter habitats should be avoided to prevent further fragmentation of those habitats. Within comparatively intact sagebrush ecosystems, treating up to 20% of degraded nesting and early brood-rearing habitats and 30% of the winter habitat may improve habitat conditions. Treatments may consist of restoring herbaceous understory, creating open patches of herbaceous vegetation, thinning dense sagebrush canopies exceeding 30% cover, creating openings within dense sagebrush, regenerating the shrub component by setting back succession, or enhancing herbaceous understory by reducing herbivory. However, at some point, it becomes difficult to mitigate habitat loss by treating vegetation because the temporary loss of habitat as a result of the treatment, combined with the habitat loss that is being mitigated, creates an unacceptable level of impacts to greater sage-grouse (Connelly et al. 2000). These impacts include loss of nesting and roosting habitat and decreased food availability. Optimal food availability allows sage-grouse to minimize brood movement during foraging, thereby lowering predator exposure and energetic costs of foraging (Lyon 2000). With decreasing availability of forbs and grasses, broods move longer distances and expend more energy to find forage. This increased movement, in addition to decreased vegetative cover, may expose chicks to greater risk of predation (Lyon 2000).

A study on coal mining activities and oil field development in North Park, Colorado, found that greater sage-grouse populations in areas experiencing disturbance decreased in relation to surrounding undisturbed populations (Braun 1986, 1987). Adult male greater sage-grouse establish fidelity to specific leks. Braun (1986) hypothesized that mining activity and large-scale habitat loss occurring adjacent to leks may contribute to a reduction in the number of yearling male recruits to those areas and that the increased road construction associated with such development also may impact greater sage-grouse populations. Road construction results in permanent travel routes, improved public access, increased long-term traffic-related disturbance to previously inaccessible regions, indirect noise impacts to leks, and direct mortality (Braun 1998). Roads also provide a clear pathway for predators to move unimpeded by vegetation or other obstructions (Lyon 2000). The road-effect distance, or the distance from a road at which a population density decrease is detected, is positively correlated with increased traffic density and speed and is more critical in years when wildlife populations are low (Forman and Alexander 1998). Studies conducted in Montana, Wyoming, and Colorado suggest that some recovery of greater sage-grouse populations may occur after a site has been developed and subsequently reclaimed following energy development, road construction, and other human disturbances (Braun 1998). However, there has been no evidence that populations attain their pre-disturbance levels.

Female greater sage-grouse also demonstrate site fidelity to nesting areas surrounding a lek (Schroeder et al. 1999; Lyon 2000). Female yearlings nest in the same area in which they hatched (Lyon 2000). Even in areas of high disturbance, females continue to maintain their site fidelity, though not without some behavioral modifications. The results from a study conducted by Lyon (2000) indicate that hens captured on disturbed leks demonstrate lower nest initiation rates, travel twice as far to nest sites, and select higher total shrub canopy cover and live sagebrush canopy cover than hens captured near undisturbed leks. The average distances between nests and the nearest lek varies from 0.7 to 3.9 miles; however, one female nested more than 12.4 miles from the nearest lek. Lyon (2000) found 74% of the hens captured from disturbed leks nested more than 1.9 miles from the lek, while 91% of the hens from undisturbed leks nested within 1.9 miles of the lek. Females that nest >2.0 miles from a lek are less likely to be protected under current BLM stipulations. Maintaining large, continuous tracts of suitable habitat protected from disturbance is critical to the sustainability of greater sage-grouse populations.

Field development also could reduce the value of some greater sage-grouse winter habitat, although some grouse winter habitat would remain on and adjacent to the JIDPA (especially within the Sand Draw buffer).

Further definition of potential greater sage-grouse impacts would be provided during annual inventory and monitoring (TRC Mariah 2004a), and additional protection measures may be applied in the JIDPA as directed by BLM.

Mourning doves are seasonal (summer) visitors in the JIDPA and populations likely would not be impacted by the Proposed Action because of their relatively high tolerance to human activity and presence, their inherent mobility, and the availability of suitable habitat on adjacent lands.

Other Birds

Non-game birds would be adversely affected by increased human activity in the JIDPA. Primary impacts to any given species would occur in direct proportion to the amount of suitable habitat removed (up to 67% of the JIDPA, depending on the alternative) plus any additional habitat avoided by the birds (and thus, at least temporarily lost) because of human disturbance. Approximately 65-73% of initial disturbance (depending on the alternative) would be reclaimed and revegetated during the LOP; however, in sagebrush communities (the dominant predisturbance vegetation type in the JIDPA), it may take decades to recover the functional value of the habitat. Wyoming big sagebrush may require 30 to 40 years to become established and may take 90 to 110 years to achieve desirable habitat characteristics (e.g., canopy height, coverage, and area). Thus, impacts, particularly for sagebrush-obligate bird species, could persist for decades after the LOP. Some increased mortality also is likely to occur due to vehicle/bird collisions resulting from increased traffic.

Amphibians and Reptiles

Direct impacts to amphibians and reptiles would occur in direct proportion to the amount of their habitats disturbed. Total surface disturbance in the JIDPA would be up to 67% of the area (depending on the alternative). However, 65-73% of that disturbance would be short-term, and wetlands and waters of the U.S. generally would be avoided. An increase in mortality due to increased traffic is also anticipated as a result of the proposed project.

All Species

Impacts to most wildlife resources would be proportional to the amount of direct (see Section 4.2.1) and indirect habitat lost and the duration of this loss. While a variety of mitigation/protection measures would be applied across alternatives (see Chapter 2 and Appendices A and B), significant adverse impacts to some wildlife resources are anticipated under all alternatives including the No Action Alternative. These impacts have been identified in the JIDPA during annual wildlife monitoring of the area (e.g., TRC Mariah 2004a). Impacts noted during annual wildlife monitoring include non-attendance or decreased attendance by greater sage-grouse on some known leks, absence/decline in known greater sage-grouse nesting, brood-rearing, and wintering in the area, and inactivity and nest failure of some raptor nests and/or territories (particularly for ferruginous hawks). These existing impacts would be exacerbated with the implementation of the proposed project and the accompanying direct and indirect disturbances to wildlife species and their habitats.

The degree of habitat fragmentation within the JIDPA at current levels is high, with 87.40% of the lands in the JIDPA being within 0.25 mile (1,320 ft) of project-related disturbance and 75.70% of the lands being within 0.125 mile (660 ft) (see Table 4.9). With the implementation of the proposed project, up to 99.98% of the JIDPA would be within 0.25 mile (1,320 ft) of project-related disturbance, and up to 99.20% would be within 0.125 mile (660 ft). Furthermore, patch sizes for areas greater than 0.25 mile from project-related disturbance would be reduced from the current average of 214 acres to as small as 3 acres (depending on the alternative) (see Table 4.10). Although, as recognized above, insufficient scientific research has been conducted to determine what level of fragmentation is critical for individual populations or species, this level of disturbance is very likely a significant impact under all alternatives for at least some of the species of wildlife that inhabit the JIDPA.

The aforementioned impacts are significant within the JIDPA and on adjacent lands under any alternative.

Wildlife impacts due to increased mortality from construction, traffic, and poaching are not anticipated to be significant on either a local or a management area level under any alternative.

Based on existing research data and observations of pronghorn reactions to oil and gas development, impacts on pronghorn populations in the Sublette Herd Unit resulting from development of the JIDPA, including habitat fragmentation and a reduction in habitat function, are anticipated to be less than significant on both a local and a management area level. No loss of pronghorn migration routes is anticipated, although pronghorn may alter their migration routes to avoid project disturbances.

4.2.2.1 No Action Alternative

Direct wildlife habitat loss through 4,209 acres of short-term and 1,409 acres of LOP disturbance is currently approved within the JIDPA (BLM 1998b, 2000b) for ongoing natural gas development and production. Under the No Action Alternative, no additional impacts to wildlife species from natural gas development would occur in the JIDPA as a result of the proposed project because no additional habitat disturbance would be approved, nor would indirect impacts change. Mortality rates due to construction would not occur; however, the potential for vehicle/wildlife collisions would remain. No further habitat fragmentation or displacement would occur beyond current levels (see Map 4.2 and Tables 4.9 and 4.10); however, considerable habitat fragmentation already exists in the JIDPA, and the area may no longer be suitable for many wildlife species. Impact duration would be approximately 63 years plus the time needed for adequate reclamation.

4.2.2.2 The Proposed Action

The Proposed Action would result in an estimated increase (over the No Action Alternative) of 16,200 acres of new initial disturbance, for a total of 20,409 acres of project-related surface disturbance. All of the new initial disturbance would be within pronghorn Sublette Herd Unit spring/summer/fall habitat. This represents 0.68% of the 4,697 square miles of spring/summer/fall habitat for the herd and 0.40% of the total acreage of the 7,938 square miles of occupied habitat. Approximately 70.4% of the total disturbance (14,369 acres) would be reclaimed and reseeded as soon as practical after disturbance (i.e., short-term disturbance). The remaining 29.6% (6,040 acres) would remain disturbed for the LOP. In addition to the direct loss of habitat, disturbance from drilling and production activities (including noise, increased traffic volume, and human presence) would affect utilization of habitats adjacent to development areas. Impact duration would be approximately 76 years plus the time needed for adequate reclamation, or 13 years longer than the No Action Alternative.

4.2.2.3 Alternative A

Implementation of Alternative A would result in the same types and acreages of impacts to wildlife species as the Proposed Action (i.e., an increase of 16,200 acres [11,569 acres of short-term disturbance and 4,361 acres of LOP disturbance] over the No Action Alternative). However, under Alternative A, selected Operator-committed and BLM-required practices for the avoidance of sensitive areas (e.g., avoidance of the Sand Draw drainage [300-ft buffer either side], greater sage-grouse leks, and raptor nests) would not occur. This likely would result in increased impacts to greater sage-grouse, raptors, and other wildlife species. Habitat fragmentation under this alternative would result in all areas within the JIDPA being within 330 ft of project disturbance. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

4.2.2.4 Alternative B

Alternative B would result in an estimated increase (over the No Action Alternative) of 3,297 acres of new initial disturbance, for a total of 7,506 acres of project-related surface disturbance in the area. Approximately 65% (4,884 acres) of the total disturbance would be short-term, and the remaining 35% (2,622 acres) would remain disturbed for the LOP. Areas of the JIDPA that currently lack well pads would have minimal new surface disturbance because this alternative does not allow for construction of new well pads and, as a result, disturbance for new roads and pipelines required in those areas also would be minimal. Habitat fragmentation would be similar to that of the No Action Alternative (see Map 4.2). Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

4.2.2.5 Alternative C

Alternative C would result in an estimated increase (over the No Action Alternative) of 6,705 acres of new initial disturbance, for a total of 10,914 acres of project-related surface disturbance in the area. Approximately 68.9% (7,515 acres) of the total disturbance would be short-term, and the remaining 31.1% (3,399 acres) would remain disturbed for the LOP. Since the location of new well pads is unknown, new habitat fragmentation conditions are not identified but likely would be similar to that shown on Map 4.4 (32 pads/section). Depending on the rate of development, impact duration would be approximately 68 to 80 years plus the time needed for adequate reclamation, or 5 to 17 years longer than the No Action Alternative .

4.2.2.6 Alternative D

Alternative D would result in an estimated increase (over the No Action Alternative) of 11,571 acres of new initial disturbance, for a total of 15,790 acres of project-related surface disturbance. Approximately 69.9% (11,037 acres) of the total disturbance would be short-term, and the remaining 30.1% (4,753 acres) would remain disturbed for the LOP. Since the location of new well pads is unknown, new habitat fragmentation conditions are not identified but likely would be intermediate to that shown on Maps 4.4 (32 pads/section) and 4.5 (64 pads/section). Depending on the rate of development, impact duration would be approximately 72 to 93 years plus the time needed for adequate reclamation, or 9 to 30 years longer than the No Action Alternative.

4.2.2.7 Alternative E

Alternative E would result in an estimated increase (over the No Action Alternative) of 6,386 acres of new initial disturbance, for a total of 10,595 acres of project-related surface disturbance. Approximately 66.1% (6,998 acres) of the total disturbance would be short-term, and the remaining 33.9% (3,597 acres) would remain disturbed for the LOP. Habitat fragmentation conditions would be as shown on Map 4.3. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

4.2.2.8 Alternative F

Alternative F would result in an estimated increase (over the No Action Alternative) of 10,446 acres of new initial disturbance, for a total of 14,655 acres of project-related surface disturbance. Approximately 72.7% (10,658 acres) of the total disturbance would be short-term, and the remaining 27.3% (3,997 acres) would remain disturbed for the LOP. Habitat fragmentation conditions would be as shown on Map 4.4. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

4.2.2.9 Alternative G

Alternative G would result in an estimated increase (over the No Action Alternative) of 13,989 acres of new initial disturbance, for a total of 18,198 acres of project-related surface disturbance. Approximately 70.3% (12,790 acres) of the total disturbance would be short-term, and the remaining 29.7% (5,408 acres) would remain disturbed for the LOP. Habitat fragmentation conditions would be as shown on Figure 4.5. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

4.2.2.10 BLM Preferred Alternative

The Preferred Alternative would result in an estimated increase (over the No Action Alternative) of 7,804 acres of new initial disturbance, for a total of 12,013 acres of project-related surface disturbance. Approximately 69.2% (8,309 acres) of the total disturbance would be short-term, and the remaining 30.8% (3,704 acres) would remain disturbed for the LOP. Since the location of new well pads is unknown, new habitat fragmentation conditions are not identified but likely would be similar to that shown on Map 4.4 (32 pads/section). Impact duration would be approximately 76 years plus the time needed for adequate reclamation, or 13 years longer than the No Action Alternative.

Under the Preferred Alternative, additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). These measures would moderate, to some extent, anticipated impacts to wildlife species.

4.2.2.11 Cumulative Impacts

CIAAs for wildlife and fisheries vary by resource. While the principle focus of the following analysis is cumulative impacts from oil and gas development, other actions in each CIAA have affected and will continue to affect wildlife. These actions include, but are not limited to, urbanization, the proliferation of roads (in addition to those for oil and gas development), WGFD species management and associated hunter harvests, livestock grazing, and recreation.

For the following cumulative impacts discussion, impacts under the 10 alternatives discussed herein can be ranked based on new initial and LOP disturbance acreages, with the following caveats.

- Although new initial and LOP disturbance under the Proposed Action and Alternative A are the same, impacts would be greater under Alternative A because selected Operator-committed practices and BLM development guidelines and stipulations would not be implemented.

- Under the Preferred Alternative, impacts may be lower than implied by disturbance acreage alone, because BLM management and monitoring requirements designed to protect resources and minimize impacts while meeting field development objectives would be implemented.

That said, Alternative A and the Proposed Action would result in the largest surface disturbance within the JIDPA (i.e., 20,409 acres new initial disturbance and 6,040 acres LOP disturbance). The next highest disturbance would be Alternative G (18,198 acres new initial and 5,408 acres LOP disturbance), followed by Alternative D (15,790 acres and 4,753 acres), Alternative F (14,655 acres and 3,997 acres), the Preferred Alternative (12,525 acres and 3,847 acres), Alternative E (10,595 acres and 3,597 acres), and Alternative C (10,914 acres and 3,399 acres). Alternative B has the lowest proposed disturbance acreage of any of the action alternatives, with 7,506 acres of new initial disturbance and 2,622 acres of LOP disturbance. Under the No Action Alternative, disturbance would be limited to that already approved—4,209 acres of new initial disturbance and 1,409 acres of LOP disturbance.

<u>Pronghorn Antelope</u>

The CIAA for pronghorn is the Sublette Herd Unit (see Map 3.13). The impacts of oil and gas development on pronghorn in the herd unit are largely unknown, but the WGFD indicates that pronghorn have been and will continue to be redistributed, and mortality may increase due to habitat loss (WGFD 2001). Avoiding a loss of habitat function on crucial winter range is especially important to maintaining pronghorn populations at a desired level. In addition, there are several migratory "bottlenecks" through which some Sublette Herd Unit pronghorn move (to and from winter range). These bottlenecks are created by natural topography and/or human activity and are crucial to the continued survival of portions of the Sublette Herd. Efforts have been initiated to mitigate the impacts to pronghorn movement through these bottlenecks. Fences, particularly those along highways, also restrict pronghorn movements and hinder use of seasonal ranges. New highway and other area fencing may further restrict pronghorn movement and further fragment habitat. The proposed project would not affect any known pronghorn crucial winter range or bottlenecks; therefore, it would not contribute to cumulative impacts to these habitat features.

Under the Preferred Alternative, approximately 0.40% (initial disturbance) and approximately 0.12% (LOP disturbance) of spring/summer/fall range in the Sublette Herd Unit would be disturbed and habitat function on an unknown amount of adjacent habitat would be reduced. Maximum disturbance to spring/summer/fall range within the Herd Unit would occur under the Proposed Action and Alternative A development scenarios—approximately 0.68% initial disturbance and 0.20% LOP disturbance. Therefore, the proposed project is not anticipated to measurably add to cumulative impacts to the Sublette Herd Unit. RFD for the Sublette Herd Unit includes 1,591 wells, additional roads, and other related development disturbing more than 12,000 acres, bringing the maximum cumulative development (existing disturbance, disturbance from the proposed project, and disturbance from RFD) within the Herd Unit to 97,000-113,200 acres, or approximately 1.4-1.7% of the area (Table 4.11). Indirect habitat loss affecting habitat function would occur on an additional but unknown amount of land. The magnitude of impacts from such development on the Sublette Herd Unit are unknown (WGFD 2001); however, they are not anticipated to be cumulatively significant.

<u>Furbearers, Small Game, and Other Mammals</u>

The CIAA for furbearers, small game, and other mammals for the JIDPA is depicted in Map 3.14 and is otherwise known as the Jonah wildlife study area.

RFD for the CIAA includes 1,014 acres primarily associated with oil and natural gas development in the Pinedale Anticline Project area (see Table 4.11). Cumulative impacts resulting from development are anticipated to be similar in kind to those described for the proposed project but would include the additional developments for the Pinedale Anticline Project. Developments would result in additional cumulative impacts to small mammals due to direct and indirect habitat loss, habitat fragmentation, increased traffic volumes, and increased vehicle/small mammal collisions. Recreational hunter harvest of small game and shooting of prairie dogs and other small non-game mammals are also anticipated to increase as a result of increased access to the area. The increased mortality experienced by small mammal populations also would have a cumulative impact on the predator species that depend on small mammal populations for prey (e.g., raptors, foxes, coyotes, badgers, etc.). Cumulative disturbance within the CIAA (i.e., Jonah wildlife study area) would range from 4.2% to 12.8% of the area, with 8.6% disturbance under the Preferred Alternative (see Table 4.11). Impacts generally would be in proportion to the amount of direct habitat loss and are anticipated to be less than significant.

<u>Raptors</u>

The CIAA for raptors is depicted in Map 3.16.

RFD disturbance in the CIAA includes 2,862 acres (see Table 4.11) and is primarily associated with natural gas development described for the Pinedale Anticline Project. With the implementation of the proposed project, between 10.1 and 11.5% of the CIAA would be surface disturbed—10.8% would be disturbed under the Preferred Alternative (see Table 4.11).

All raptor nests in the Pinedale Anticline Project Area are protected by No Surface Occupancy buffers year-round and active nests are protected during the nesting season by timing restrictions and seasonal buffers. Monitoring of raptor nests in the Pinedale Anticline and Jonah Field wildlife study areas is conducted annually (TRC Mariah 2004a, 2004b). The results of these investigations have led to the application of additional mitigation (artificial nest structure placement) and likely would continue to identify expanded mitigation opportunities.

Table 4.11 Potentially Disturbed Acreage in Each Wildlife CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Cumulative Impact Analysis Area (CIAA) Percent of CIAA	Total Acreage of CIAA	Existing Disturbance In CIAA, Outside JIDPA	RFD	Disturbance: No Action			Proposed Action and Alternative A			Alternative B			Alternative C		
				New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Sublette Antelope Herd Unit	6,727,270	80,791	12,000	4,209	1,409	97,000	20,409	6,040	113,200	7,390	2,561	100,181	10,914	3,399	103,705
Percent of entire CIAA		0.01				1.4			1.7			1.5			1.5
Jonah Wildlife Study Area	188,888	2,729	1,014	4,209	1,409	7,952	20,409	6,040	24,152	7,390	2,561	11,133	10,914	3,399	14,657
Percent of entire CIAA		1.4				4.2			12.8			5.9			7.8
Raptors	1,184,443	113,092	2,862	4,209	1,409	120,153	20,409	6,040	136,363	7,390	2,561	123,344	10,914	3,399	126,868
Percent of entire CIAA		9.5				10.1			11.5			10.4			10.7
Greater Sage-grouse	1,061,805	28,767	1,716	4,209	1,409	34,692	20,409	6,040	50,892	7,390	2,561	37,873	10,914	3,399	41,397
Percent of entire CIAA		2.71							4.8						3.9
						3.2						3.6			

Cumulative Impact Analysis Area (CIAA) Percent of CIAA	Disturbance: Alternative D			Alternative E			Alternative F			Alternavtive G			Preferred Alternative		
	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[2]	New	LOP	Cumulative[1]
Sublette Antelope Herd Unit	15,790	4,755	108,581	10,595	3,597	103,386	14,655	3,997	107,446	18,198	5,408	110,989	12,525	3,847	105,316
Percent of entire CIAA			1.6			1.5			1.6			1.6			1.6
Jonah Wildlife Study Area	15,790	4,755	19,533	10,595	3,597	14,338	14,655	3,997	18,398	18,198	5,408	21,941	12,525	3,847	105,316
Percent of entire CIAA			10.3			7.6			9.7			11.6			8.6
Raptors	15,790	4,755	131,744	10,595	3,597	126,549	14,655	3,997	130,609	18,198	5,408	134,152	12,525	3,847	105,316
Percent of entire CIAA			11.1			10.7			11.0			11.3			10.9
Greater Sage-grouse	15,790	4,755	46,273	10,595	3,597	41,078	14,655	3,997	45,138	18,198	5,408	48,681	12,525	3,847	105,316
Percent of entire CIAA			4.4			3.9			4.3			4.6			4.1

[1] Cumulative disturbance = new + existing + RFD.

Raptors using the JIDPA and CIAA for nesting and foraging would experience continued adverse effects within nesting and foraging territories, which would likely lead to reductions in the regional reproductive success of raptors in the CIAA. These adverse effects are anticipated to be cumulatively significant.

Game Birds

The CIAA for greater sage-grouse is depicted in Map 3.18. There are approximately 52 known leks in the CIAA, with the highest percentage of those occurring east of Highway 191.

RFD in the CIAA includes 1,716 acres and is primarily associated with oil and gas development (see Table 4.11). With the implementation of the proposed project, disturbance within the CIAA would range from 3.2-4.8% of the area—disturbance under the Preferred Alternative would be 4.1%.

The proposed project and RFD likely would result in some disturbance of nesting, brood-rearing, wintering, and possibly breeding greater sage-grouse, and although the magnitude of impact resulting from that disturbance is unknown, it is anticipated that cumulative effects on the continued apparent decline in regional greater sage-grouse populations would be significant.

The CIAA for mourning dove is the Jonah Field wildlife study area (see Map 3.14). No significant cumulative impacts to mourning doves are anticipated.

Other Birds

The CIAA for other birds is the Jonah Field wildlife study area (see Map 3.14). Little additional project-related disturbance is anticipated in wildlife study area outside the JIDPA, other than that for the Burma Road upgrade and impacts occurring for the Pinedale Anticline Project. Impacts generally would be in proportion to the amount of direct habitat loss and are anticipated to be less than significant.

Amphibians and Reptiles

The CIAA for amphibians and reptiles is the Jonah Field wildlife study area (see Map 3.14). Little additional project-related disturbance is anticipated in the wildlife study area outside the JIDPA, other than the Burma Road upgrade that would disturb the area adjacent to existing disturbance, and impacts occurring for the Pinedale Anticline Project. Impacts would generally be in proportion to the amount of direct habitat loss and are anticipated to be less than significant.

Fisheries

The CIAA for fisheries includes all 10 project-affected watersheds (see Map 3.9), the same CIAA as for soils, surface waters, and vegetation. Affected drainages include Expanded Sand Draw-Alkali Creek, Granite Wash, Reduced Upper Alkali Creek-Green River, Big Sandy River-Bull Draw, Long Draw, Upper Eighteen Mile Canyon, Jonah Gulch, 140401040603, North Alkali Draw, and Southeast New Fork River-Blue Rim. Project-affected drainages do not support fish; therefore, cumulative impacts on fisheries would not be significant as a result of the proposed project. See Section 4.1.8.11 and Table 4.3 for further information regarding cumulative disturbance within these watersheds.

4.2.2.12 Unavoidable Adverse Impacts

Unavoidable impacts to wildlife would include reductions in available habitat and habitat effectiveness due to both direct surface disturbance/vegetation removal and project-related activities such as increased traffic, noise, and human presence. Some direct wildlife mortality to small mammals during construction and from project traffic/vehicle collisions is also likely to occur.

4.2.3 Threatened, Endangered, Proposed, and Candidate and BLM Wyoming Sensitive Species

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with wildlife and fisheries which are also relevant for TEP&C and BWS species:

- to maintain, improve, or enhance the biological diversity of all plant and wildlife species while ensuring healthy ecosystems;
- to restore disturbed or altered habitat with the objective to attain desired native plant communities, while providing for wildlife needs and soil stability; and
- to conserve and develop recreational resources for the benefit of present and future generations;
- to consider wildlife migration corridors, crucial winter ranges, and other important habitats when evaluating land use proposals;
- to support and maintain healthy wildlife populations as an appropriate and desired land use;
- to establish more watering systems on all grazing lands for livestock, wildlife, and game/non-game birds; and
- to minimize conflicts between wildlife and domestic pets.

Impacts to TEP&C species would be considered significant if any project action would adversely affect or jeopardize federal TEP&C species or their critical habitat and/or any recovery program. Impacts to BWS species would be significant if project activities would cause any BWS species to become federally listed.

Black-footed ferrets are not known to occur, nor are they likely to occur, within the JIDPA, and the JIDPA and vicinity have been block-cleared for ferrets by the USFWS (i.e., surveys for ferrets are not required in the area because USFWS has concluded that their presence in the area is unlikely) (USFWS 2004). However, should ferrets be discovered in the JIDPA, consultation would be initiated with the USFWS to ensure their protection and management.

No bald eagle nests or winter roosts are known to occur on the JIDPA; however, they do use the Green and New Fork River corridors north of the JIDPA for nesting and migration and may occasionally forage in the JIDPA. It is anticipated that bald eagles would avoid the JIDPA for the LOP and would move to other suitable foraging areas in the region.

Since no withdrawals or depletions of surface water nor increased turbidity or sedimentation of surface waters are expected to occur as a result of development of the JIDPA, no adverse affects to the four species of endangered fish present in the Green and Colorado Rivers below Flaming Gorge Dam are anticipated to occur.

Ute ladies'-tresses habitat is not known to occur nor is the species likely to occur within the JIDPA.

A biological assessment (BA) with USFWS concurrence of effects determinations for the above federally listed TEP&C species would be obtained prior to project authorization.

The best habitat areas for the BWS pygmy rabbit (e.g., basin big sagebrush communities) occur along Sand Draw, and pygmy rabbits do occur in this area both on and adjacent to the JIDPA (TRC Mariah 2004a). Idaho pocket gophers may occur within the JIDPA in areas of shallow, stony soils. White-tailed prairie dog towns have been recorded within the JIDPA, and populations routinely utilize habitats on or close to surface disturbance; thus, to some degree, prairie dogs may adapt to the human presence/disturbance associated with the proposed project. The ability of habitats in the JIDPA to support these mammals likely would decrease due to continued habitat disturbance, habitat fragmentation, and direct mortality.

Mountain plovers nest and forage in areas of low, sparse vegetation (often associated with prairie dog towns), and plovers have been observed in the vicinity of the JIDPA during wildlife monitoring efforts (e.g., TRC Mariah 2002, 2004a). Burrowing owls and ferruginous hawks nest and forage in the vicinity of the JIDPA; however, their use of the area appears to be declining in recent years (TRC Mariah 1999, 2001a, 2001b, 2002, 2004a). Similarly, greater sage-grouse forage, lek, nest, and winter in the vicinity of the JIDPA, but male lek attendance is declining on some leks on and adjacent to the JIDPA and a decrease in the use of the JIDPA for nesting, brood-rearing, and wintering also appears to be occurring (TRC Mariah 1999, 2001a, 2001b, 2002, 2004a). These declines likely are, in part, associated with increased human activity and disturbance associated with oil and gas activities in the area.

Species which are sagebrush obligates (i.e., sage thrasher, Brewer's sparrow, and sage sparrow) likely would be adversely affected due to habitat loss/disturbance, which could have negative impacts on these populations regionally, and this impact is anticipated to be significant under all alternatives. Ingelfinger (2001) reported a 50-60% reduction in sagebrush obligates within 100 m of roads in the Pinedale Anticline Project area, likely due to traffic, increased horned lark abundance, and avoidance of habitat edges created by roads. The author suggested that oil and gas development likely would result in a decline in populations of sagebrush obligates and an increase in populations of horned larks, as well as additional nesting opportunities for common ravens on structures associated with gas extraction. Ravens prey on sagebrush-obligate nestlings (Martin and Carlson 1998). Nicholoff (2003) recommends that, for Brewer's sparrow, sage sparrow, and sage thrasher, road construction and other developments that would reduce sagebrush habitat patch size to less than 50 acres be avoided where practical. For loggerhead shrike, another BWS species which occurs within the vicinity of the JIDPA, Nicholoff (2003) recommends minimizing conversion of sagebrush and other shrublands and woodlands to non-native grasslands or croplands.

Populations of long-billed curlew have been declining due to loss of suitable habitat as grasslands are converted to cropland or urban development (Nicholoff 2003). No cropland conversion or urban development is proposed; however, some unknown amount of disturbance and habitat fragmentation could result if suitable habitat is disturbed.

Impacts to TEP&C and BWS animal species generally would be as described for wildlife (see Section 4.2.2), whereas impacts to TEP&C and BWS plant species generally would be as described for vegetation (see Section 4.2.1). Vegetation/habitat recovery to approximate predisturbance productivity could take 30 to over 100 years in sagebrush habitats (Braun 1998; Slater 2003). Impacts include 1) the direct loss of habitat due to the removal of vegetation and possible increased weed infestations; 2) displacement (wildlife only) due to disturbance from project-related activities, and increased public access to the JIDPA (indirect habitat loss); 3) habitat fragmentation; 4) direct mortality due to construction activities and animal/vehicle collisions; and 5) potential increased mortality due to poaching and harassment.

This project is unlikely to adversely affect TEP&C species occurring or potentially occurring on or adjacent to project-affected areas due primarily to the absence of these species on the area and the implementation of appropriate mitigation measures (see Chapter 2 and Appendices A and B). Therefore, the project is not anticipated to significantly impact TEC&P species under any alternative. Significant impacts to BWS species are anticipated within the JIDPA under all alternatives (most notably to sagebrush-obligate species). However, these impacts are not anticipated to result in the need to federally list any BWS species.

4.2.3.1 No Action Alternative

Currently, a total of 4,209 acres of short-term and 1,409 acres of LOP disturbance are approved within the JIDPA (BLM 1998b, 2000b). Under the No Action Alternative, no additional impacts to TEP&C and BWS species from oil and gas development would occur in the JIDPA. Impact duration would be approximately 63 years plus the time needed for adequate reclamation.

4.2.3.2 The Proposed Action

The Proposed Action would result in an estimated increase (over the No Action Alternative) of 16,200 acres of new initial disturbance, for a total of 20,409 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 70.4% of the total disturbance (14,369 acres) would be reclaimed and reseeded as soon as practical after disturbance (i.e., short-term disturbance). The remaining 29.6% (6,040 acres) would remain disturbed for the LOP. Impact duration would be approximately 76 years plus the time needed for adequate reclamation, or 13 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.3 Alternative A

Implementation of Alternative A would result in the same types and acreages of impacts to TEP&C and BWS species as the Proposed Action (i.e., an increase of 16,200 acres [11,569 acres of short-term disturbance and 4,361 acres of LOP disturbance] over the No Action Alternative). However, under Alternative A, selected Operator-committed and BLM-required practices (e.g., avoidance of Sand Draw buffer) would not occur; thus, additional impacts to BWS species and their habitats (e.g., pygmy rabbit, ferruginous hawk, burrowing owl, sagebrush-obligate species) would likely occur. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.4 Alternative B

Alternative B would result in an estimated increase over the No Action Alternative of 3,297 acres of new initial disturbance, for a total of 7,506 acres of project-related surface disturbance in the area. Most of the disturbance would occur in habitats used by BWS species. Approximately 65% (4,884 acres) of the total disturbance would be short-term, and the remaining 35% (2,622 acres) would remain disturbed for the LOP. Areas of the JIDPA that currently lack well pads would have minimal new surface disturbance because the alternative does not allow for construction of new well pads and, as a result, disturbance for new roads and pipelines required in those areas also would be minimal. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.5 Alternative C

Alternative C would result in an estimated increase over the No Action Alternative of 6,705 acres of new initial disturbance, for a total of 10,914 acres of project-related surface disturbance in the area. Most of the disturbance would occur in habitats used by BWS species. Approximately 68.9% (7,515 acres) of the total disturbance would be short-term, and the remaining 31.1% (3,399 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 68 to 80 years plus the time needed for adequate reclamation, or 5 to 17 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.6 Alternative D

Alternative D would result in an estimated increase over the No Action Alternative of 11,571 acres of new initial disturbance, for a total of 15,790 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 69.9% (11,037 acres) of the total disturbance would be short-term, and the remaining 30.1% (4,753 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 72 to 93 years plus the time needed for adequate reclamation, or 9 to 30 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.7 Alternative E

Alternative E would result in an estimated increase over the No Action Alternative of 6,386 acres of new initial disturbance, for a total of 10,595 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 66.1% (6,998 acres) of the total disturbance would be short-term, and the remaining 33.9% (3,597 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.8 Alternative F

Alternative F would result in an estimated increase over the No Action Alternative of 10,446 acres of new initial disturbance, for a total of 14,655 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 72.7% (10,658 acres) of the total disturbance would be short-term, and the remaining 27.3% (3,997 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.9 Alternative G

Alternative G would result in an estimated increase over the No Action Alternative of 13,989 acres of new initial disturbance, for a total of 18,198 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 70.3% (12,790 acres) of the total disturbance would be short-term, and the remaining 29.7% (5,408 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 76 to 105 years plus the time needed for adequate reclamation, or 13 to 42 years longer than the No Action Alternative.

Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.10 BLM Preferred Alternative

The Preferred Alternative would result in an estimated increase over the No Action Alternative of 7,804 acres of new initial disturbance, for a total of 12,013 acres of project-related surface disturbance. Most of the disturbance would occur in habitats used by BWS species. Approximately 69.2% (8,309 acres) of the total disturbance would be short-term, and the remaining 30.8% (3,704 acres) would remain disturbed for the LOP. Depending on the rate of development, impact duration would be approximately 76 years plus the time needed for adequate reclamation, or 13 years longer than the No Action Alternative.

The additional Preferred Alternative-specific mitigation and monitoring measures listed for vegetation and wildlife (see Section 2.14) would moderate, to some extent, any impacts to TEP&C and BWS species. Impacts still would occur at potentially significant levels for most, if not all BWS species identified as occurring in the JIDPA. Impacts to TEP&C species and their habitat would be minimal because of their infrequent use of the area.

4.2.3.11 Cumulative Impacts

The CIAA for TEP&C and BWS species includes the entire range of each potentially affected species, with an emphasis for BWS species, on the BLM PFO area. With regard to federally listed TEP&C species, the proposed project would not likely contribute to cumulative impacts to the black-footed ferret or Ute ladies'-tresses, because these species are not known to occur on the JIDPA nor are they likely to be affected by the project. Because no bald eagle nests or winter roosts are known to occur within 1 mile of the JIDPA and alternate foraging areas exist within relatively close proximity to the JIDPA, it is unlikely that the project would have any cumulative impact on the bald eagle. The proposed project would not add to cumulative impacts (surface water depletions) for the four Colorado River endangered fish species.

Project-related impacts to BWS species would add to impacts from other disturbance in the CIAA, including existing roads and traffic, oil and gas development, grazing and any other activity that would result in direct mortality, habitat fragmentation, or loss of habitat/habitat function. However, there is no evidence that any of the species would be proposed for listing as threatened or endangered as a result of cumulative impacts under any of the project alternatives. Site-specific projects requiring surface disturbance on BLM lands would require additional permitting which, in turn, may include mitigation measures for BWS similar to those for this project (see Appendices A and B).

4.2.3.12 Unavoidable Adverse Impacts

Habitat loss (direct and indirect) would occur due to construction, and human presence would further reduce habitat functionality in some of the remaining undisturbed or minimally disturbed areas. This would result in decreased populations of some BWS species on the JIDPA. Some direct mortality, especially to small mammals, likely would occur during construction and from project-related traffic.

4.2.4 Wild Horses

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979), and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with wild horses:

- to protect, maintain, and control viable, healthy herds of wild horses while retaining their free roaming nature;
- to provide adequate habitat for free-roaming wild horses through management consistent with environmental protection; and
- to provide opportunity for the public to view wild horses.

Impacts to wild horses would be significant if there would be a reduction in AUMs of a magnitude that would require modification to the management of wild horses in the LCHMA, or other actions that would prevent the realization of herd objectives, or if project disturbance resulted in a violation of RMP wild horse objectives.

There would be an increase in wild horse displacement, including movement of wild horses off the RSFO LCHMA onto PFO portion of the JIDPA (through potentially damaged fences or gates left open), and potential injury as a result of encounters with project facilities (e.g., cattle guards, traffic). Project impacts would occur primarily from vegetation loss (i.e., AUM loss); however, some impact to wild horse viewing is also anticipated under all alternatives since the quality of views (i.e., set with an oil and gas development background) would be reduced. With the revegetation and reclamation measures proposed to ensure successful revegetation (see Appendix G) and other practices identified in Appendices A and B, no significant impacts to wild horses are anticipated under any alternative.

4.2.4.1 No Action Alternative

Under the No Action Alternative, there would be no additional activities that would potentially affect wild horse populations other than those currently approved for the area (BLM 1998b, 2000b). Approximately 16 AUMs would be lost within the LCHMA for the LOP. The duration of impacts would be approximately 63 years and until areas are adequately reclaimed.

4.2.4.2 The Proposed Action

The Proposed Action would result in the direct removal of forage from approximately 2,415 acres (242 AUMs) initially, and 715 acres (72 AUMs) for the LOP within the 519,541-acre LCHMA. Impact duration is anticipated to be approximately 76 years and until adequate reclamation is achieved.

4.2.4.3 Alternative A

Implementation of Alternative A would result in the same types of impacts as all other development alternatives; however, impacts would be increased in areas that would otherwise have been avoided (e.g., steep slopes, drainage buffers). Alternative A would result in the direct removal of forage from approximately 2,415 acres (242 AUMs) initially, and 715 acres

(72 AUMs) for the LOP within the 519,541-acre LCHMA. Impact duration would be dependent upon the rate of development (from 76 to 105 years) plus the time required for adequate reclamation.

4.2.4.4 Alternative B

Under implementation of Alternative B, there would be forage losses on approximately 867 acres (87 AUMs) initially and 306 acres (31 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 76 to 105 years) plus the time required for adequate reclamation.

4.2.4.5 Alternative C

Under implementation of Alternative C, there would be forage losses on approximately 1,276 acres (128 AUMs) initially and 398 acres (40 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 68 to 80 years) plus the time required for adequate reclamation.

4.2.4.6 Alternative D

Under implementation of Alternative D, there would be forage losses on approximately 1,861 acres (186 AUMs) initially and 561 acres (56 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 72 to 93 years) plus the time required for adequate reclamation.

4.2.4.7 Alternative E

Under implementation of Alternative E, there would be forage losses on approximately 1,237 acres (124 AUMs) initially and 422 acres (42 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 76 to 105 years) plus the time required for adequate reclamation.

4.2.4.8 Alternative F

Under implementation of Alternative F, there would be forage losses on approximately 1,725 acres (172 AUMs) initially and 470 acres (47 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 76 to 105 years) plus the time required for adequate reclamation.

4.2.4.9 Alternative G

Under implementation of Alternative G, there would be forage losses on approximately 2,150 acres (215 AUMs) initially and 639 acres (64 AUMs) for the LOP in the LCHMA. Impact duration would be dependent upon the rate of development (from 76 to 105 years) plus the time required for adequate reclamation.

4.2.4.10 BLM Preferred Alternative

Under implementation of the Preferred Alternative, there would be forage losses on approximately 1,469 acres (147 AUMs) initially and 452 acres (45 AUMs) for the LOP in the LCHMA. Impact duration is anticipated to be approximately 76 years and until adequate reclamation is achieved.

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14).

4.2.4.11 Cumulative Impacts

The CIAA for wild horses is the entire LCHMA (see Map 3.20). Other existing developments in the LCHMA area are generally limited to secondary roads and natural gas development. Existing, proposed, and RFD (surface disturbance) activities are unlikely to reduce the carrying capacity of the Little Colorado Herd Management Unit although shifts in distribution may occur. Undo time expenditure and unnecessary hazing of wild horses back onto the RSFO LCHMA from the PFO portion of the JIDPA may occur due to increased area use for natural gas development and the failure to close field office boundary gates. The primary factor limiting the distribution of wild horses in the LCHMA is the availability of water, which is not anticipated to be affected cumulatively under any alternative except possibly the Preferred Alternative, if new water sources are provided. Cumulative impacts to wild horses are anticipated to be less than significant since wild horse population objectives are currently being met or exceeded in the LCMHA, and the reclamation activities that would be implemented under all alternatives have the potential to provide increased forage for wild horses. The aesthetic values associated with wild horse viewing would continue to decline where horses are observed in areas of development. This would occur cumulatively under all alternatives.

4.2.4.12 Unavoidable Adverse Impacts

Other than the temporary short-term and LOP loss of forage, no unavoidable adverse impacts to wild horses are anticipated.

4.3 CULTURAL AND HISTORICAL RESOURCES

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) prescribe the following management goals/objectives associated with cultural resources:

- to design cultural resource management actions to maintain the value of cultural resources;
- to expand the opportunities for scientific study and educational and interpretive uses of cultural resources;
- to protect and preserve important cultural resources or their historic record for future generations;

- to resolve conflicts between cultural resources and other resource uses; and conserve and develop historic resources for the benefit of present and future generations.

Because of the requirement for compliance with Section 106 of the NHPA and with the ARPA on federal lands, all areas on federal lands (surface or mineral estate) proposed for surface disturbance would be surveyed for cultural resources. These inventories would serve to protect most cultural properties from significant damage and would increase the site database and further our understanding of history and prehistory. Impacts to cultural and historic resources would be considered significant if they resulted in non-mitigated impacts to National Register-eligible historic properties, loss of scientifically important data or artifacts, a violation of the NHPA and/or ARPA, or disturbed Native American sensitive sites, or if they were inconsistent with the goals/objectives listed above. Adverse impacts to NRHP-eligible properties, or properties considered important to Native American groups, would be significant if they cannot be satisfactorily mitigated as determined through consultation with SHPO, ACHP, and other interested parties.

Impacts to cultural resources identified in a discovery situation (archaeological features found during and not prior to surface disturbing activities) could be greater and more significant than impacts to resources that were previously identified because damage to discovery sites would occur prior to their recordation and evaluation, thereby complicating mitigation procedures. The most significant and time-consuming mitigation of discoveries would likely be for sites with structural remains in San Arcacio soil contexts along Sand Draw and when subsurface components containing extensive or abundant artifact assemblages are located during large disturbances. Mitigation of impacts to discoveries could often be accomplished through data recovery excavations, which would increase our understanding of prehistory to varying degrees, depending on the nature and extent of the discovery. Significant impacts can occur in situations where undocumented NRHP-eligible archaeological sites are impacted but not recognized (and therefore not treated as discoveries and appropriately mitigated).

The Site 48SU4000 complex is highly sensitive and currently at risk. Extant and potential field developments pose a risk of direct threats to the site complex, and these threats would continue as the number of individuals familiar with and accessing the area increases due to ancillary adverse effects resulting from vandalism. To begin addressing these issues, the BLM and one of the Operators have negotiated a long-term site monitoring plan that includes a detailed inventory and recording of the entire District, as well as photographic monitoring and evaluation of looting. Miner (2001) has recommended pre-emptive mitigative excavations of rockshelters in highly visible locations and at significant locations in the vicinity of any proposed well pads and related facilities. Area-specific plans and procedures would continue to be promulgated and implemented to protect the resources in this area.

Impacts would primarily occur in direct proportion to the volume of new surface disturbance (i.e., more acres of disturbance generally would result in more discoveries, excavation, chances for illegal artifact collection and/or vandalism, and/or impacts to sites, locales, and places considered sacred, sensitive, or of importance to modern-day Native Americans [especially the Shoshone People]). Vandalism and illegal collection impacts would occur in proportion to the amount of human use on the area. Vandalism may be minimized through law enforcement, site monitoring activities, and educational programs. Application of various mitigation protocol (see Appendices A and B), would reduce impacts to cultural resources under all alternatives; however, in the absence of a Programmatic Agreement and Cultural Resource Management Plan, potential significant impacts to cultural resources could occur under any alternative.

Because of the requirement for cultural resource inventories in new disturbance areas, a large number of cultural properties would be found and added to the cultural resource database under all development alternatives. In addition, a large number of site mitigations (e.g., excavations) would be likely to occur, as avoidance of some NRHP-eligible sites likely would not be possible. Data recovery excavations would serve to increase our understanding of the prehistory of the region.

Procedures for identifying and protecting cultural resources on State of Wyoming lands are not in place. Generally, BLM requires inventory on State of Wyoming lands as a connected action for the first access; however, once federal access via a ROW or other federal permit to these lands is obtained, uninventoried future construction and project developments and associated unmitigated site disturbance may occur. Only with the implementation of a Programmatic Agreement that addresses State of Wyoming land development protocol could the avoidance of significant adverse impacts to cultural resources on these lands be assured.

Vandalism to cultural properties and illegal artifact collection would continue to be an issue in the JIDPA. Construction of new roads for well field expansion would provide access to additional areas, increasing the potential for vandalism. The increase in development under all development alternatives would increase traffic and human presence in the area, leading to additional artifact collecting and "pot hunting." Potential impacts associated with vandalism and illegal artifact collection are assumed to be proportional to the level of human activity (i.e., with a higher human presence there would be increased impact potential). Therefore, these potential impacts would likely be greatest during the development period, but would continue for the LOP.

Subsurface prehistoric discoveries resulting from construction are common in portions of the JIDPA, and more of these discoveries are likely to occur with continued development. Discoveries usually occur on the toes of small but discreet upland hillocks and rises flanked by intermittent drainages and on the terraces and valley slopes adjacent to Sand Draw. Sediments along Sand Draw are particularly sensitive; these are primarily San Arcacio soils known to contain intact Early Archaic period sites, including those with housepits. These soils extend as much as 0.5 mile from each side of the drainage channel. Impacts to cultural resources discovered during construction activities would be minimized by relocating further proposed surface disturbances or through appropriate mitigation. Any cultural resources discovered during project construction would be treated in accordance with 36 C.F.R. 800 and the State-wide protocol.

While avoidance of eligible sites would likely remain the primary tool to minimize potential adverse effects to cultural resources, there is a high degree of new development proposed for the JIDPA, with much of this development likely to occur in geomorphologically sensitive areas with high discovery potential, and project-by-project avoidance would prove to be increasingly difficult and time-consuming. Since substantial new ground disturbance is proposed within the JIDPA under all development alternatives, it would not only be much more difficult to avoid identified cultural resources, but there would likely be an increase in unanticipated discoveries. Such unexpected discoveries are currently being handled on a case-by-case basis under the general direction of 36 C.F.R. 800.13. Consultation involves the Operators, BLM, Wyoming SHPO, Advisory Council on Historic Preservation, and other interested parties. Under all project development alternatives, a greater number of construction projects would be delayed due to discoveries and subsequent consultation requirements. Because of the frequently complex nature of such discoveries, the need for development of case-by-case treatment plans, the exposed nature of the discovery, and the availability of archaeologists to evaluate the discovery, delays are common. Implementation of Programmatic Agreements and treatment or discovery plans that identify standard treatments, procedures, and management alternatives would lessen the impacts unexpected discoveries have on specific development projects. Duplication of paperwork is reduced, time frames for decision-making are greatly condensed, more "hands-on" management of an already damaged resource can occur, and overall management efficiencies are increased. A reduction in delay to Operators also results in a savings in construction costs and lessened shut-down impediments. Development and implementation of these plans would be beneficial to all parties, given the substantial increase in proposed ground disturbance within culturally sensitive areas. Programmatic approaches in the JIDPA could also benefit data synthesis and provide useful information to scholars and the general public.

Past consultation with Native American Tribes has determined that the 48SU4000 Archaeological District is sensitive to Native Americans, as are several rock alignment sites along the edge of Yellow Point Ridge. Any increase in ground-disturbing activities has an increased potential of impacting significant sites, locales, and places considered sacred, sensitive, or of importance to modern-day Native Americans (especially the Shoshone People).

4.3.1 No Action Alternative

Under the No Action Alternative, there would be no additional surface disturbance other than that already approved by the BLM (1998b, 2000b). Prior NEPA documents concluded that there would be no significant adverse impacts to cultural resources as a result of the project; however, these conclusions assumed implementation of a Programmatic Agreement among BLM, SHPO, and Operators. Since this Programmatic Agreement expired, significant impacts have occurred, and while most cultural resource impacts have already happened, potentially significant impacts could still occur. Few new cultural resource inventories would be conducted, and no new sites would be recorded and added to the cultural resource database. Vandalism and illegal artifact collecting may continue for the LOP. In the absence of new ground disturbance, no additional unanticipated discoveries are likely to occur. Cultural resource impacts would continue for an estimated 63 years under the No Action Alternative. No new impacts to Native American religious or culturally significant sites are anticipated beyond current levels.

4.3.2 The Proposed Action

Under the Proposed Action, an estimated 20,409 acres (67% of the JIDPA) would be directly impacted by surface-disturbing activities. This equates to an average disturbance of 429 acres per 640-acre section. Impacts to cultural resources would be increased due primarily to new surface disturbance (16,200 acres). Vandalism and illegal artifact collection would likely be greatest during development (13 years), but would continue for approximately 76 years and until project personnel are no longer required.

4.3.3 Alternative A

Under Alternative A, impacts to cultural resources would be increased from those of the No Action Alternative, be the same as those of the Proposed Action, but be increased in areas such as Sand Draw that would be avoided under other alternatives. Vandalism and illegal artifact collection would likely be greatest during development (13 to 42 years) but the duration of these impacts would continue for the LOP (from 76 to 105 years).

4.3.4 Alternative B

Under Alternative B, approximately 7,298 acres of the JIDPA would be directly impacted by surface-disturbing activities, and an additional 283 acres of disturbance would occur at locations outside the JIDPA (e.g., Burma Road upgrade). This would result in an increase to potential impacts to cultural resources from that of the No Action Alternative. Cultural property avoidance may be more difficult under Alternative B as compared with the other development alternatives (i.e., existing pads would be increased in size) since pad locations are fixed. Vandalism and artifact collection would likely be greatest during development (13 to 42 years) but duration of these impacts would continue for the LOP (from 76 to 105 years).

4.3.5 Alternative C

Under Alternative C, approximately 10,631 acres of the JIDPA would be directly impacted by surface-disturbing activities, and an additional 283 acres of disturbance would occur outside the JIDPA. This would result in an increase to potential impacts to cultural resources from that of the No Action Alternative. Vandalism and illegal artifact collection would likely be greatest during development (5 to 17 years) but would continue for the LOP (68 to 80 years).

4.3.6 Alternative D

Under Alternative D, approximately 15,507 acres of the JIDPA would be impacted, and an additional 283 acres of disturbance would occur outside the JIDPA. This would result in an increase to potential impacts to cultural resources from that of the No Action Alternative. Vandalism and illegal artifact collection would likely be greatest during development (9 to 30 years) but would continue for the LOP (72 to 93 years).

4.3.7 Alternative E

Under Alternative E, approximately 10,312 acres of the JIDPA would be impacted, and an additional 283 acres of disturbance would occur outside the JIDPA. This would result in an increase to potential impacts to cultural resources from that of the No Action Alternative. Vandalism and illegal artifact collection would likely be greatest during development (13 to 42 years) but would continue for the LOP (76 to 105 years).

4.3.8 Alternative F

Under Alternative F, approximately 14,372 acres of the JIDPA would be impacted, and an additional 283 acres of disturbance would occur outside the JIDPA. This would result in an increase to potential impacts to cultural resources from that of No Action Alternative. Vandalism and illegal artifact collection would likely be greatest during development (13 to 42 years) but would continue for the LOP (76 to 105 years).

4.3.9 Alternative G

Under Alternative G, approximately 17,915 acres of the JIDPA would be impacted, and an additional 283 acres of disturbance would occur outside the JIDPA. This would result in an increase to potential impacts to cultural resources from that of the No Action Alternative. Vandalism and illegal artifact collection would likely be greatest during development (13 to 42 years) but would continue for the LOP (76 to 105 years).

4.3.10 BLM Preferred Alternative

Under the Preferred Alternative, approximately 11,730 acres of the JIDPA (38%) would be directly impacted by surface-disturbing activities, and an additional 283 acres of disturbance would occur outside the JIDPA. An average disturbance of 243 acres per 640-acre section would occur in the JIDPA. Impacts to cultural resources would be increased from that of the No Action Alternative due primarily to new surface disturbance (7,804 acres more than No Action). Vandalism and illegal artifact collection would likely be greatest during development (13 years) but would continue for the LOP (76 years).

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Any measure that reduces the volume of surface disturbance or the level of human presence has the potential to reduce impacts to cultural resources.

4.3.11 Cumulative Impacts

Cumulative impacts to cultural resources within their CIAA (see Map 3.5) would include those detailed in past NEPA documents (BLM 1997a, 1998a, 2000a) and would generally be as described for this project, but would occur over the larger CIAA and as a result of additional non-project-related ground-disturbing and vandalism/illegal collection activities primarily associated with energy developments in the Pinedale Anticline area. Additional direct impacts to cultural resources in the CIAA and outside the JIDPA have resulted primarily from development of the Pinedale Anticline Gas Field to the north of the JIDPA.

The great increase in the human presence in the JIDPA and surrounding areas over the last 8 years has tremendously increased vandalism and artifact collection (personal communication, September 2004, with Dave Vlcek, Cultural Resource Specialist, PFO). Numerous contacts among regulatory agency personnel and consultants have noted considerable illegal artifact collection in the area. The cumulative effect of this activity has been adverse. Illegal artifact removal has made the evaluation of surficial archaeological sites quite difficult due to the absence of diagnostic artifacts, tools (which aid in the determination of site function), and the dislocation of the tools of the archaeologist.

Unmitigated loss of cultural resources in discovery and undocumented site situations associated with ground-disturbing actions would accumulate. Inventory, recordation, and data recovery projects triggered by ground-disturbing actions would continue to increase the cultural resource database, likely improving future cultural resource management decisions. Generally, the greater the increase in permitted activity, the greater the data acquisition of cultural resource information will be. Already in 2004, several major new archaeological discoveries have been made and documented, greatly increasing our knowledge of the prehistory of the area. The recovery of a 7,300-year-old human burial is one such example and the data recovery efforts at Site 48SU4479 are beginning to rewrite the prehistory of the Upper Green River Basin. Cumulatively, archaeological investigations in the JIDPA have made notable positive impacts upon our knowledge of the archeology of the region.

Data recovery excavations remove all or a portion of in situ cultural materials at sites, thereby resulting in potential future data loss if new data recovery and analysis techniques are developed. These impacts would accumulate as additional sites are excavated.

With the implementation of the cultural resource mitigation actions identified in Appendices A and B, cumulative impacts to cultural resources would be minimized or offset.

Increased surface-disturbing activities and human presence primarily resulting from expanded energy development activities in the CIAA would result in increased cumulative adverse effects, and because many of these impacts are indirect (pot hunting), they are difficult to minimize or mitigate. Under any project development alternative, cumulative impacts would increase with increased surface disturbance and human activity, and significant cumulative effects to cultural resources could occur if undocumented and unrecognized NRHP-eligible sites are impacted and unmitigated.

4.3.12 Unavoidable Adverse Impacts

Because of the requirement for compliance with Section 106 of the NHPA and with the ARPA on federal lands, adverse impacts are generally avoided or mitigated with the exception of situations where undocumented NRHP-eligible sites are impacted but not recognized, thereby occurring without mitigation. This type of unavoidable adverse impact may occur under all alternatives.

Unmitigated adverse effects to eligible sites could also occur on State of Wyoming lands because fewer protections are afforded to cultural resources on lands falling outside BLM jurisdiction. Unexpected discoveries on state lands have occurred, and procedures for mitigative treatment of these finds are not in place. Therefore, unavoidable adverse impacts to discovery sites would continue until or unless formal procedures for protecting cultural resources on State of Wyoming lands are implemented.

4.4 SOCIOECONOMICS

The PFO and RSFO RMP RODs (BLM 1988b, 1997b, 2004b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with socioeconomics:

- to coordinate land use decisions with economic factors and needs;
- to mitigate economic, social, and environmental impacts on communities caused by rapid or large-scale growth and development;
- to plan for the provision of public facilities and services, including safe and efficient transportation and utility systems, in coordination with local land use policies, goals, and objectives; and
- to provide adequate, suitable land to meet housing needs of all residents.

BLM (2004b) criteria stipulate that impacts to socioeconomic resources would be considered potentially significant if any of the following were to occur:

- changes in total employment in Lincoln, Sublette, and Sweetwater Counties exceed an increase or decrease of 1% of the trend or

- changes in local tax revenues exceed an increase or decrease of 15% of the trend.

The SCBC and SCPC (2003) emphasize the following values specific to the social traditions and socioeconomic base of Sublette County.

- Sublette County's unique local culture should be preserved and enriched, a culture characterized by a rural Wyoming flavor, a thriving private business community, an atmosphere friendly to working families, and the security of friendly crime-free communities.

- There should be an abundance of economic freedom and diverse opportunities for residents old and new to pursue prosperity and happiness--complemented and sustained by a business-friendly atmosphere, reasonable taxation, a low cost of living, limited regulation, wise development of its natural resources, and a strong tradition of a good work ethic.

Unless otherwise cited, the socioeconomic information that follows has been summarized from the *Socioeconomic Analysis Technical Support Document for the Jonah Infill Drilling and South Piney Projects Environmental Impact Statements* (BLM 2005), which is available from the BLM PFO. Please refer to that document for more detailed socioeconomic information and analysis. Additional information has been taken from the socioeconomic profile (BLM 2003b) prepared for inclusion in the Pinedale RMP.

BLM defines a significant change as any change that would result in a 15% or greater change of any affected factor. The following analyses show that the project under all alternatives is compatible with BLM management objectives. Socioeconomic impacts are anticipated as a result of increased local taxes and revenues. Under the No Action Alternative, the affects of increased employment, economic activity, and substantial federal, state, local, and county revenues would not occur; which could result in impacts on socioeconomics. Cumulative economic impacts are likely to occur.

In the long-term, all alternatives would likely result in economic impacts; however, while population is not likely to be affected over the LOP as a direct result of this project, there may be short-term (development phase) population impacts as a result of cumulative impacts from in-migration associated with this project in combination with other regional projects (e.g., Pinedale Anticline).

Depending upon the number of wells (1,250, 2,200, or 3,100) and the number of wells developed per year (75, 150, or 250), project construction, drilling, completion, and production would require from 43 to 82 years to complete (the LOP). The fewer the number of wells and/or the faster the pace of development, the shorter the LOP. The estimated number of years to complete the project under each alternative is shown in Table 2.2. Production for the LOP could range from 3,366 billion cubic feet (BCF) under the No Action Alternative (no new development) to

8,191 BCF under the Alternative A (3,100 new wells and new well pads). The anticipated gas and condensate recovery volumes are shown in Table 4.2.

The economic impact of the Proposed Action, alternatives, and cumulative impacts on the study-area economy were analyzed in two phases using the methods developed for the Southwest Regional Economic Evaluation (SWREE) (UWAED 1997) and the Jack Morrow Hills Coordinated Action Plan (JMHCAP) (UWAED 2003; BLM 2003a). Phase I was the development phase, which considered the economic impacts associated with drilling and completion of infill wells in the JIDPA. Due to the large price fluctuations in natural gas prices, the economic impacts of production were estimated based on cost of production rather than total output. Phase II considered the economic impact of natural gas and condensate production as a result of the production from the wells completed under Phase I.

<u>Assumptions and Methods</u>

Assumptions and methods are detailed in BLM (2005). Economic impacts are presented in terms of real and nominal impact. A real discount rate has been used to adjust and to eliminate the effect of expected inflation to determined discounted constant-dollar (present value or "real value") of benefits and costs. Pursuant to OMB Circular No. A-94, the real discount factor is calculated as $1/(1+i)^t$ where i is the interest rate and t is the project year (OMB 2004). The present value is the value of those activities after the real discount rate has been applied over time. As presented herein, the nominal value of project activities is the simple calculation of dollars with no adjustments. Natural gas economic activity will depend upon three primary factors: 1) total number of wells, 2) total number of pads on which wells can be placed, and 3) rate of development. Total recovery will depend upon the number of wells (1,250, 2,200, or 3,100) and the number of pads they are placed on. Some combinations of conventional/directional drilling may make full recovery uneconomical. An estimated 10,500 BCF of natural gas and 99.85 million barrels of Jonah Field condensate (oil) are present beneath the JIDPA (see Table 4.2). No alternative anticipates total recovery of all natural gas or condensate resources present in the field. Total annual per well operation cost is presented in Table 4.12.

<u>Labor</u>

An estimated 7,011-16,863 worker-years of direct employment would be provided by the Proposed Action during the LOP (see Appendix G). Jobs indirectly created or induced as a result of development and operations are presented in terms of annual job equivalents (AJEs). An AJE represents 12 months of employment. For example, one AJE could represent one job for 12 months or two jobs for 6 months or three jobs for 4 months. For the purposes of this analysis, a job is defined as 260 worker-days or 1 worker year, a person-year is 365 days; therefore, there are approximately 1.4 worker years per person year. An AJE would not necessarily result in a new job; it may simply represent the continuation of an existing job that would otherwise have been terminated had the development not occurred. Average annual starting wages per job would not necessarily be the earnings for each job created/maintained. Actual wages are determined on an individual basis by employers as influenced by market forces.

Table 4.12 Annual Cost of Natural Gas Production, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.[1]

Annual Production Operating Costs	Annual Cost per Well
Annual Production (million cubic feet [MCF])	717,232
Direct Labor and Overhead	$16,831
Nonlabor Annual Costs	
Fuel, Chemicals, and Disposal	9,850
Surface Maintenance	5,847
Subsurface Maintenance	5,979
Electricity	--
Gas Compression Costs	--
Gas Transportation Costs	191,041
Total Annual Costs	$229,548
Nonlabor Annual Costs	$212,717
Total Annual Cost Per MCF	$0.32
Nonlabor Cost Per MCF	$0.30

[1] Source: Operators. Assumes natural gas recovery costs include recovery of condensate.

Economic Activity from Development and Production

An in-depth discussion of expected economic activity is presented in BLM (2005). A summary of expected economic activity from one conventional and one directionally drilled well is presented in Table 4.13. AJEs represent secondary jobs and do not include proposed jobs presented in Appendix G. Expenditures made to drill and complete one conventional well would generate economic activity (direct and secondary) of $2,719,091 and would generate 16.7 AJEs. Expenditures made to drill and complete one directionally drilled well would generate economic activity (direct and secondary) of $3,051,586 (includes $621,292 of secondary labor earnings) and would generate 19.4 AJEs. This activity is assumed to remain constant across all alternatives on a per well basis. The timing of economic activity will depend on the approved number of wells and the rate of development.

The value of natural gas production is based on revenues less cost of operation. Table 4.14 shows that production from one BCF of natural gas would generate total economic activity (direct and secondary) of $3,632,083 (includes $132,083 of secondary labor earnings) and would create 3.92 AJEs. One MBO is assumed to generate total economic activity (direct and secondary) of $21,792,498 (includes $792,498 of secondary labor earnings) and would create 23.52 AJEs. The economic activity associated with condensate production is likely conservatively underestimated because condensate from the Jonah Field is of particularly high quality and generally sells for a price higher than the price of crude oil. Assumed production rates, decline curves, and discounting tables are presented in BLM (2005: Appendix A).

Table 4.13 Economic Activity from Gas Drilling Per Well, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Estimated Impacts	Conventional Well	Directionally Drilled Well
Direct Expenditures[1,2]		
Drilling ($)	$653,574	$897,184
Completion ($)	$1,533,110	$1,533,110
Total Direct Expenditures ($)	$2,186,684	$2,430,294
Secondary Labor Earning		
Drilling ($)	$239,402	$328,287
Completion ($)	$293,005	$293,005
Total Secondary Labor Earnings ($)	$532,407	$621,292
Total Economic Activity Impact per Well	$2,719,091	$3,051,586
Annual Job Equivalents (AJEs)		
Drilling	7.3	3.3
Completion	9.4	1.2
Total AJEs per Well[3]	16.7	19.4
Average Earnings Per Created Job ($)[4]	$31,881	$32,025

1 Includes proposed labor costs.
2 Completion includes the cost of completion and setting of production equipment.
3 AJEs are jobs indirectly created as a result of the activity. They do not include the direct labor jobs (proposed) presented in Appendix G.
4 This estimated average annual starting wage per job would not necessarily be the actual wage paid for each created job. Actual wages are determined on an individual basis by employers as influenced by market forces.

Table 4.14 Economic Activity Gas Production from One BCF of Natural Gas and One MBO, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Resource	Economic Activity
Natural Gas	**Activity per BCF**
Revenue[1]	$3,500,000
Secondary Labor Earnings	$132,083
Total Economic Activities	$3,632,083
AJEs	3.92
Condensate	**Activity per Million Barrels**
Revenue[2]	$21,000,000
Secondary Labor Earnings	$792,498
Total Economic Activities	$21,792,498
AJEs	23.52

1 Price is $3.50/MCF based on CREG (2004). The value of production is based on revenues less cost of operation.
2 Price is $21/bbl based on CREG (2004). Assumes natural gas recovery costs include recovery of condensate.

Government Revenues

Under all alternatives (including No Action), the project would generate substantial revenues for state, county, and local governments, as well as area school districts, through state sales tax, federal income tax, ad valorem taxes, severance taxes, federal minerals royalties, and other taxes on facilities and production. Assumptions regarding the analysis of project effects on government revenues are detailed in BLM (2005).

The estimated revenues and taxes resulting from the project, as well as their present value, for the LOP are presented in detail in BLM (2005), including the likely distribution of those funds to the U.S., Wyoming, and affected counties, cities, and towns based on current statutes and distribution trends. For the purposes of this analysis, the rate of development and an average decline curve for individual well production (BLM 2005: Appendix A) was used to estimate total annual field production; well life was assumed to be 40 years. Increases in taxes and revenues would have the effect of providing counties and communities with more discretionary dollars to develop infrastructure and provide for the needs of low-income residents; thus, the dependence on federal or state grant monies would be reduced.

All counties in the study area would benefit from increased revenues from federal royalties, severance taxes, sales taxes, and presumably use and lodging taxes, although the latter are not discussed further herein.

Because development and production would occur within Sublette County, directly related increases in ad valorem production and property taxes would impact only Sublette County and its communities. Ad valorem taxes on production were estimated herein; however, real property values are likely to change if population fluctuates due to cumulative non-project-related factors, which could result in fluctuating receipts from ad valorem taxes on property. Real property value changes are beyond the scope of this analysis and are not addressed further.

Recreation

Economic losses could result if recreationists were displaced from the JIDPA and moved their activities out of the study area. Losses would be proportional to the number of displaced recreationists. For the purposes of this analysis, it is assumed that all recreation would be lost from the JIDPA for the LOP. (It is likely that most of this loss has already occurred due to extant development effects.)

Direct impacts from displaced nonconsumptive recreationists (per visitor day) could result in a loss of $29.62 (including $6.80 of labor income) and 0.000518 AJEs each (Table 4.15). If all 3,396 RVDs (see Section 3.4) were lost (regardless of the alternative), there would be a loss of direct expenditures of $100,590 (including $23,093 labor earnings) and a loss of 1.8 AJEs annually for the LOP (BLM 2005).

However, it is likely that any recreationists discouraged from engaging in activities in the JIDPA as a result of natural gas development would relocate their activities to other locations in the vicinity that would provide similar recreational opportunities unique to the PFO area; thus, no actual economic loss is likely to result from loss of recreation due to the proposed project. Individuals may experience some impacts in terms of lessened enjoyment and satisfaction from relocated recreational activities.

Table 4.15 Economic Activity per RVD from Nonconsumptive Recreation, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Item	Economic Activity per RVD
Direct Expenditures	$22.82
Secondary Labor Earnings	$6.80
Total Economic Activity per RVD	$29.62
AJES per RVD	0.000518

Economic activity from hunting could be reduced if hunters were displaced from the JIDPA and moved their activities out of the study area. Losses would be proportional to the number of displaced hunters. Under the Proposed Action and alternatives, populations of pronghorn antelope and/or greater sage-grouse, which are the two principle species hunted on the JIDPA, would likely be displaced to such an extent that recreational hunting on the JIDPA may no longer occur. Cottontail rabbits are also hunted on the JIDPA, but are unlikely to be displaced by project activities. However, it is likely that hunters already avoid the area due to extant development. Lands adjacent to the JIDPA may absorb displaced hunting pressure since displaced wildlife (most notably pronghorn antelope and greater sage-grouse) may also move to adjacent lands; thus, no economic loss may result from loss of hunting due to the project. However, for the purposes of this economic analysis, it is conservatively assumed that all hunting on the JIDPA would be lost for the LOP.

Only cottontail, greater sage-grouse, and pronghorn are likely to be hunted on the JIDPA. WGFD does not collect resident versus nonresident information for cottontail and greater sage-grouse hunting; therefore, it will be conservatively assumed for the purposes of this analysis that all hunters are nonresident. Direct impacts from displaced pronghorn hunters (61.0 hunter days per year attributable to JIDPA) could result in a loss of $536.46/hunter day (including $155.16 of labor income) and 0.012087 AJEs each (Table 4.16). Direct impacts from displaced cottontail hunters (26.4 hunter days per year) could result in a loss of $243.48/hunter day (including $70.42 of labor income) and 0.005486 AJEs each. Direct impacts from displaced greater sage-grouse hunters (16.3 hunter days per year) could result in a loss of $183.32 (including $53.02 of labor income) and 0.004131 AJEs each. If all hunters relocate their activities away from the JIDPA could result in a loss of $42,140 ($12,188 of labor income) and 0.95 AJEs of annual economic activity (BLM 2005).

It is likely that any hunters discouraged from engaging in activities in the JIDPA as a result of natural gas development would relocate their activities to other locations in the vicinity; thus, no economic loss is likely to result from loss of hunting due to the proposed project.

<u>Grazing</u>

There would be a reduction in available forage on grazing allotments within the JIDPA due to road, pipeline, and well pad construction (see Section 4.5.2). For the purposes of this analysis, it is conservatively assumed that, based on the reduction in forage, BLM would reduce the number

Table 4.16 Economic Activity per Hunter Day, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

	Economic Activity per Hunter Day			
Item	Pronghorn	Cottontail	Greater Sage-grouse	Total
Direct Expenditures	$381.30	$173.06	$130.30	$684.66
Secondary Labor Earnings	$155.16	$70.42	$53.02	$278.60
Total Secondary Activity per Hunter Day	$536.46	$243.48	$183.32	$963.26
AJEs per Hunter Day	0.012087	0.005486	0.004131	0.021704

of permitted AUMs during initial disturbance and for the LOP; these estimated reductions are presented in BLM (2005). The economic activity from these AUMs is presented in Table 4.17. The assumed reduction in AUMs does not take into consideration the possibility that areas reclaimed shortly after initial disturbance--areas not needed for the LOP--would provide more forage (primarily grass) for livestock than the previously undisturbed range. Total economic impact per AUM lost is estimated at $114.99 (including $18.46 labor earnings) and 0.000709 AJEs annually and (Table 4.17). Additionally, fees paid to the BLM by permittees ($1.35/AUM) would not be realized if the number of permitted AUMs were reduced.

For the purposes of this economic analysis, it is conservatively assumed that all affected AUMs (cumulative plus RFD) would be lost under each action alternative for the LOP (BLM 2005). Total losses would depend on the length of the LOP, which depends on the number of wells and rate of development ultimately approved. Some AUMs would return to productivity during the LOP as reclamation proceeds and forage production increases. Removal and subsequent reinstatement of any permitted AUMs would be at the discretion of the BLM.

Social Impacts

Social impacts are discussed in more detail in BLM (2005).

The project could result in some increases in population in Sublette, Lincoln, and Sweetwater Counties, as a result of job seekers from other areas moving to the area in search of employment; although existing industry expertise and services in the three counties is generally adequate to service additional oil and gas development. Some limited degree in-migration of labor is anticipated as a result of the project; without adequate planning at the local level, increases in population would likely have some effect on communities in the study area.

Personal per capita income in the study area ranged from $16,140 to $28,037 in 2000. Estimated annual starting wages per job created as a result of the project would be from 50-58% higher than the personal per capita income reported in 2000. Thus, there would likely be impacts from increased income to local families and reduced poverty as a result of the Proposed Actions and alternatives. These impacts would not be realized under the No Action Alternative.

Table 4.17 Economic Activity from Grazing per AUM, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Item/AUM	Economic Activity per AUM
Value of Production	$35.29
Indirect Economic Activity (not labor)	$61.24
Secondary Labor Earnings	$18.46
Total Economic Activity per AUM	$114.99
AJEs per AUM	0.000709

It is not anticipated that the project would result in an in-migration of workers to the study area. With an estimated 1,713 available workers available in the study area and 12,000 available workers in Wyoming, the estimated number of laborers that would be directly employed as a result of the project would be readily available. The project would directly provide 166-401 jobs annually (assuming a 43-year LOP) and would indirectly generate 1,690 to 5,256 AJEs annually. Some of these jobs would be existing jobs that would continue to occur as a result of continued development and operations that would otherwise have been lost; some jobs would be newly created parallel or transitional jobs. These jobs would likely reduce or prevent an increase in unemployment in the study area and the state. The project would result in impacts resulting from increased local employment--both to the workforce directly involved in oil and gas development and to the general service economy--especially during construction and drilling. However, the existing labor shortage reported by Mast (2004) may be incrementally increased by the project (personal communication, December 2004, with Roy Allen, Economist, BLM Wyoming State Office, Cheyenne and with Marilyn Filkins, Sublette County Attorney, Pinedale).

Increased revenues, incomes, and population in the study area would likely result in increased entropy in the study area society. Crime could increase in the study area as a result of greater affluence among the residents of the study area. However, the population in the study area is not anticipated to increase in the long-term as a result of this project; therefore, no project-specific increase in crime is anticipated. However, because of the demographics of the laborers attracted to oil and gas development and production, the existing crime situation, which is already affecting the CIAA, may be incrementally increased by the project.

Increased affluence in the study area could attract additional health-care providers to the area or encourage existing health care providers to remain in the area. However, impacts already being experienced by the healthcare community may be incrementally increased by the project as a result of increases in population by individuals attracted to potential new opportunities.

While it is possible that there may be some increase in the study area population as a result of job-seekers coming to the area, such an increase in population would not place an undue burden on existing infrastructure. For instance, nearly 32% of the housing in Sublette County is vacant, although the habitability of this vacant housing is unknown. No housing shortages are anticipated. However, if there were an increase in the population, increased demand would likely cause an increase in housing prices (rental costs and home sale prices). Additionally, increased affluence in the study area is likely to cause an increase in the demand for higher-quality housing. This would result in increased ad valorem tax revenues to local governments. It could also make it more difficult for some individuals to obtain satisfactory housing within affordable price ranges, which would have an effect on those individuals. Impacts to housing already being experienced by the affected communities may be incrementally increased by the project as a result of increases in population. A motel is being planned for construction in Pinedale and several mancamps are also under discussion by area operators not involved with this project, to help alleviate pressures on housing. Additionally, several multi-unit housing developments are under discussion (personal communication, December 2004, with Roy Allen, Economist, BLM Wyoming State Office, Cheyenne and Cyd Goodrich, Realtor, Pinedale Properties).

Increased cost of living and inflation already being experienced by the affected communities also may be incrementally increased by the project.

Increased revenues to schools as a result of increased ad valorem and other taxes and revenues would be an impact to the school systems, thereby allowing the purchase of higher quality teaching materials and potentially increasing the wages of teachers, which could attract teachers with higher credentials than would otherwise have been attracted to positions within the study area. Any increases in population would likely aid in offsetting the current trend toward school closures/consolidations in some communities. Additionally, increased funding would provide schools with more options to improve education and raise Wyoming Comprehensive Assessment System scores, thus increasing the overall education rate and improving the quality of the overall work force in the study area. Increases in population may help reduce impacts already being experienced by schools in affected communities that have resulted in school closures. All area schools have plenty of capacity for expansion of enrollment (Blevins et al 2004).

4.4.1 No Action Alternative

See BLM (2005) for a detailed analysis of socioeconomic impacts related to production, recreation, and grazing, as well as social impacts. Under the No Action Alternative, no additional development would occur. This would reduce the number of rigs, crews, and associated services currently operating in the area. Currently, one oilfield service operator employs over 300 people and employs local contractors from over 30 companies within the town of Rock Springs (Schlumberger Oil Field Services Companies 2003). It is approximated that between 1996 and 2002, 59.3% of all exploration and production oilfield service fees paid in the state were spent on services in the Jonah Field (Schlumberger Oil Field Services Companies 2003). These services and associated jobs would likely be reduced or eliminated under the No Action Alternative. No additional economic activity from development would occur under this alternative--no additional secondary labor earnings or jobs would be created, and no additional taxes or revenues from development would be realized.

Under the No Action Alternative, the least amount of change in economic activity from current conditions would be expected when compared to all other alternatives. Because no additional development would occur, no economic activity from development would occur (Table 4.18). Production would be limited to the life of currently producing wells, therefore, only up to 3,366 BCF of gas and 31.98 MBO would be recovered under this alternative. Over the LOP, the No Action Alternative would generate up to $9,275.7 million present value, including $1,753.7 million present value in taxes/royalties. Based on a population of 6,024 (year 2002), this would be nominally equivalent to the county receiving funds of $123,144 (approximately $3,079 annually) for each person in the county (see BLM 2005).

Table 4.18 Summary of Total Economic Activity Resulting from Natural Gas Development and Production Over the Life of Field, Jonah Infill Drilling Project, Sublette County, 2005.

	Economic Activity Resulting from Development (LOF)									
Economic Effect	No Action Alternative	Proposed Action	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F	Alternative G	Preferred Alternative
Total Anticipated Natural Gas Recovery over the LOF (BCF)	3,366	7,947	8,191	6,124	6,657	7,554	6,302	7,186	7,876	Approximately the same as Alternative G
Total Anticipated Condensate Recovery over the LOF (million bbls)	31.98	75.50	77.81	58.18	63.24	71.76	59.87	68.27	74.82	
Potential Range of Change in Employment										
Secondary Development Employment (AJEs)	--	52,930 to 53,342	52,187.5 to 52,605.0	60,625 to 61,110	21,617 to 22,119	38,466 to 38,474	59,848 to 60,316	57,823 to 99,071	53,740 to 54,193	
Average Earnings Per Job	--	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	$31,881 to $32,025	
Secondary Production Employment (AJEs)	13,947	32,928	33,939	25,374	27,583	31,299	26,112	29,775	32,634	
Average Earnings Per Job	$47,173	$47,173	$47,173	$47,173	$47,173	$47,173	$47,173	$47,173	$47,173	
Recreation AJEs	--	-92.4 to -144.2	-92.4 to -144.3	-92.4 to -144.4	-79.2 to -100.3	-86.2 to -123.1	-92.4 to -144.4	-92.4 to -144.4	-92.4 to -144.4	
Hunting AJEs	--	-49.9 to -77.9	-49.9 to -77.9	-49.9 to -77.9	-42.8 to -54.2	-46.6 to -66.5	-49.9 to -77.9	-49.9 to -77.9	-49.9 to -77.9	
Grazing AJEs	--	-65.7 to -102.7	-65.7 to -102.7	-24.4 to -38.1	-30.5 to -38.6	-47.6 to -68.0	-34.5 to -53.9	-47.4 to -74.1	-58.7 to -91.7	
Potential Range of Change in Employment	13,947	85,110.0 to 85,945.2	85,918.5 to 86,219.1	85,832.3 to 86,223.6	59,047.5 to 49,508.9	69,584.6 to 69,515.4	85,732.2 to 86,151.8	87,408.3 to 128,549.0	86,173.0 to 86,513.0	
NOMINAL VALUE OF ECONOMIC ACTIVITY										
75 Wells Per Year Development Rate										
Value of Development[1] (millions of $)	0.0	8,655.9	8,565.1	9,612.5	3,568.6	6,227.7	9,514.7	9,263.4	8,760.6	Approximately the same as Alternative G
Value of Production[1,2] (millions of $)	12,922.5	30,509.5	31,446.1	23,510.8	25,556.9	29,000.6	24,194.1	27,587.9	30,236.8	
Taxes/royalties from proposed project (millions of $)	2,334.9	6,076.0	6,239.1	4,881.4	4,850.7	5,646.0	4,997.8	5,592.7	6,034.8	
Recreation (millions of $)	0.0	-8.2	-8.2	-8.2	-5.7	-7.0	-8.2	-8.2	-8.2	
Hunting (millions of $)	0.0	-3.5	-3.5	-3.5	-2.4	-2.9	-3.5	-3.5	-3.5	
Grazing (millions of $)	-1.5	-14.2	-14.2	-5.3	-5.3	-9.4	-7.8	-10.2	-12.0	
Total Nominal Economic Activity (millions of $)	15,255.9	45,215.5	46,224.5	37,987.7	33,962.7	40,854.9	38,687.2	42,422.1	45,008.6	
150 Wells Per Year Development Rate										
Value of Development[1] (millions of $)	0.0	8,655.9	8,565.1	9,612.5	3,796.5	6,227.7	9,507.8	15,678.7	8,760.6	
Value of Production[1,2] (millions of $)	12,922.5	30,509.5	31,446.1	23,510.8	25,556.9	29,000.6	24,194.1	27,587.9	30,236.8	
Taxes/royalties (millions of $)	2,334.9	6,076.5	6,239.1	4,881.4	4,865.7	5,646.0	4,997.3	6,015.6	6,034.8	
Recreation (millions of $)	0.0	-6.1	-6.1	-6.1	-4.9	-5.5	-6.1	-6.1	-6.1	
Hunting (millions of $)	0.0	-2.6	-2.6	-2.6	-2.1	-2.3	-2.6	-2.6	-2.6	
Grazing (millions of $)	-1.5	-10.5	-10.5	-3.9	-4.6	-7.4	-5.8	-7.6	-8.9	
Total Nominal Economic Activity (millions of $)	15,255.9	45,222.7	46,231.1	37,992.0	34,207.5	40,859.0	38,684.7	49,265.9	45,014.7	
250 Wells Per Year Development Rate										
Value of Development[1] (millions of $)	0.0	8,588.6	8,497.2	9,536.2	3,490.3	6,228.7	9,440.6	9,191.2	8,688.3	
Value of Production[1,2] (millions of $)	12,922.5	30,509.5	31,446.1	23,510.8	25,556.9	29,000.6	24,194.1	27,587.9	30,236.8	
Taxes/royalties (millions of $)	2,334.9	6,072.1	6,234.7	4,876.4	4,845.5	5,646.1	4,992.9	5,588.0	6,030.1	
Recreation (millions of $)	0.0	-5.3	-5.3	-5.3	-4.5	-4.9	-5.3	-5.3	-5.3	
Hunting (millions of $)	0.0	-2.2	-2.2	-2.2	-1.9	-2.1	-2.2	-2.2	-2.2	
Grazing (millions of $)	-1.5	-9.1	-9.1	-3.4	-4.2	-6.6	-5.0	-6.5	-7.7	
Total Nominal Economic Activity (millions of $)	15,255.9	45,153.7	46,161.4	37,912.5	33,882.1	40,861.8	38,615.2	42,353.2	44,940.1	

Table 4.18 (Continued)

Economic Effect	No Action Alternative	Proposed Action	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F	Alternative G	Preferred Alternative
	Economic Activity Resulting from Development (LOF)									
	PRESENT VALUE OF ECONOMIC ACTIVITY[3]									
75 Wells Per Year Development Rate										
Value of Development[2] (millions of $)	0.0	4,496.4	4,452.8	4,997.3	2,655.7	3,818.0	4,946.5	4,815.8	4,554.5	Approximately the same as Alternative G
Value of Production[2] (millions of $)	9,275.7	12,101.0	12,144.6	9,325.1	14,130.0	13,208.8	9,596.1	10,942.1	11,992.8	
Taxes/royalties (millions of $)	1,753.7	2,557.3	2,561.7	2,108.2	2,733.2	2,665.9	2,151.9	2,378.2	2,542.8	
Recreation (millions of $)	0.0	-2.7	-2.7	-2.7	-2.5	-2.6	-2.7	-2.7	-2.7	
Hunting (millions of $)	0.0	-1.1	-1.1	-1.1	-1.0	-1.1	-1.1	-1.1	-1.1	
Grazing (millions of $)	-0.9	-5.4	-5.4	-2.0	-2.7	-4.1	-3.0	-3.9	-4.6	
Total Present Value of Economic Activity (millions of $)	11,028.5	19,145.4	19,149.8	16,424.7	19,512.7	19,684.9	16,687.6	18,128.4	19,081.6	
150 Wells Per Year Development Rate										
Value of Development[2] (millions of $)	0.0	6,058.3	5,994.8	6,727.8	3,209.1	4,781.8	6,654.5	10,973.6	6,131.6	
Value of Production[2] (millions of $)	9,275.7	15,864.2	16,349.9	12,225.0	16,049.7	16,543.1	12,580.4	14,345.1	15,722.5	
Taxes/royalties (millions of $)	1,753.7	3,156.6	3,239.5	2,543.2	3,073.1	3,217.8	2,602.8	3,061.5	3,134.5	
Recreation (millions of $)	0.0	-2.5	-2.5	-2.5	-2.3	-2.4	-2.5	-2.5	-2.5	
Hunting (millions of $)	0.0	-1.1	-1.1	-1.1	-1.0	-1.0	-1.1	-1.1	-1.1	
Grazing (millions of $)	-0.9	-5.1	-5.1	-1.9	-2.4	-3.8	-2.8	-3.7	-4.3	
Total Present Value of Economic Activity (millions of $)	11,028.5	25,070.4	25,575.5	21,490.6	22,326.1	24,535.3	21,831.3	28,372.9	24,980.7	
250 Wells Per Year Development Rate										
Value of Development[2] (millions of $)	0.0	6,631.8	6,561.2	7,363.5	3,151.8	5,265.1	7,289.7	7,097.1	6,708.8	
Value of Production[2] (millions of $)	9,275.7	17,963.8	18,511.2	13,842.7	17,145.3	18,212.2	14,245.2	16,243.3	17,803.0	
Taxes/royalties (millions of $)	1,753.7	3,474.7	3,574.9	2,725.2	3,242.5	3,483.9	2,798.3	3,165.4	3,446.6	
Recreation (millions of $)	0.0	-2.4	-2.4	-2.4	-2.3	-2.3	-2.4	-2.4	-2.4	
Hunting (millions of $)	0.0	-1.0	-1.0	-1.0	-0.9	-1.0	-1.0	-1.0	-1.0	
Grazing (millions of $)	-0.9	-6.6	-6.6	-2.5	-2.5	-3.7	-3.6	-4.7	-5.6	
Total Present Value of Economic Activity (millions of $)	11,028.5	28,060.4	28,637.3	23,925.5	23,533.9	26,954.2	24,326.2	26,497.8	27,949.5	

[1] Includes nonproject labor earnings resulting from secondary economic activity induced by project activities. These earnings do not include project labor earnings.

[2] Natural gas plus condensate; Proposed Action and Alternatives A-G include wells currently in production (i.e., No Action Alternative wells); natural gas price is $3.50/mcf and condensate is $21/bbl.

[3] Variable development rates porvided for each alternative; well life is assumed to be 40 years; see TRC Mariah (2004c) for a discussion of discounting. The discount rate used for this analysis was 3.5%. Conservatively assumes revenues are received as a lump sum at year end.

Grazing could be reduced by up to $0.9 million present value. No effect would be expected to occur on recreation or hunting resources. The least total economic activity would occur under the No Action Alternative of all alternatives and this alternative would create the least number of AJEs.

4.4.2 Proposed Action

See BLM (2005) for a detailed analysis of impacts related to this alternative. Because no new development would occur under the No Action Alternative, development impacts would be greater under the Proposed Action which provides that up to 3,100 new (assumed at 2,825 conventional, 275 directional) wells would be developed (see Table 4.18). The economic activity under the 250 wells/year development rate (12.5 years) would be $4,496.4 million present value and 52,930.0 AJEs for the LOP (BLM 2005). The Proposed Action would have more economic activity in terms of production than the No Action Alternative because of the higher level of resource recovery. The number of AJEs that would be created in the study area would be up to 85,945.2 with an average wage ranging from $31,881 to $47,173.

Over an LOP of 52.5 years (12.5 years to develop), economic activity would be $28,060.4 million present value, including $3,474.7 million present value in taxes/royalties (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to the county receiving funds of $305,292 (approximately $5,815 annually) for each person in the county (BLM 2005). BLM (2005) presents speculative examples of what budgets for Big Piney, Pinedale, and Sublette County may be in year 10 of development under the Proposed Action. Under the Proposed Action, local area government operating budgets would likely expand and increase the amount of services and infrastructure provided to community residents. These impacts would be higher under the Proposed Action than under the No Action Alternative.

The Proposed Action could result in a present value loss of economic activity from recreation of $2.4 million, hunting of $1.0 million, and grazing of $6.6 million over the LOP. Impacts to recreation, hunting, and grazing would be greater than for the No Action Alternative due to increased disturbance and longer project duration. Under the Proposed Action, if it is assumed that all 3,396 RVDs are relocated for the LOP, reduced recreation economic activity would amount to $2.4 million present value and up to 92.4 AJEs. These impacts would be higher than under the No Action Alternative. Under the Proposed Action, if it is assumed that all 103.7 hunter days per year are relocated for the LOP, reduction in economic activity from hunting expenditures would amount to $1.0 million present value and up to 49.9 AJEs. These impacts would be higher than under the No Action Alternative. Under the Proposed Action, if it is assumed that 1,761 AUMs would be lost for the LOP, reduction in economic activity would amount to $6.6 million present value and up to 65.5 AJEs.

4.4.3 Alternative A

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative A, change in economic activity from current conditions would be expected from the development of up to 3,100 wells and the recovery of up to 8,191 BCF of gas and 77.81 MBO (see Table 4.18). Economic activity from Alternative A would be less than that expected from the Proposed Action due to the removal of directional drilling, but greater than expected under the No Action Alternative. This alternative would have more nominal economic activity in terms of production than the Proposed Action or the No Action Alternative because of the higher level of resource recovery.

Economic activity could range from $19,149.8 million present value (including $2,561.7 million in taxes and revenues) to $28,637.3 million present value (including $3,574.9 million in taxes and revenues) (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $314,077 (approximately $5,982 annually) for each person in the county (BLM 2005). Property tax revenues would likely be higher under this alternative than under the No Action Alternative or Proposed Action due to the greater amount of construction involved with development, which would result in an increased tax base resulting from capital improvements in the JIDPA. Because Alternative A maximizes resource recovery, benefits to consumers and local, state, and national economies would likely be higher than under the Proposed Action. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but more under this alternative than under the No Action Alternative, but less than under the Proposed Action due to reduced development expenditures. Alternative A would generate the most overall taxes and revenues and the most funds for the school capital account over the LOP compared to all others alternatives (BLM 2005).

The number of AJEs that would be created in the study area could range from 85,918.5-86,219.1 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would be higher than under the No Action Alternative and would likely be similar to but reduced from that described for the Proposed Action because fewer AJEs would be created to attract new workers (BLM 2005). The potential for population changes from secondary employment would likely be lowest under Alternative A when compared to all other alternatives that contain a development component.

This alternative could result in a loss of economic activity from recreation ranging from $2.4 million present value to $2.7 million present value, hunting ranging from $1.0 million present value to $1.1 million present value, and grazing ranging from $6.6 million present value to $5.1 million present value over the LOP. The loss of economic activity from recreation, hunting, and grazing would be increased under Alternative A as compared to the No Action Alternative and longer development periods under the 75 and 150 wells/year development rates would result in greater reductions in economic activity from these resources than under the Proposed Action. The greatest loss in grazing from all alternatives would occur under Alternative A 75 wells/year development rate.

4.4.4 Alternative B

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative B, change in economic activity from current conditions would be expected from the development of up to 3,100 wells and the recovery of up to 6,124 BCF of gas and 58.18 MBO (see Table 4.18).

Economic activity from Alternative B would be more than that expected from the Proposed Action and the No Action Alternative due to the increased amount of directional drilling from the development activities. The least economic activity would occur under Alternative B when compared to all alternatives except for the No Action Alternative, both in nominal and real terms as well as numbers of jobs. This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery.

Economic activity could range from $16,424.7 million present value (including $2,108.2 million present value in taxes and revenues to $23,925.5 million present value including $2,725.2 million present value in taxes and revenues (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $240,050 (approximately $5,334 annually) for each person in the county (BLM 2005). Under Alternative B, property tax revenues would increase due to the increased tax base resulting from capital improvements in the JIDPA, but at a lower amount than under the Proposed Action due to the decreased number of well pads. However, this alternative would result in a lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action and may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase under this alternative when compared to the No Action Alternative, but less than under the Proposed Action due to reduced development expenditures and lower recovery of resources.

The number of AJEs that would be created in the study area could range from 85,832.3-86,223.6 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would likely be similar to but increased from that described for the Proposed Action because more AJEs would be created to attract new workers (BLM 2005).

Under Alternative B, losses to economic activity for recreation, hunting, and grazing would be the same as those described for Alternative A (BLM 2005).

4.4.5 Alternative C

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative C, change in economic activity from current conditions would be expected from the development of up to 1,250 wells and the recovery of up to 6,657 BCF of gas and 63.24 MBO (see Table 4.18).

Impacts to economic activity from Alternative C would be greater than for the No Action Alternative, but would be less than half that expected from the Proposed Action due to the reduced number of wells to be developed (BLM 2005). This alternative would also have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery.

Economic activity could range from $23,533.9 million present value (including $3,242.5 million present value in taxes and revenues) to $19,512.7 million present value (including $2,733.2 million present value in taxes and revenues) (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $249,465 (approximately $5,091 annually) for each person in the county (BLM 2005). Impacts to taxes and revenues would be greater than that expected for the No Action Alternative, but less than that described for the Proposed Action. This alternative would result in more tax and revenue economic activity than the No Action Alternative; however, due to lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action, it may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but less under this alternative than under the Proposed Action due to lower recovery of resources.

Alternative C would produce the least economic activity in terms of both dollars and jobs (except for the No Action alternative) when compared to the other alternatives.

The number of AJEs that would be created in the study area under Alternative C could range from 59,047.5-49,508.9 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would be greater than that described for the No Action Alternative, but likely be less than that described for the Proposed Action due to the creation of fewer AJEs as a result of fewer wells being developed (BLM 2005).

This alternative could result in a loss of economic activity from recreation ranging from $2.3 million present value to $2.5 million present value, hunting ranging from $0.9 million present value to $1.0 million present value, and grazing ranging from $2.4 million present value to $2.7 million present value over the LOP. Impacts to these resources would be greater under Alternative C than under the No Action Alternative, but would be less than for the Proposed Action due to reduced disturbance over the LOP.

4.4.6 Alternative D

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative D, change in economic activity from current conditions would be expected from the development of up to 2,200 wells and the recovery of up to 7,554 BCF of gas and 71.76 MBO (see Table 4.18). Economic activity from development under Alternative D would be greater than that expected from the No Action Alternative, but less than that expected from the Proposed Action due to the reduced number of wells to be developed. This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery.

Economic activity could range from $26,954.2 million present value (including $3,483.9 million present value in taxes and revenues) to $19,684.9 million present value (including $2,665.9 million present value in taxes and revenues (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $286,915 (approximately $5,855 annually) for each person in the county (BLM 2005). Impacts to taxes and revenues would be greater than that expected for the No Action Alternative, but less than that described for the Proposed Action. This alternative would result in more tax and revenue economic activity than the No Action Alternative; however, due to lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action, it may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but less under this alternative than under the Proposed Action due to lower recovery of resources.

The number of AJEs that would be created in the study area could range from 69,584.6-69,515.4 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would be higher than that expected for the No Action Alternative, but would likely be similar to but decreased from that described for the Proposed Action due to fewer numbers of AJEs being created as a result of fewer wells being developed (BLM 2005).

This alternative could result in a loss of economic activity from recreation ranging from $2.3 million present value to $2.6 million present value, hunting ranging from $1.0 million present value to $1.1 million present value, and grazing ranging from $3.7 million present value to $4.1 million present value over the LOP. Impacts to recreation, hunting, and grazing would be higher than that expected for the No Action Alternative but would be less than for the Proposed Action due to reduced disturbance over the LOP.

4.4.7 Alternative E

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative E, change in economic activity from current conditions would be expected from the development of up to 3,100 wells and the recovery of up to 6,302 BCF of gas and 59.87 MBO (see Table 4.18). Economic activity from development Alternative E would be more than that expected from the No Action Alternative or the Proposed Action due to the increased number of directionally drilled wells to be developed. This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery, but more than under the No Action Alternative.

Economic activity could range from $24,326.2 million present value (including $2,798.3 million present value in taxes and revenues) to $16,687.6 million present value (including $2,151.9 million present value in taxes and revenues (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $246,416 (approximately $4,694 annually) for each person in the county (BLM 2005). Under Alternative E, property tax revenues would increase from that expected under the No Action Alternative due to the increased tax base resulting from capital improvements in the JIDPA, but at a lower amount than under the Proposed Action due to the decreased number of well pads. Impacts to taxes and revenues would be greater than that expected for the No Action Alternative, but less than that described for the Proposed Action. This alternative would result in more tax and revenue economic activity than the No Action Alternative; however, due to lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action, it may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but less under this alternative than under the Proposed Action due to lower recovery of resources.

The number of AJEs that would be created in the study area could range from 85,732.2-86,151.8 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would be higher than for the No Action Alternative and would likely be similar to but somewhat higher than that described for the Proposed Action due to the increased number of AJEs created because of the higher level of directional drilling (BLM 2005).

Alternative E could result in a loss of economic activity from recreation ranging from $2.4 million present value to $2.7 million present value, hunting ranging from $1.0 million present value to $1.1 million present value, and grazing ranging from $2.8 million present value to $3.6 million present value over the LOP. Under Alternative E, changes to economic activity for recreation, hunting, and grazing would be the same as those described for Alternative A (BLM 2005).

4.4.8 Alternative F

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative F, change in economic activity from current conditions would be expected from the development of up to 3,100 wells and the recovery of up to 7,186 BCF of gas and 68.27 MBO (see Table 4.18). Economic activity from Alternative F would be more than that expected from the either No Action Alternative or the Proposed Action due to the increased number of directionally drilled wells to be developed. This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery, but more than under the No Action Alternative.

Economic activity could range from $26,497.8 million present value (including $3,165.4 million present value in taxes and revenues) to $18,128.4 million present value (including $2,378.2 million present value in taxes and revenues (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $278,376 (approximately $5,302 annually) for each person in the county (BLM 2005). Under Alternative F, property tax revenues would increase from that described for the No Action Alternative due to the increased tax base resulting from capital improvements in the JIDPA, but at a lower amount than under the Proposed Action due to the decreased number of well pads. However, this alternative would result in a lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action and may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but less under this alternative than under the Proposed Action due to lower recovery of resources.

The number of AJEs that would be created in the study area could range from 87,408.3-128,549.0 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would likely be higher than that described for either the No Action Alternative or the Proposed Action. The potential for population changes from secondary employment would likely be highest under Alternative F when compared to all other alternatives.

This alternative could result in a loss of economic activity from recreation ranging from $2.4 million present value to $2.7 million present value, hunting ranging from $1.0 million present value to $1.1 million present value, and grazing ranging from $4.3 million present value to $5.6 million present value over the LOP. Impacts would likely be similar to those described under Alternative A.

The greatest total economic activity in terms of dollars and jobs would occur under the Alternative F under the 150 wells/year development rate (see Table 4.57).

4.4.9 Alternative G

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under Alternative G, change in economic activity from current conditions would be expected from the development of up to 3,100 wells and the recovery of up to 7,876 BCF of gas and 74.82 MBO (see Table 4.18).

Economic activity from Alternative G would similar to but slightly higher than that described for the Proposed Action due to the slightly increased number of directionally drilled wells to be developed and would be higher than that expected for the No Action Alternative. This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery, but more than under the No Action Alternative.

Economic activity could range from $27,949.5 million present value (including $3,446.6 million present value in taxes and revenues) to $19,081.6 million present value (including $2,542.8 million present value in taxes and revenues (see Table 4.18). Based on a population of 6,024 (year 2002), this would be nominally equivalent to Sublette County receiving funds of $302,847 (approximately $5,769 annually) for each person in the county (BLM 2005). Under Alternative G, property tax revenues would increase over that described for the No Action Alternative due to the increased tax base resulting from capital improvements in the JIDPA, but at a lower amount than under the Proposed Action due to the decreased number of well pads. However, this alternative would result in a lower recovery of resources and a lower supply of natural gas over the long-term than under the Proposed Action and may result in higher consumer prices and increased dependence on foreign supplies. While, conceptually, changes in production for this field could impact pricing of natural gas for consumers, given the size of the market it is not likely that a measurable change in market price would be associated with this alternative due to the length of the LOP. Local area government operating budgets would likely increase but less under this alternative than under the Proposed Action due to lower recovery of resources.

The number of AJEs that would be created in the study area could range from 86,173-86,513 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would likely be similar to but somewhat higher than that described for the Proposed Action due to the increased number of AJEs created as a result of the higher number of directionally drilled wells (BLM 2005).

This alternative could result in a loss of economic activity from recreation ranging from $2.4 million present value to $2.7 million present value, hunting ranging from $1.0 million present value to $1.1 million present value, and grazing ranging from $4.3 million present value to $5.6 million present value over the LOP. Under Alternative G, changes to economic activity from recreation and hunting would be the same as those described for Alternative A (BLM 2005). Impacts would be less than for the Proposed Action due to reduced disturbance over the LOP.

4.4.10 BLM Preferred Alternative

See BLM (2005) for a detailed analysis of impacts related to this alternative. Under the Preferred Alternative, change in economic activity from current conditions would be expected from the development of up to 3,100 wells. Economic activity would be greater than that described under the No Action Alternative and similar to that described under Alternative G (see Section 4.4.9). This alternative would have less nominal economic activity in terms of production than the Proposed Action because of the lower level of resource recovery, but more than under the No Action Alternative.

4.4.11 Cumulative Impacts

The CIAA for socioeconomics includes Sublette, Lincoln, and Sweetwater Counties. All of these counties depend upon the oil and gas industry for a portion of their economic activity and tax base (refer to Section 3.4), and the project, along with other oil and gas development, would increase employment opportunities, expand the tax base, and improve the abilities for the counties to maintain and increase services and infrastructure to their residents. When considering employment, tax base/revenues, and general economic health, increased oil and gas development produces impacts. Wells developed as part of this project would add proportionately to the economic potential to be realized in the area. Local communities would experience economic impacts from an increase in consumption of local goods and services and increased sales tax revenues. For instance, construction of well pads and roads is usually contracted to local construction companies, and it is likely that many employees would spend some of their payroll in these communities. Actual impacts would depend on the rate of development and the number of wells.

Increases in regional oil and gas development activity in a short period of time can cause notable changes in employment and income. These variables can in turn cause changes in population trends, which could have detrimental effects on community services, social structures and lifestyles. Increased oil and gas development is expected under all alternatives except No Action, and would cause an increase in taxes and revenues to all governments in the study area proportional to the volume of gas produced and associated development levels. Increases to ad valorem taxes would be expected to occur in Sublette County. Conversely, under the No Action Alternative, these increases would not be realized, which could result in negative impacts to local government. Additional revenues would accrue to the U.S. in the form of personal and corporate income taxes. Wyoming, and especially Sublette, Sweetwater, and Lincoln Counties are highly dependent on mineral revenues, and the revenue anticipated from the Proposed Action would add to those revenues.

Where the surface is in private ownership and the minerals are in federal ownership, a lease holder has the right of ingress and egress on the private surface and the right to disturb whatever is reasonably necessary to recover the minerals. This does not prevent the private owner and the lease holder from entering into mutually acceptable terms regarding surface use to facilitate the process. When both the surface and minerals are in private ownership, negotiations for a lease--including financial considerations--are between the private owner and the potential lessee, and the terms of the lease--financial and otherwise--are negotiated by the two parties. It is usual for the private mineral owner to share in the profits from the recovery of the mineral resource.

However, some portion of the resident population, as well as many non-residents, prioritize preserving the naturalness of the area above all else and are not in favor of the high level of oil and gas development proposed in JIDPA. These individuals may be affected on a personal aesthetic and moral level by the Proposed Action and alternatives.

4.4.12 Unavoidable Adverse Impacts

There would be avoidable adverse impacts to socioeconomics as a result of the proposed project. Impacts could be reduced by implementation of suggested mitigation measures.

4.4.13 Environmental Justice

EO 12898 directs BLM to assess whether an action would have disproportionately high and adverse human health or environmental impacts on minority and/or low-income communities. The EO has three goals:

- to focus federal agency attention on the environment and human health conditions in minority communities and low-income communities;
- to promote non-discrimination in federal programs that substantially affect human health and the environment; and
- to provide minority communities and low-income communities greater access to information on, and opportunities for public participation in, matters relating to human health and the environment.

Sublette County is neither a minority community nor a low-income community (see Section 3.4.12), and no impact associated with environmental justice would occur.

4.5 LAND USE

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with land use (including status/ownership, livestock/grazing management, recreation, and transportation):

- to manage public lands to support the goals and objectives of other resource programs;
- to respond to public demand for land use authorizations;
- to acquire administrative and public access, where necessary;
- to maintain or improve the quality of land resources in the state;
- to coordinate land use decisions with economic factors and needs;
- to provide for a cooperative process of local land use planning with other governmental agencies;
- to plan for continuing use of agricultural-rural lands and for potential changes in use of these lands;

- to plan land use consistent with the orderly development, use, and conservation of renewable and nonrenewable natural resources;

- to plan for the provision of public facilities and services, including safe and efficient transportation and utility systems, in coordination with local land use policies, goals, and objectives;

- to minimize conflicts among utility corridor needs, competing land uses, and local land use plans;

- to consider the conservation and enhancement of natural resources with the economic benefit of resource development;

- to consider site-specific environmental features (e.g., soil types, wetlands, riparian areas, topography, drainage patterns) as part of land use planning decisions and in the review of development proposals;

- to plan land use in a manner that minimizes environmental pollution and disruption of natural resources;

- to establish more watering systems on all grazing lands for livestock, wildlife, and game/non-game birds;

- to support/encourage multiple-use policy implementation on federal and state lands;

- to ensure the continued availability of outdoor recreational opportunities sought by the public while protecting other resources;

- to prevent resource degradation resulting from recreation and other uses and to provide for the anticipated increase in recreational uses on BLM-administered lands;

- to conserve and develop scenic resources for the benefit of present and future generation; and

- to encourage recreational enterprise while preserving natural values.

Impacts to land use would be significant if project activities precluded other current uses of the JIDPA for the long term, if there would be a reduction in AUMs of a magnitude that would require modification in grazing allotments or other actions that would prevent the realization of grazing management goals, or if project activities resulted in a violation of BLM RMP or other land use plan goals/objectives. Impacts to land use are assumed to be proportional to the amount of new initial and/or LOP disturbance for all alternatives. Impacts would primarily result from surface disturbing activities and/or the presence of oil and gas developments. Impacts to land use, specifically, grazing and recreation would be significant in the short-term under all project alternatives (see Sections 4.5.2 and 4.5.3, respectively).

4.5.1 Status/Ownership

The current JIDPA land uses of livestock grazing (see Section 4.5.2), natural gas production (see Section 4.1.3), wildlife habitat (see Section 4.2.2), and recreation--primarily hunting (see Section 4.5.3)—are anticipated to continue for the LOP under all alternatives. Further development of the JIDPA primarily for natural gas extraction would alter the historic land use pattern for the LOP. There is the potential for some impacts to existing roads on the area if these roads are not adequately upgraded prior to their use for the project. Natural gas recovery would continue to be the dominant use of the JIDPA and would maintain the changed character of the landscape from a relatively undisturbed area (prior to about 1996) to one with industrial development; however, other existing uses are not anticipated to be excluded as defined in Section 103(1) of FLPMA. After the LOP, land use likely would revert back to primarily livestock grazing, wildlife habitat, and recreation under all alternatives.

Ownership of surface and mineral estates in the JIDPA are anticipated to be unchanged under all alternatives; therefore, no significant impacts to land status/ownership are anticipated from the project.

4.5.1.1 No Action Alternative

Under the No Action Alternative, there would be no additional activities that would potentially affect land status or ownership, as previously identified for the area and including oil and gas development on 4,209 acres of new (short-term) and 1,409 acres of LOP (BLM 1998b, 2000b). Natural gas production is currently the dominant use of the JIDPA and would continue to be the dominant use for approximately 63 years.

4.5.1.2 The Proposed Action

Under the Proposed Action, the ownership of surface and mineral estates in the JIDPA are anticipated to be unchanged. There would be increased natural gas development and production operations from that of the No Action Alternative under the Proposed Action; there would be an increase of approximately 16,200 acres of new initial surface disturbance. New and LOP surface disturbance would be 20,409 acres and 6,040 acres, respectively. The duration of the project under the Proposed Action would be approximately 76 years.

4.5.1.3 Alternative A

Implementation of Alternative A would result in the same types of impacts and surface disturbance as the Proposed Action (see Section 4.5.1.2). However, natural gas development would occur in areas that would have been avoided under other action alternatives. Project duration would be dependent upon the rate of development (from 76 to 105 years).

4.5.1.4 Alternative B

Implementation of Alternative B would result in the same types of impacts as the No Action Alternative but would result in an increase of 3,297 acres of new initial surface disturbance from that of the No Action Alternative. Total new and LOP disturbance under Alternative B would be 7,506 acres and 2,622 acres, respectively. Project duration would be dependent upon the rate of development (from 76 to 105 years).

4.5.1.5 Alternative C

Implementation of Alternative C would result in the same types of impacts as the No Action Alternative but would result in an increase of 6,705 acres of new initial surface disturbance from that of the No Action Alternative. Total new and LOP disturbance under Alternative C would be 10,914 acres and 3,399 acres, respectively. Project duration would be dependent upon the rate of development (from 68 to 80 years).

4.5.1.6 Alternative D

Implementation of Alternative D would result in the same types of impacts as the No Action Alternative but would result in an increase of 11,581 acres of new initial surface disturbance from that of the No Action Alternative. Total new and LOP disturbance under Alternative D would be 15,790 acres and 4,755 acres, respectively. Project duration would be dependent upon the rate of development (from 72 to 93 years).

4.5.1.7 Alternative E

Implementation of Alternative E would result in the same types of impacts as the No Action Alternative but would result in an increase of 6,386 acres of new initial surface disturbance from that of the No Action Alternative. Total new and LOP disturbance under Alternative E would be 10,595 acres and 3,597 acres, respectively. Project duration would be dependent upon the rate of development (from 76 to 105 years).

4.5.1.8 Alternative F

Implementation of Alternative F would result in the same types of impacts as the No Action Alternative but would result in an increase of 10,446 acres of new initial surface disturbance from the No Action Alternative. Total new and LOP disturbance under Alternative F would be 14,655 acres and 3,997 acres, respectively. Project duration would be dependent upon the rate of development (from 76 to 105 years).

4.5.1.9 Alternative G

Implementation of Alternative G would result in the same types of impacts as the No Action Alternative but would result in an increase of 13,989 acres of new initial surface disturbance from that of the No Action. Total new and LOP disturbance under Alternative G would be 18,198 acres and 5,408 acres, respectively. Project duration would be dependent upon the rate of development (from 76 to 105 years).

4.5.1.10 BLM Preferred Alternative

Implementation of the Preferred Alternative would result in the same types of impacts as the No Action Alternative but would result in an increase of an estimated 8,316 acres of new initial surface disturbance from that of the No Action Alternative. Total new and LOP disturbance under the Preferred Alternative would be 12,525 acres and 3,847 acres, respectively. Project duration is anticipated to be approximately 76 years.

Under the Preferred Alternative, additional mitigation and monitoring measures would be implemented to ensure achievement of specific management objectives and to minimize project-related impacts (see Section 2.14). No specific measures are identified for land status/ownership. However, many of the measures identified for other resources (e.g., vegetation, wildlife, livestock, recreation) would mitigate, to some extent, impacts to land status.

4.5.1.11 Cumulative Impacts

The CIAA for land status/ownership is the JIDPA and the leases that extend beyond the project area; therefore, cumulative impacts would be the same as the impacts described for each of the alternatives above. Landownership would not change, and natural gas recovery would continue to be a dominant use but not to the exclusion of other existing uses. After the LOP, land use would revert back to livestock grazing, wildlife habitat, and recreation.

4.5.1.12 Unavoidable Adverse Impacts

There would be no unavoidable adverse impacts to land status/ownership.

4.5.2 Livestock/Grazing Management

Impacts to grazing would be significant if there would be a reduction in AUMs of a magnitude that would require modification in grazing allotments (e.g., changes in ranching operations, livestock trailing, watering, fencing, and feeding), other actions that would prevent the realization of grazing goals, or if project activities resulted in a violation of RMP or other land use plan grazing objectives. Impacts to grazing are assumed to be proportional to the amount of new initial and/or LOP disturbance for all alternatives. Impacts would primarily result from surface disturbing activities and/or the presence of oil and gas developments and associated disturbance to livestock. Significant impacts could occur under any of the project development alternatives if AUM reductions require grazing allotment modifications; this action would be most likely to occur in the Sand Draw and Stud Horse Common Allotments under the Proposed Action and Alternatives A, D, F, and G. Impacts to grazing are anticipated to be significant in the short-term under all alternatives, even with the implementation of identified reclamation practices (see Appendix G) and mitigations (see Appendices A and B).

The principal impact to livestock/grazing management would be the direct impact resulting from the removal of forage due to proposed surface disturbance. Livestock operations (primarily animal movement, forage availability [i.e., AUMs], and distribution) would be significantly adversely affected under each of the development alternatives in the short-term due to the increased number and density of well pads, noise, and other project-related activities. Economic impacts to livestock/grazing management are described in Section 4.4. Short-term removal of vegetative cover would remove rangeland from production until revegetation is successful. Disturbance would be greatest in the Sand Draw allotment and less in each of the remaining three allotments (Table 4.19). The actual loss of production on lands subjected to short-term disturbance would be dependent on the success of reclamation efforts. As with short-term disturbance, LOP disturbance would be greatest in the Sand Draw allotment.

The construction of additional roads and associated reclamation efforts could affect the pattern of livestock forage utilization on the JIDPA and could concentrate animals along roads and on

Table 4.19 Acreage, AUMs, and Percent of AUMs Potentially Affected by Grazing Allotment, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Allotment	Total Acres in Allotment	Total AUMs	Average Federal Acres per AUM	AUMs in JIDPA	Percent of JIDPA Occurring in Allotment	No Action[1]		Proposed Action and Alternative A[2]		Alternative B[3]		Alternative C[4]		Alternative D[5]		Alternative E[6]		Alternative F[7]		Alternative G[8]		Preferred Alternative[9]		RFD[10] (acres)
						New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	New[11]	LOP	
Potentially Affected Acres (Includes Existing Project-required Disturbance)[12, 13]																								
Stud Horse Common	15,590	1,730	8.2	670	18.0	720	243	3,623	1,073	1,300	457	1,914	597	2,791	841	1,856	633	2,587	705	3,225	959	2,203	677	252
Sand Draw	31,740	2,324	13.2	1,571	68.0	2,721	917	13,686	4,052	4,912	1,728	7,229	2,256	10,545	3,178	7,012	2,391	9,773	2,663	12,182	3,622	8,325	2,562	0
Boundary	31,994	2,996	10.0	363	12.0	480	162	2,415	715	867	306	1,276	398	1,861	561	1,237	422	1,725	470	2,150	639	1,469	452	24
Blue Rim Desert	41,273	2,826	14.6	--	0.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	--	--	120
No Allotment	640	0	--	--	2.0	80	27	403	119	144	51	213	66	310	93	206	70	287	78	358	107	245	75	--
Total	120,597	9,876		2,604	100.0	4,001	1,348	20,126	5,959	7,223	2,541	10,631	3,318	15,507	4,674	10,312	3,516	14,372	3,916	17,915	5,327	12,242	3,766	396
Change from No Action	--	--	--	--	--	--	--	16,125	4,611	3,222	1,193	6,630	1,970	11,506	3,326	6,311	2,168	10,371	2,568	13,914	3,979	8,241	2,418	--
Potentially Affected AUMs (Includes Existing Project-required Disturbance)[14]																								
Stud Horse Common	15,590	1,730	8.2	670	18.0	88	30	442	130	159	56	233	73	340	103	226	77	315	86	393	117	269	83	31
Sand Draw	31,740	2,324	13.2	1,571	68.0	206	70	1,036	307	372	131	548	171	799	241	531	181	740	202	923	274	631	194	0
Boundary	31,994	2,996	10.0	363	12.0	48	16	242	72	87	31	128	40	186	56	124	42	172	47	215	64	147	45	2
Blue Rim Desert	41,273	2,826	14.6	--	0.0	--	--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
No Allotment	640	0	--	--	2.0	--	--	--	--	--		--	--	--	--	--	--	--	--	--	--	--	--	--
Total	120,597	9,876		2,604	100.0	342	116	1,720	509	618	218	909	284	1,325	400	881	300	1,227	335	1,531	455	1,047	322	41
Change from No Action	--	--	--	--	--	--	--	1,378	393	276	102	567	168	983	284	539	184	885	219	1,189	339	705	206	--
Percent of Potentially Affected AUMs Within the JIDPA (Includes Existing Project-required Disturbance)[15]																								
Stud Horse Common	15,590	1,730	8.2	670	18.0	5.1	1.7	25.5	7.5	9.2	3.2	13.5	4.2	19.7	5.9	13.1	4.5	18.2	5.0	22.7	6.8	15.5	4.8	n/a
Sand Draw	31,740	2,324	13.2	1,571	68.0	8.8	3.3	44.6	13.2	16.0	5.6	23.6	7.4	34.4	10.4	22.9	7.8	31.9	8.7	39.7	11.8	27.1	8.3	n/a
Boundary	31,994	2,996	10.0	363	12.0	1.6	0.5	8.1	2.9	2.9	1.0	4.3	1.3	6.2	1.9	4.1	1.4	5.8	1.6	7.2	2.1	4.9	1.5	n/a
Blue Rim Desert	41,273	2,826	14.6	--	0.0	--	--	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	n/a
No Allotment	640	0	--	--	2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	n/a
Total[16]	120,597	9,876		2,604	100.0			--																

1 Existing project-required disturbance.
2 Proposed Action and Alternative A assume 20,126 acres of new initial and 6,020 acres of LOP disturbance in the JIDPA.
3 Alternative B assumes 7,223 acres of new initial and 2,541 acres LOP disturbance in the JIDPA.
4 Alternative C assumes 10,631 acres of new initial and 3,318 acres of LOP disturbance in the JIDPA.
5 Alternative D assumes 15,507 acres of new initial and 4,674 acres of LOP disturbance in the JIDPA.
6 Alternative E assumes 10,312 acres of new initial and 3,516acres of LOP disturbance in the JIDPA.
7 Alternative F assumes 14,372 acres of new initial and 3,916 acres of LOP disturbance in the JIDPA.
8 Alternative G assumes 17,915 acres of new initial and 5,327 acres of LOP disturbance in the JIDPA.
9 Preferred Alternative assumes 12,242 acres of new initial and 3,766 acres of LOP disturbance in the JIDPA.
10 RFD = reasonable foreseeable development; n/a = not applicable.
11 Excludes 283 acres of new initial and 81 acres of LOP disturbance associated with selected ancillary facilities which may be constructed outside the JIDPA.
12 Excludes 208 acres (short-term) and 61 acres LOP disturbance outside JIDPA.
13 Assumes percent JIDPA occurring in each allotment multiplied by proposed new initial and LOP disturbance.
14 Assumes number of potentially affected acres divided by average federal acres/AUM.
15 Assumes number of potentially affected AUMs divided by total number of AUMs permitted in each allotment multiplied by 100.
16 Percentages are not additive.

reclaimed areas, thus increasing the chances of vehicle/livestock collisions. Construction and drilling activities could contribute to livestock movement off uplands and concentration in lowlands and reclamation areas. Proposed increased road/well densities would cause an increase in the amount of fugitive dust and its accumulation on forage and in the air, thereby increasing the potential for "dust pneumonia" in cattle. Project hazards to livestock in addition to increased traffic include pipeline trenches and unprotected water sources, and potential impacts from these hazards would increase proportionally to the number of new developments under all project alternatives.

4.5.2.1 No Action Alternative

Under the No Action Alternative, there would be no additional impacts to livestock/grazing management other than those already approved for the area, which include 4,001 acres of new initial and 1,348 acres of LOP disturbance (excludes minor disturbances outside the JIDPA) in the JIDPA (see Table 4.58) (BLM 1998b, 2000b). An estimated 342 AUMs initially and 116 AUMs for the LOP would be affected under the No Action Alternative. Project duration is anticipated to be approximately 63 years and until areas are adequately reclaimed.

4.5.2.2 The Proposed Action

The JIDPA contains a total of approximately 2,604 AUMs or 26% of the total 9,876 permitted AUMs distributed among three grazing allotments. Under the Proposed Action, LOP AUM loss would increase from the No Action Alternative by approximately 393 AUMs. Some additional minor and unquantified AUM loss would occur to the Blue Rim Desert allotment, primarily associated with the Burma Road upgrade. Implementation of the Proposed Action would affect a total of approximately 1,720 AUMs in the short term and 509 AUMs for the LOP (see Table 4.19). Under the Proposed Action, approximately 70% (1,204 AUMs) of all disturbance would be reclaimed as soon as practical after disturbance and reclamation on these areas would likely provide forage within an estimated 5 to 10 years after disturbance; therefore, all 1,720 AUMs would not be out of production at any one time. AUM losses would accumulate as development occurs for approximately 12 years but would occur for the entire 76-year LOP and until areas are adequately reclaimed. LOP losses are those associated with disturbances that would not be reclaimed until project abandonment.

4.5.2.3 Alternative A

Implementation of Alternative A would result in the same types and acreage of impacts as the Proposed Action (see Section 4.5.2.2). However, under this alternative, selected Operator-committed and BLM-required practices (i.e., avoidance of selected area buffers) would not be implemented. Therefore, impacts to forage resources in these areas (most notably along Sand Draw and other drainage channels) would be greater than that of other project alternatives. The duration of surface disturbance and hence forage loss would depend on the rate of development and the rate of reclamation; losses would accumulate during development (13 to 42 years) and would continue for the LOP (76 to 105 years).

4.5.2.4 Alternative B

Implementation of Alternative B would result in the same types of impacts as the No Action Alternative; however, LOP forage loss would increase by approximately 102 AUMs (see Table 4.19). Implementation of Alternative B would affect approximately 618 AUMs in the short term and 218 AUMs for the LOP. Under Alternative B, approximately 65% (400 AUMs) of all disturbance would be reclaimed as soon as practical after disturbance; therefore, all 618 AUMs would not be out of production at the same time. AUM losses would accumulate as development occurs (13 to 42 years) but would also occur for the LOP (76 to 105 years) and until areas are adequately reclaimed.

4.5.2.5 Alternative C

Implementation of Alternative C would result in the same types of impacts as the No Action Alternative, however, LOP forage loss would increase by approximately 168 AUMs (see Table 4.19). Implementation of Alternative C would affect a total of approximately 909 AUMs in the short term and 284 AUMs for the LOP. Under Alternative C, approximately 69% (625 AUMs) of all disturbance would be reclaimed as soon as practical after disturbance; therefore, all 909 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (5 to 17 years) but would also occur for the LOP (68 to 80 years) and until areas are adequately reclaimed.

4.5.2.6 Alternative D

Implementation of Alternative D would result in the same types of impacts as the No Action Alternative; however, LOP forage loss would increase by approximately 284 AUMs (see Table 4.19). Implementation of Alternative D would affect a total of approximately 1,325 AUMs in the short term and 400 AUMs for the LOP. Under Alternative D, approximately 70% (925 AUMs) of all disturbance would be reclaimed as soon as practical after disturbance; therefore, all 1,325 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (9 to 30 years) but would also occur for the LOP (72 to 93 years) and until areas are adequately reclaimed.

4.5.2.7 Alternative E

Implementation of Alternative E would result in the same types of impacts as the No Alternative; however, LOP forage loss would increase by approximately 184 AUMs (see Table 4.19). Implementation of Alternative E would affect a total of approximately 881 AUMs in the short term and 300 AUMs for the LOP. Under Alternative E, approximately 66% (581 AUMs) of all disturbance would be reclaimed as soon as practical after disturbance; therefore, all 881 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (13 to 42 years) but would also occur for the LOP (76 to 105 years) and until areas are adequately reclaimed.

4.5.2.8 Alternative F

Implementation of Alternative F would result in the same types of impacts as the No Action Alternative; however, LOP forage loss would increase by approximately 219 AUMs (see Table 4.19). Implementation of Alternative F would affect a total of approximately 1,227 AUMs in the short term and 335 AUMs for the LOP. Under Alternative F, approximately 73% (892 AUMs) of disturbance would be reclaimed as soon as practical after disturbance; therefore, all 1,227 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (13 to 42 years) but would also occur for the LOP (76 to 105 years) and until areas are adequately reclaimed.

4.5.2.9 Alternative G

Implementation of Alternative G would result in the same types of impacts as the No Action Alternative; however, LOP forage loss would increase by approximately 339 AUMs (see Table 4.19). Implementation of Alternative G would affect a total of approximately 1,531 AUMs in the short term and 455 AUMs for the LOP. Under Alternative G, approximately 71% (1,076 AUMs) of disturbance loss would be reclaimed as soon as practical after disturbance; therefore, all 1,531 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (13 to 42 years) but would also occur for the LOP (76 to 105 years) and until areas are adequately reclaimed.

4.5.2.10 BLM Preferred Alternative

Implementation of the Preferred Alternative would result in the same types of impacts as the No Action Alternative, however, LOP forage loss would increase by approximately 206 AUMs (see Table 4.58). Implementation of the Preferred Alternative would affect approximately 1,047 AUMs in the short term and 322 AUMs for the LOP. Under the Preferred Alternative, approximately 69% (722 AUMs) of disturbance would be reclaimed as soon as practical after disturbance; therefore, all 1,047 AUMs would not be out of production at the same time. AUM loss would accumulate as development occurs (13 to 42 years) but would also occur for the LOP (76 to 105 years) and until areas are adequately reclaimed.

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Any measure that reduces the volume of surface disturbance has the potential to reduce impacts to livestock grazing.

4.5.2.11 Cumulative Impacts

The CIAA for livestock/grazing includes all of the four grazing allotments (Stud Horse Common, Sand Draw, Blue Rim Desert, and Boundary) that may be affected by the proposed development. These four allotments cover 120,597 acres and contain a total of 9,876 AUMs (see Table 4.19). RFD surface disturbance in these allotments is estimated to be approximately 396 acres (46 AUMs) in the long term and would be associated with development for the Pinedale Anticline Project. Therefore, maximum cumulative short-term impact (i.e., the combined existing, proposed, and RFD disturbance) would result in the loss of approximately 1,766 AUMs or 17.9% of the combined allotments. Maximum long-term cumulative AUM loss within all allotments is estimated to be less than 550 AUMs. Cumulative impacts to livestock/grazing across alternatives would be proportional to the extent of surface disturbance and development features/human activity.

4.5.2.12 Unavoidable Adverse Impacts

The project would result in the temporary and potentially long-term loss of livestock forage and available AUMs.

4.5.3 Recreation

Impacts to recreation would be considered significant if project development changes the recreational use of the JIDPA or would result in a violation of BLM RMP or other land use plan recreation objectives. Impacts to recreation are assumed to be proportional to the amount of development for all alternatives. Dispersed recreation opportunities would be lost from the JIDPA for the LOP under all project alternatives including the No Action Alternative, resulting in significant impacts for the LOP under all alternatives.

No developed recreation sites or facilities are present in or immediately adjacent to the JIDPA; therefore, no significant impacts to sites or facilities are anticipated. Project-improved roads may promote some increased recreational use (e.g., driving for pleasure, sightseeing, desire to view a natural gas field). However, long-term displacement or elimination of existing dispersed recreation due to increased levels of gas field development activity is anticipated. In addition, some potential recreational visitors would likely avoid the JIDPA because of a perceived reduction in the quality of the recreational experience.

Outdoor recreation is important both in terms of the satisfaction it provides residents of the region and for the activity it generates in the region's economy as a result of expenditures by nonresident visitors; the economic impacts associated with project-affected recreation are described in Section 4.4. Hunting pressure for any species on the JIDPA is likely to be directly related to wildlife population size, structure, and availability. Under all alternatives, populations of pronghorn and greater sage-grouse, which are the two primary hunted species on the JIDPA, would likely be displaced to such an extent that recreational hunting on the JIDPA may no longer occur (see also Section 4.2.2). However, lands adjacent to the JIDPA could, and likely would, absorb displaced hunting pressure since displaced wildlife would in part also likely move to adjacent lands. It is anticipated that not all wildlife would move to alternate locations, and that their breeding, nesting, brood-rearing, and foraging opportunities would in part be jeopardized; therefore, the wildlife populations currently found on the JIDPA are anticipated to decline. This would result in the loss of potential recreational opportunities associated with wildlife (e.g., hunting, wildlife viewing and photography, etc.), and associated recreational opportunities and revenues from these activities would also be lost.

4.5.3.1 No Action Alternative

Under the No Action Alternative, there would be no additional impacts to recreation other than those which have occurred as a result of approved development in the Jonah Field (i.e., loss of dispersed recreation and hunting for the 63-year LOP and until areas are adequately reclaimed). Past NEPA documents concluded that there would be no significant adverse impacts to recreation as a result of the project (BLM 1998b, 2000b).

4.5.3.2 The Proposed Action

Under the Proposed Action, impacts to recreational opportunities are anticipated to increase from levels under the No Action Alternative as 3,100 new well pads and associated roads would be constructed. Duration of impacts would be for the 76-year LOP and until areas are adequately reclaimed.

4.5.3.3 Alternative A

Impacts to recreation under Alternative A would be the same as those of the Proposed Action. However, under this alternative, selected Operator-committed and BLM-required area-avoidance practices would not be implemented; therefore, increased impacts to greater sage-grouse, raptors, and other wildlife are anticipated due to disturbance in habitat buffers, this would likely result in decreased wildlife populations and subsequent reductions in hunting and wildlife viewing opportunities. Duration of impacts would be for the LOP and until areas are adequately reclaimed (i.e., from 76 to 105 years).

4.5.3.4 Alternative B

Implementation of Alternative B would result in the same types of impacts to recreation as No Action but would likely occur at increased levels due to expanded development. Impacts would likely be reduced from those of the Proposed Action due to the absence of disturbance in portions of the JIDPA. Duration of impacts would be for the LOP and until areas are adequately reclaimed (i.e., 76 to 105 years).

4.5.3.5 Alternative C

Implementation of Alternative C would result in the same types of impacts to recreation as the No Action Alternative but impacts would be increased as more well pads and roads would be constructed. However, Alternative C provides for fewer areas of surface disturbance than the Proposed Action, Alternatives D, E, F, G, and the Preferred Alternative, and this decreased disturbance would likely result in reduced impact levels, including human presence, traffic, and noise. Duration of impacts would be for the LOP and until areas are adequately reclaimed (i.e., 68 to 80 years).

4.5.3.6 Alternative D

Implementation of Alternative D would result in the same types of impacts to recreation as the No Action Alternative but impacts would be increased as more well pads and roads would be constructed. However, Alternative D provides for fewer areas of surface disturbance than the Proposed Action, Alternative G, and the Preferred Alternative, and this decreased disturbance would likely result in reduced impact levels, including human presence, traffic, and noise. Duration of impacts would be for the LOP and until areas are adequately reclaimed (i.e., 72 to 93 years).

4.5.3.7 Alternatives E, F, and G

Alternative E (16 total pads/section), Alternative F (32 total pads/section), and Alternative G (64 total pads/section) would produce the same types of impacts as the No Action Alternative, and it is assumed that impacts to recreation would likely be proportional to the different volumes and densities of surface disturbance (as well as other disturbances [e.g., human presence, noise, traffic, dust]). Given that any increased level of project-related human presence or disturbance has the potential to adversely affect the perceived quality of the recreational experience, then it follows that the greater the disturbance, the greater the likelihood that recreational opportunities would be negatively impacted. Duration of impacts would be for the LOP and until areas are adequately reclaimed (i.e., 76 to 105 years).

4.5.3.8 BLM Preferred Alternative

Under the Preferred Alternative impacts to recreational opportunities are anticipated to be of the same type as all other alternatives and would be increased from levels under the No Action

Alternative as additional development would occur. Duration of impacts would be for the LOP and until areas are adequately reclaimed.

While no recreation-specific mitigations for reducing impacts to recreation are proposed under the Preferred Alternative, any measure that reduces the volume of surface disturbance and human presence as well as those measures that minimize adverse effects to wildlife has the potential to reduce impacts to recreation (see Section 2.14).

4.5.3.9 Cumulative Impacts

The CIAA for recreation is shown on Map 3.23. Existing disturbance in the CIAA is 84,352 acres, and RFD surface disturbance includes 7,014 acres primarily associated with natural gas development. The extent of development throughout the CIAA has and will continue to result in displaced recreational use from the area.

Maximum cumulative disturbance (i.e., the combined alternative-specific and RFD disturbance) in the recreation CIAA for all alternatives is presented in (Table 4.20). Cumulative impacts to recreation are anticipated to be similar under all development alternatives.

Since it is assumed that the majority of workers employed for this project would be hired from the local workforce, there would be little increase in local populations and subsequent demand for recreation associated specifically with this project. However, regional populations are increasing in part from natural gas development projects, and this increase is creating an additional demand for recreation facilities and public access areas. Within the CIAA, traditional dispersed recreation has been and will continue to be directed away from areas with increased road and well development for the long term due to a reduction in the quality of the recreational experience on the part of some users. Some individuals may no longer recreate in the area at all. Current users of recipient areas may be adversely affected by increased use, over-crowding, and/or a feeling that the quality of the recreation experience of solitude has been decreased.

It is anticipated that the upgraded conditions on the Burma and Luman Roads would be retained after project completion allowing for increased recreational use of the area. This additional non-paved road development for oil and gas projects opens new areas for recreational use and raises the awareness of the recreational opportunity in these newly open areas for nontraditional use and new users. This new access and increased awareness of opportunities could encourage existing and new recreational use of previously primitive or semi-primitive areas, displacing those traditional recreational users with more new users and different uses (i.e., OHV) that may put new stresses on resources in these areas.

4.5.3.10 Unavoidable Adverse Impacts

Some level of unavoidable adverse impact to recreation is anticipated under all alternatives due to the likely avoidance of the JIDPA by recreational visitors.

4.5.4 Transportation

Impacts due to traffic volume would be considered significant if the proposed project resulted in the inability of the BLM, the State of Wyoming, and/or Sublette County to achieve land use planning objectives for transportation. Since the design of new and upgraded roads in the JIDPA would be in compliance with the BLM road standard guidelines (BLM 1985, 1991a), the

Table 4.20 Cumulative Acreage of Disturbance in the Recreation CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Cumulative Impact Analysis Area (CIAA)	Total Acreage of CIAA	Existing Disturbance In CIAA, Outside JIDPA	RFD	Disturbance					
				No Action			Proposed Action and Alternative A		
				New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Recreation	1,557,558	84,352	7,014	4,209	1,409	95,575	20,409	6,040	111,775
Percent of entire CIAA									7.2

5.4

6.1

Cumulative Impact Analysis Area (CIAA)	Disturbance											
	Alternative B			Alternative C			Alternative D			Alternative E		
	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Recreation	7,390	2,561	98,756	10,914	3,399	102,280	15,790	4,755	107,156	10,595	3,597	101,961
Percent of entire CIAA			6.3			6.6			6.9			

6.6

Cumulative Impact Analysis Area (CIAA)	Disturbance								
	Alternative F			Alternative G			Preferred Alternative		
	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Recreation	14,655	3,997	106,021	18,198	5,408	109,564	12,525	3,847	103,891
Percent of entire CIAA			6.8						6.7

[1] Cumulative disturbance = new + existing + RFD.

7.0

Transportation Plan for this project (Appendix G), individually approved APD and ROW road specifications, and continued Sublette County and WDOT consultation would occur, no significant transportation impacts are anticipated under any alternative. Furthermore, the project would be implemented with mitigation as identified in Appendices A and B. Further detail on transportation planning and effects is provided in the project Transportation Plan (Appendix G).

From 199 to 672 miles of new roads would be required for this project (Table 4.21). Impacts to existing, upgraded, and newly constructed roads could result from inadequate road maintenance resulting in road failure. While maintenance agreements would be established by Operators, adverse weather conditions coupled with increased traffic may result in roads being temporally impassable (i.e., stuck vehicles, vehicles driving off roads). Increased traffic volumes are anticipated under all Alternatives except the No Action Alternative. For the LOP and especially during development, traffic increases may cause congestion and road damage and an increased potential for vehicle collisions.

For impact analysis, it is assumed that transportation impacts would be greatest during development and would be proportional to the rate of development (i.e., the faster the development pace, the greater the impact to transportation).

4.5.4.1 No Action Alternative

The current estimate of existing and/or proposed in the JIDPA is approximately 199 miles (see Table 4.21). Under No Action, transportation impacts would continue at existing approved levels, the Burma Road would not be upgraded, and the duration of impacts would be approximately 63 years. A total of approximately 1,063,900 round trips, which could occur to and from any location in the JIDPA, or approximately 73 round trips per day is anticipated under the No Action Alternative for the LOP (Appendix G). Prior decisions found that the existing Jonah Field developments would be unlikely to have significant transportation impacts (BLM 1998b, 2000b).

4.5.4.2 The Proposed Action

Under the Proposed Action, approximately 664 miles of resource roads, 8 miles of new collector/local roads, and 12 miles of Burma Road improvement would be required for field development (see Table 4.21). A total of approximately 8,698,600 round trips or approximately 496 round trips per day is anticipated under the Proposed Action for the LOP (Appendix G). This is an increase of 473 new miles of road and 7,634,700 round trips when compared to the No Action Alternative. The length of the Proposed Action and therefore increased traffic volumes is estimated to be 76 years.

4.5.4.3 Alternative A

Under Alternative A, impacts would be the same as for the Proposed Action Alternative; however, some new roads would be built in areas that would be avoided under other project alternatives, and the duration of impacts could be extended by an additional 29 years (at a development rate of 75 wells/year) beyond the Proposed Action Alternative depending upon the rate of development.

Table 4.21 Miles of New Roads, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Alternative	Miles of New Resource Roads[1]	Miles of New In-Field Collector Roads	Miles of Burma Road Upgrade
No Action Alternative[1]	199	0	0
Proposed Action[2]	664	8	12
Alternative A[2]	664	8	12
Alternative B[1]	199	0	12
Alternative C[2]	387	8	12
Alternative D[2]	529	8	12
Alternative E[2]	239	8	12
Alternative F[2]	353	8	12
Alternative G[2]	652	8	12
Preferred Alternative[2,3]	353	8	12

1 Based on 0.4 mile per well pad.
2 Based on 0.15 mile per well pad and includes existing (No Action) road miles.
3 Assumed to be similar to Alternative F.

4.5.4.4 Alternative B

Under Alternative B, impacts would be similar to the No Action Alternative in that no new well pads or roads would be built (see Table 4.21). Impacts would increase from the No Action Alternative due to new development and would increase from the Proposed Action during development due to the increased time necessary to drill the additional directional wells; however, during production, impacts would be decreased from the Proposed Action and all other development alternatives since traffic would occur only to the existing pads. The Burma Road would be upgraded. A total of approximately 8,202,300 round trips or approximately 468 round trips per day is anticipated under Alternative B for the LOP (Appendix G). This is an increase of 7,138,400 round trips when compared to the No Action Alternative. Duration of impacts would be from 76 (250 wells/year) to 105 years (75 wells/year), depending upon the rate of development.

4.5.4.5 Alternative C

Under Alternative C, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 387 total miles of resource roads, 8 miles of new in-field collector roads, and 12 miles of Burma Road improvement would be developed (see Table 4.21). A total of approximately 3,507,600 round trips or approximately 200 round trips per day is anticipated under Alternative C for the LOP (Appendix G). This is an increase of 196 new miles of road and 2,443,700 round trips when compared to the No Action Alternative. Duration of impacts could be from 68 years (250 wells/year) to 80 years (75 wells/year), depending upon the rate of development.

4.5.4.6 Alternative D

Under Alternative D, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 529 total miles of resource roads, 8 miles of new in-field collector roads, and 12 miles of Burma Road improvement would be developed (see Table 4.21). A total of approximately 6,232,600 round trips or approximately 356 round trips per day is anticipated under Alternative D for the LOP (Appendix G). This is an increase of 338 new miles of road and 5,168,700 round trips when compared to the No Action Alternative. Duration of impacts could be from 72 years (250 wells/year) to 93 years (75 wells/year), depending upon the rate of development.

4.5.4.7 Alternative E

Under Alternative E, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 239 total miles of resource roads, 8 miles of new in-field collector roads, and 12 miles of Burma Road improvement would be developed (see Table 4.21). A total of approximately 8,342,500 round trips or approximately 476 round trips per day is anticipated under Alternative E for the LOP (Appendix G). This is an increase of 48 new miles of road and 7,278,600 round trips when compared to the No Action Alternative. Duration of impacts could be from 76 years (250 wells/year) to 105 years (75 wells/year), depending upon the rate of development.

4.5.4.8 Alternative F

Under Alternative F, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 353 total miles of resource roads, 8 miles of new in-field collector roads, and 12 miles of Burma Road improvement would be developed (see Table 4.21). A total of approximately 8,744,000 round trips or approximately 499 round trips per day is anticipated under Alternative F for the LOP (Appendix G). This is an increase of 162 new miles of road and 7,680,100 round trips when compared to the No Action Alternative. Duration of impacts could be from 76 years (250 wells/year) to 105 years (75 wells/year), depending upon the rate of development.

4.5.4.9 Alternative G

Under Alternative G, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 652 total miles of resource roads, 8 miles of in-field collector roads, and 12 miles of Burma Road improvement would be developed (see Table 4.21). A total of approximately 8,691,600 round trips or approximately 496 round trips per day is anticipated under Alternative G (Appendix G). This is an increase of 461 new miles of road and 7,627,700 round trips when compared to the No Action Alternative. Duration of impacts could be from 76 years (250 wells/year) to 105 years (75 wells/year), depending upon the rate of development.

4.5.4.10 BLM Preferred Alternative

Under the Preferred Alternative, impacts would be increased from the No Action Alternative due to the increase in the number of new well pads and access roads. Approximately 353 miles of resource roads, 8 miles of new collector/local roads, and 12 miles of Burma Road improvement would be required for field development (see Table 4.21). A total of approximately 8,744,600 round trips or approximately 499 round trips per day is anticipated under the Preferred Action for the LOP. This is an increase of 162 new miles of road and 7,680,100 round trips when compared to the No Action Alternative. Duration of impacts could be from 76 years (250 wells/year) to 105 years (75 wells/year) depending upon the rate of development.

Under the Preferred Alternative additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Any measure that reduces the volume of human presence or centralizes development actions has the potential to reduce impacts to transportation. Furthermore, those measures associated with the JIWG also could reduce impacts to transportation through appropriate planning.

4.5.4.11 Cumulative Impacts

Cumulative impacts from traffic resulting from the project in combination with other regional projects and overall regional growth could be significant. The project would be the major contributor to increased traffic on secondary roads within the JIDPA. Field development would result in increased traffic volumes on major highways (especially on U.S. Highway 191, a major tourist corridor) and on county and local roads. Increased traffic would result in an increased potential for public traffic hazards and other safety and road maintenance concerns. However, the magnitude of the increase would depend on alternative-specific development levels and development rates (i.e., 75, 150, or 250 new wells developed per year). Existing major highways and county roads are adequate to handle anticipated increased traffic (Appendix G). The costs of maintaining county and local roads would be borne, to some extent, by Operators primarily through tax payments. Cumulative impacts on transportation are anticipated to be slightly beneficial for the long term as an increase in available roads, improved road conditions, and increased revenues for state-sponsored road improvements occur. It is anticipated that the upgraded conditions on the Burma and Luman Roads would be retained after project completion allowing for increased recreational use of the area under all alternatives.

4.5.4.12 Unavoidable Adverse Impacts

Unavoidable adverse impacts to transportation would occur for the LOP primarily as a result of increased traffic and the expanded road network.

4.6 VISUAL RESOURCES

The BLM PFO and RSFO RMP RODs (BLM 1988b,1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with visual resources:

- to maintain or improve scenic values and visual quality and to establish priorities for managing the visual resources in conjunction with other resource values; and
- to conserve and develop scenic resources for the benefit of present and future generations.

The BLM defines a significant impact to visual resources, on federal lands and minerals, as project-related development that would not meet VRM class objectives for an area. A significant impact would occur if oil and gas development becomes the dominant feature in the landscape where the objectives for that land are to maintain the existing character of the landscape. Impacts to visual resources are assumed to be proportional to the amount of new initial and LOP development. A significant impact to the visual resources on non-federal lands and minerals is also defined as an apparent change, to the casual observer, from a natural landscape to an "industrialized appearing" landscape in areas visible from U.S. Highway 191, residential areas, and the town of Pinedale. Due to the presence of natural gas development as a dominant visual feature throughout the JIDPA, as well as project effects such as haze, nighttime lighting, increased traffic, and short-term visible smoke plume events, significant visual resource impacts are anticipated under all alternatives for the LOP and until areas are adequately reclaimed. These significant visual resource impacts would not occur within the JIDPA specifically since the entire JIDPA is considered a Class IV VRM area and the project under all alternatives is generally consistent with Class IV objectives, but would occur at locations where the JIDPA and/or project effects (e.g., light sources, haze, smoke plumes) are visible. These non-JIDPA areas include VRM Class II and III areas, sections of U.S. Highway 191, and other locations including wilderness and wilderness study areas.

4.6.1 No Action Alternative

Under the No Action Alternative, there would be no new impacts to visual resources beyond those already approved for Jonah Field developments. The duration of impacts would be approximately 63 years and until areas are adequately reclaimed. While past NEPA decisions for the project identified no significant impacts to visual resources (BLM 1998b, 2000b), significant visual resource impacts from the existing developments have since been identified as described above.

4.6.2 The Proposed Action

Implementation of the Proposed Action would result in a continuation of the existing long-term visual characteristics of the JIDPA as a developed natural gas field with increased impacts to visual resources from that of the No Action Alternative due to increased development and prolonged development life. Increased natural gas field developments would include greater well pad densities, more miles of roads and associated traffic, and more ancillary facilities. Impact duration is anticipated to be approximately 76 years and until areas are adequately reclaimed.

4.6.3 Alternative A

Implementation of Alternative A would result in the same types and volumes of visual resource impacts as the Proposed Action; however, there would be increased visual resource impacts in the resource buffer areas that would have otherwise been avoided under the other project alternatives. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 76 to 105 years).

4.6.4 Alternative B

Implementation of Alternative B would result in the same types of impacts as No Action but would be increased due to expanded development. Impacts would be reduced from the other project alternatives since no new well pads or roads would be built. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 76 to 105 years).

4.6.5 Alternative C

Implementation of Alternative C would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Reductions in visual resource impacts from those of the Proposed Action are anticipated as development would be concentrated on fewer well pads. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 68 to 80 years).

4.6.6 Alternative D

Implementation of Alternative D would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Reductions in visual resource impacts from those of the Proposed Action are anticipated as development would be concentrated on fewer well pads. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 72 to 93 years).

4.6.7 Alternative E

Implementation of Alternative E would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Reductions in visual resource impacts from those of the Proposed Action (3,100 wells/pads) are anticipated as development would be concentrated on fewer well pads. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 76 to 105 years).

4.6.8 Alternative F

Implementation of Alternative F would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Under this alternative, visual resource impacts are anticipated to be similar to those of the Proposed Action but reduced since the 3,100 proposed wells would be concentrated on only 1,028 well pads. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 76 to 105 years).

4.6.9 Alternative G

Implementation of Alternative G (64 total pads/section) would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Under this alternative, visual resource impacts are anticipated to be similar to those of the Proposed Action but reduced since the 3,100 proposed wells would be concentrated on only 2,553 well pads. Duration of impacts would be dependent upon the rate of development plus the time needed for adequate reclamation (i.e., from 76 to 105 years).

4.6.10 BLM Preferred Alternative

Implementation of the Preferred Alternative would result in the same types of visual resource impacts as No Action, but impacts would be increased since more well pads and roads would be constructed. Under this alternative, visual resource impacts are anticipated to be similar to those of the Proposed Action (3,100 wells/pads), but slightly less as the Operators would implement unique development procedures and additional mitigation requirements. Duration of impacts would be approximately 76 years.

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Any measure that reduces regional haze or smoke plumes, the volume of surface disturbance, human presence, and/or traffic, as well as those measures that minimize adverse effects vegetation or facilitate enhanced reclamation have the potential to reduce impacts to visual resource.

4.6.11 Cumulative Impacts

Total surface disturbance resulting from the Proposed Action and Alternative A would be 20,409 acres (the most disturbance of all potential alternatives), all of which would occur on areas designated as VRM Class IV. RFD (disturbance) in the visual resource CIAA (see Map 3.24) includes 7,302 acres of existing disturbance primarily from natural gas developments in the Jonah, Pinedale Anticline, Fontenelle, Moxa, and Stagecoach Draw project areas (Table 4.22). Maximum cumulative disturbance for the visual resources CIAA (i.e., the combined existing, proposed [Proposed Action and Alternative A], and RFD disturbance) is 166,452 acres, or 8.0% of the CIAA.

Most of the visual resource CIAA is designated as VRM Class IV (see Map 3.24). Class IV areas allow for management activities that require major modifications to the existing character of the landscape. Although the activities may dominate the view of the casual observer and the relative change to the landscape may be high, all management activities must be conducted to minimize the impact to the visual quality of the area. Under all project alternatives, the JIDPA and its incumbent developments coupled with other regional developments are visible and may dominate the viewscape from VRM Class II and III areas, some sections of U.S. Highway 191, and nearby wilderness and wilderness study areas within the CIAA; therefore, significant cumulative impacts to regional visual resources would occur at these sites.

4.6.12 Unavoidable Adverse Impacts

The expansion of gas development facilities, and various development effects (e.g., haze, smoke plumes, nighttime lighting effects on regional star-gazing) and associated roads would be an unavoidable adverse impact to visual resources on the JIDPA and at locations where it is visible outside the JIDPA. This impact would occur throughout the LOP and for some additional time necessary for reclaimed areas to acquire predisturbance visual characteristics.

4.7 HAZARDOUS MATERIALS

The PFO and RSFO RMP RODs (BLM 1988b, 1997b) and land use plans for the State of Wyoming (WSLUC 1979) and Sublette County (SCBC and SCPC 2003) identify the following management goals/objectives associated with hazardous materials:

- to protect public and environmental health and safety on BLM-administered public lands;

Table 4.22 Cumulative Acreage of Disturbance in the Visual Resources CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005.

Cumulative Impact Analysis Area (CIAA)	Total Acreage of CIAA	Existing Disturbance In CIAA, Outside JIDPA	RFD	Disturbance					
				No Action			Proposed Action and Alternative A		
				New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Visual Resources	2,089,363	138,740	7,302	4,209	1,409	150,252	20,409	6,040	166,452
Percent of entire CIAA									8.0

Cumulative Impact Analysis Area (CIAA)	Disturbance											
	6.6			7.2								
	Alternative B			Alternative C			Alternative D			Alternative E		
	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Visual Resources	7,390	2,561	153,433	10,914	3,399	156,957	15,790	4,755	161,833	10,595	3,597	157,002
Percent of entire CIAA			7.3			7.5			7.8			

Cumulative Impact Analysis Area (CIAA)	Disturbance								
								7.5	
	Alternative F			Alternative G			Preferred Alternative		
	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]	New	LOP	Cumulative[1]
Visual Resources	14,655	3,997	160,698	18,198	5,408	164,241	12,525	3,847	158,567
Percent of entire CIAA			7.7						7.6

[1] Cumulative disturbance = new + existing + RFD.

7.9

- to comply with applicable federal and state laws;
- to prevent waste contamination due to any BLM-authorized action;
- to minimize federal exposure to the liabilities associated with waste management on public lands; and
- to integrate hazardous materials and waste management policies and controls into all BLM programs.

Impacts associated with hazardous materials would be considered significant if project activities resulted in violations of the aforementioned goals/objectives and/or local, state, and federal laws. Impacts to soils, surface and ground water resources, and wildlife could result from accidental hazardous materials spills, pipeline ruptures, and/or exposure to hazardous materials. It is likely that only small amounts of soil potentially would be contaminated and, should this occur, the affected area would be cleaned up in an appropriate and timely manner (Appendix G). Proper containment of oil and fuel in storage areas, containment of fluids in reserve pits, appropriate pipeline design and construction, proper well casing and cementing, and location of wells away from drainages (all but Alternative A) would prevent potential surface and ground water contamination. Project operations would comply with all relevant federal and state laws regarding hazardous materials and with directives identified in the Hazardous Materials Summary for this project (Appendix G) and existing SPCCPs.

With the implementation of the aforementioned procedures plus the additional mitigations and practices identified in Appendices A, B, and G, no significant impacts are anticipated under any project alternative.

4.7.1 No Action Alternative

Under the No Action Alternative, there would be no new developments and associated opportunities for material spills, pipeline ruptures, and/or exposure to hazardous materials above present levels and as previously approved for the JIDPA. Prior NEPA documents concluded that there would be no significant adverse impacts involving hazardous materials (BLM 1998b, 2000b). The duration for potential impacts would be for the LOP which is anticipated to be approximately 63 years and until all potentially contaminated sites are remediated.

4.7.2 The Proposed Action

Under the Proposed Action Alternative there would be an approximate six-fold increase (from 533 approved wells to 3,100 new wells) in the potential for material spills, pipeline ruptures, and/or exposure to hazardous materials above current approved levels. The duration for potential impacts would be for the LOP which is anticipated to be approximately 76 years and until all potentially contaminated sites are remediated.

4.7.3 Alternative A

Implementation of Alternative A would have the same potential for hazardous material impacts as the Proposed Action Alternative. However, potential impacts to wildlife and surface waters would be increased in some areas since selected wildlife and drainage buffers would not be avoided. The duration for potential impacts would be for the LOP which would be dependent upon the approved rate of development (i.e., from 76 to 105 years) and until all potentially contaminated sites are remediated.

4.7.4 Alternative B

Implementation of Alternative B would have the same potential types of hazardous material impacts as the No Action Alternative; however, impacts would be increased due to the addition of new wells, pipelines, and produced materials. Potential impacts and impact areas would be limited to the existing well pads and roads since no new pads or roads would be constructed. The duration for potential impacts would be dependent upon the rate of development (i.e., from 76 to 105 years) and until all potentially contaminated sites are remediated.

4.7.5 Alternative C

Under Alternative C, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximately two-fold increase (from 533 [No Action] to 1,250 new wells) in the potential for impacts. Potential impacts would be increased from those of the No Action Alternative due to the addition of new wells, pipelines, and produced materials. The duration of the impacts would be dependent upon the rate of development (i.e., from 68 to 80 years) and until all potentially contaminated sites are remediated.

4.7.6 Alternative D

Under Alternative D, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximately four-fold increase (from 533 [No Action] to 2,200 new wells) in the potential for impacts. Potential impacts would be increased from those of the No Action Alternative due to the addition of new wells, pipelines, and produced materials. The duration of the impacts would be dependent upon the rate of development (i.e., from 72 to 93 years) and until all potentially contaminated sites are remediated.

4.7.7 Alternative E

Under Alternative E, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximate six-fold increase in the potential for material spills, pipeline ruptures, and/or exposure to hazardous materials above current approved levels (from 533 wells [No Action] to 3,100 new wells). The duration of the impacts would be dependent upon the rate of development (i.e., from 76 to 105 years) and until all potentially contaminated sites are remediated.

4.7.8 Alternative F

Under Alternative F, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximate six-fold increase in the potential for material spills, pipeline ruptures, and/or exposure to hazardous materials above current approved levels (from 533 wells [No Action] to 3,100 new wells). The duration of the impacts would be dependent upon the rate of development (i.e., from 76 to 105 years) and until all potentially contaminated sites are remediated.

4.7.9 Alternative G

Under Alternative G, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximate six-fold increase in the potential for material spills, pipeline ruptures, and/or exposure to hazardous materials above current approved levels (from 533 wells [No Action] to 3,100 new wells). The duration of the impacts would be dependent upon the rate of development (i.e., from 76 to 105 years) and until all potentially contaminated sites are remediated.

4.7.10 BLM Preferred Alternative

Under the Preferred Alternative, the types of potential impacts would be the same as under the No Action Alternative, but there would be an approximate six-fold increase in the potential for material spills, pipeline ruptures, and/or exposure to hazardous materials above current approved levels (from 533 wells [No Action] to 3,100 new wells). The duration of the impacts would be approximately 76 years and until all potentially contaminated sites are remediated.

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.14). Any measure that reduces the overall level of development, the number of proposed facilities or facility locations, and/or traffic, as well as any actions that facilitate enhanced reclamation have the potential to reduce potential hazardous material impacts.

4.7.11 Cumulative Impacts

All existing, proposed, and future development projects would use mitigation measures similar to those described for this project (Appendix G) to prevent soil contamination, surface and ground water pollution, and wildlife exposure; therefore cumulative impacts from hazardous materials are expected to be as described above for the various project alternatives and are not anticipated to be significant. There would, however, be some increased potential for hazardous material impacts associated with expanded regional developments associated with other oil and gas projects.

4.7.12 Unavoidable Adverse Impacts

With strict adherence to identified hazardous material management requirements (Appendix G), no unavoidable adverse impacts are anticipated.

4.8 COMPENSATORY MITIGATION

Preliminary research and monitoring results, as well as the impact results reported here, indicate that existing surface disturbance activity especially when combined with certain project alternatives considered in this EIS may be appropriate for CM.

Mitigation measures fall within the actions the Secretary of the Interior can direct to prevent unnecessary or undue degradation of the public lands and protect surface resources in the approval of surface use plans. These measures, as part of the Proposed Action, are analyzed as part of BLM's compliance with the National Environmental Policy Act (NEPA). Mitigation, as defined by the Council on Environmental Quality (CEQ) in 40 CFR 1608.20, may include one or more of the following:

> (1) Avoiding the impact altogether by not taking a certain action or parts of an action;
> (2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
> (3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
> (4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
> (5) **Compensating** for the impact by replacing, or providing substitute resources or environments. [emphasis added]

As a general guideline, CM may be considered after other forms of on-site mitigation, including best management practices, have been analyzed. In other words, while on-site mitigation is the first priority when mitigating significant impacts, CM is an available tool for enhancing mitigation when impacts to BLM resources cannot be adequately mitigated on the site where the impacts are occurring.

It is assumed that any BLM-approved CM project would reduce impacts to the same or similar resources impacted by Jonah Infill activities, or would substitute resources for those impacted by Jonah Infill activities. However, any quantitative analysis of beneficial effects of CM cannot be identified until specific projects are proposed and it is known what specific impacts that project is intended to mitigate. The BLM may include other affected Federal agencies and the State of Wyoming in discussions regarding selection of specific CM projects, and may provide opportunity for public input.

A partial list of CM project ideas is provided in Section 5.2. Included with each idea is an estimated cost, where available, and the resources whose impacts might be mitigated by that type of project. There is no implied prioritization in that list.

4.8.1 Operator-proposed CM

The Operators have committed to funding a Cumulative Impacts Mitigation Fund (CIMF) to offset impacts of their proposed Jonah Infill development. While details are emerging, one form of financing the fund could be to deposit a particular dollar amount for every acre of new initial surface disturbance in the JIDPA above a certain acreage threshold. For example, Operators have suggested a hypothetical amount of $850.00 for every acre of new initial surface disturbance authorized in the JIDPA, above a threshold of 11,000 acres. The CIMF could be administered by an independent Advisory Board.

The hypothetical dollar amounts that the Operators would commit to the CIMF by alternative, based on the acres of surface disturbance each alternative would approve if selected, are shown below and summarized in Table 2.12.

No Action:

> No new initial surface disturbance approved for authorization
> = No money committed to the CIMF

Proposed Action:

16,200	acres new initial surface disturbance approved for authorization
- 11,000	acres new initial surface disturbance authorization threshold
5,200	acres x $850/acre of authorized new initial surface disturbance
= $4,420,000	potentially available to finance CIMF

Alternative A:

16,200	acres new initial surface disturbance approved for authorization
- 11,000	acres new initial surface disturbance authorization threshold
5,200	acres x $850/acre of authorized new initial surface disturbance
= $4,420,000	potentially available to finance CIMF

Alternative B:

3,297	acres new initial surface disturbance approved for authorization
11,000	acres new initial surface disturbance authorization threshold
= No money committed to the CIMF	

Alternative C:

6,705	acres new initial surface disturbance approved for authorization
11,000	acres new initial surface disturbance authorization threshold
= No money committed to the CIMF	

Alternative D:

11,581	acres new initial surface disturbance approved for authorization
- 11,000	acres new initial surface disturbance authorization threshold
581	acres x $850/acre of authorized new initial surface disturbance
= $493,850	potentially available to finance CIMF

Alternative E:

6,386	acres new initial surface disturbance approved for authorization
11,000	acres new initial surface disturbance authorization threshold
= No money committed to the CIMF	

Alternative F:

10,446	acres new initial surface disturbance approved for authorization
11,000	acres new initial surface disturbance threshold
= No money committed to the CIMF	

Alternative G:

13,989	acres new initial surface disturbance approved for authorization
- 11,000	acres new initial surface disturbance authorization threshold
2,989	acres x $850/acre of authorized new initial surface disturbance
= $2,540,650	potentially available to finance CIMF

BLM Preferred Alternative:

8,316	acres new initial surface disturbance approved for authorization
11,000	acres new initial surface disturbance authorization threshold
= No money committed to the CIMF	

4.8.2 BLM Preferred Alternative CM

In lieu of the proposed CIMF, the Operators could voluntarily develop proposals, submit those proposals to BLM for approval, and fund and implement the BLM-approved CM projects.

4.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible and irretrievable commitment of resources is defined as a permanent reduction of resources that, once lost, cannot be regained. The degree of loss would be dependent upon the alternative implemented. The primary irreversible and irretrievable commitment of resources for this project would result from the recovery of the natural gas and condensate reserves from the Lance Pool (see Section 4.1.4). These recovered reserves would no longer be available; however, some reserves would remain and could be recovered in the future with improved technology. Other permanent irreversible and irretrievable commitments of resources would include soils lost through water or wind erosion (see Section 4.1.7); accidental or inadvertent destruction and/or vandalism of cultural (see Section 4.3) or paleontological (see Section 4.1.6) resources; loss of wildlife due to direct mortality (see Section 4.2.2); and the labor, materials, and energy expended during project-related activities (see Appendix G).

4.10 SHORT-TERM USE OF THE ENVIRONMENT VS. LONG-TERM PRODUCTIVITY

For the purposes of this discussion, short-term use of the environment is that use during the LOP, whereas long-term productivity refers to the period after the project is completed and the area is adequately reclaimed. Short-term use of the JIDPA for natural gas recovery for the LOP would not affect the long-term productivity of the area. LOP commitments of resources would include loss of vegetation productivity (see Section 4.2.1), wildlife habitat/habitat function (see Section 4.2.2), and livestock forage (see Section 4.5.2) on lands devoted to project activities (e.g., well pads, roads) until these areas are adequately reclaimed. After the project is completed and disturbed areas are reclaimed, the same resources that were present prior to project activities would be available, except for the natural gas and oil resources (see Section 4.1.4). It may take 20 years or more after the LOP for some of the reclaimed areas to revegetate to predisturbance levels; however, reclamation would eventually provide conditions to support wildlife, livestock, and recreation. Use of the JIDPA during the LOP would not preclude the subsequent long-term use of the area for any purpose for which it was suited prior to the project.

CHAPTER 5 — ADDITIONAL POTENTIAL MITIGATION, MONITORING MEASURES AND COMPENSATORY MITIGATION IDEAS

This chapter provides a summary of mitigation and monitoring actions that could be applied to the project to further minimize adverse impacts or verify the presence, extent or absence of anticipated impacts. This list itemizes mitigation, monitoring, and compensatory mitigation (CM) that have been identified by the public and/or Interdisciplinary Team (IDT) members and that are not already included in the BLM Preferred Alternative (see Section 2.14) or the Operator-committed practices detailed in Appendix B. Each listed measure is briefly summarized and includes an identification of how application of the measure may influence project effects. CM ideas include estimated costs where available, and identification of which resource(s) might benefit from that type of CM project.

Any of the listed actions may be required or recommended under any alternative if this project is approved. Decisions regarding the inclusion or exclusion of these actions will be made in the ROD for this project.

5.1 ADDITIONAL MITIGATION OPPORTUNITIES

The JIWG could consider the following measures for application to the project as part of its annual recommendations to the BLM. Following JIWG recommendation, BLM could require certain of these actions, or make appropriate recommendations to affected Governments, Agencies, and/or applicable Operators. Operators could commit to the application of these measures with or without JIWG recommendation.

5.1.1 Air Quality

The following mitigation actions could reduce overall project emissions, which in turn could protect other resources such as visibility, acid deposition, vegetation, wildlife and other resources potentially affected by fugitive dust and emissions. These actions include:

- a HAP assessment at five locations in the JIDPA to assess ambient air concentrations to address public concerns;
- work with WDEQ/AQD to evaluate the use of alternate technologies (e.g., condensers on dehydrators, carbon filters on condensate tanks, remote telemetry monitoring) for well pad production facilities (dehydrators, separators, heaters) to reduce emissions from these features and traffic;
- use low-pressure gas gathering pipelines to reduce compression needs, recover flash gas lost during processing, and eliminate VOC and HAP emissions when the gas is introduced to the sales gas distribution system;

- use Tier II-compliant diesel engines and/or other low emission drill rig engines, including alternatively powered drill rig engines (e.g., natural gas, hybrid non-diesel), on all drill rigs operating in the JIDPA when they become available;

- work with the WDEQ/AQD developing and financing appropriate identification, monitoring, and emissions control procedures for HAPs and other emissions from water treatment/disposal facilities; and

- use alternative energy sources (e.g., solar, wind, hydrogen) to power proposed internal combustion engines.

5.1.2 Topography

The following action could protect important or unique topographic features in the JIDPA, which in turn could reduce soil erosion and protect the wildlife habitats provided by these features:

- no disturbance at rock outcrops in the JIDPA.

5.1.3 Paleontology

The following action could protect important or unique paleontological features in the JIDPA by identifying their location and subsequently restricting project activities that could disturb them:

- an active program of inventory and evaluation of sediments known or suspected to contain paleontological materials and an assessment of cumulative impacts.

5.1.4 Soil Resources

The following actions could protect soils by reducing erosion, compaction, loss through mixing with unsuitable plant growth material, and the time necessary for disturbance to be reclaimed. By reducing soil erosion, these actions could also protect surface water quality and promote revegetation, which in turn could promote the provision of forage for livestock and wildlife. These actions include:

- site-specific predisturbance landscape descriptions, including soils data, plant species composition and cover data, and proposed reclamation seed mixes with application rates;

- analyze soils prior to disturbance to determine appropriate reclamation seed mixtures and potential soil amendment needs; and

- utilization of fertilizers or other soil amendments at reclamation sites to facilitate site re-vegetation.

5.1.5 Surface Water Resources

The following actions could protect surface water resources and could protect ground water quality in areas where surface water percolates below the ground surface:

- utilize catchment basins, sediment retention ponds, and/or spreader dikes within or external to the JIDPA to capture potentially increased flows due to runoff from disturbed areas to prevent channel morphology damage;

- monitor channel condition in the JIDPA with photo points and/or other appropriate methods in coordination with BLM;

- no additional linear crossings (road and/or pipeline crossings/crossing corridors) of Sand Draw and/or other ephemeral drainages, unless it can be proven that such activity would reduce the erosive potential of the JIDPA and could be accomplished with no disturbance to the drainages;

- hold storm water and snowmelt water in the JIDPA for as long as possible to allow for infiltration, reduce runoff energy and associated sediment loads, using geofabrics, jute netting, spreader dikes, retention ponds, additional armoring of existing water courses, or other techniques;

- develop and implement an adaptive surface water management plan for the entire JIDPA which could include the NPDES process and consider runoff on a cumulative watershed basis;

- pipeline crossings of all drainage channels could be fitted with shutoff valves or other systems to minimize accidental discharge and facilitate channel protection from contamination in the event of a pipeline break;

- maximize recycling of waters utilized and produced for this project and increase capacities to both treat and re-use clean produced water within the field;

- consider produced water treatment and/or disposal facilities (e.g., evaporation ponds) on federal surface in the JIDPA; and

- file all NPDES permits and associated water quality data with the BLM and consult with WDEQ, WGFD, BLM and livestock permittees before any water release.

5.1.6 Vegetation, Including TEP&C and BWS Plant Species

The following actions could protect vegetation, including TEP&C and BWS plant species and protect soils, water quality, and wildlife habitat and livestock forage:

- scalping and post-construction ripping rather than removal and re-spreading of topsoil for all new pipelines;

- establish vegetative plots to scientifically evaluate reclamation success, to develop appropriate procedures for timely sagebrush reestablishment, and/or to further identify the most desirable reclamation species; and

- in coordination with the BLM, Natural Resources Conservation Service and Sublette County Conservation District, Operators could utilize irrigation at reclamation sites to improve germination and vegetation establishment.

5.1.7 Wildlife, Including TEP&C and BWS Animal Species

The following actions could protect wildlife, including TEP&C and BWS animal species and soils, vegetation, and water quality resources:

- utilization of low-profile tanks within line-of-sight, up to a maximum of 0.5 mile, of greater sage-grouse leks;
- develop water sources within the JIDPA that are outside of areas with a high level of development for area wildlife and/or convert existing project-developed water wells for wildlife use when they are no longer required;
- avoid all raptor nest territories (rather than just active nests) during the nesting season;
- expand annual wildlife monitoring in the JIDPA and Wildlife Study Area to include new wildlife/habitat study opportunities identified in consultation with the BLM, WGFD and/or USFWS;
- modify wildlife protection measures (e.g., altered buffer area sizes, seasonal restriction dates) based on the results of annual monitoring and/or other regional wildlife studies;
- develop habitat enhancement projects on the JIDPA to accommodate displaced wildlife or altered migration routes; and
- inventory the Big Piney white-tailed prairie dog complex for black-footed ferrets and pursue a block clearance of the complex.

5.1.8 Cultural Resources

The following actions could protect cultural resources:

- develop and implement a research design, discovery plan, and/or cultural resource management plan for the combined areas of the Pinedale Anticline Project Area and JIDPA, and consult with SHPO pursuant to the effect of these plans on affected cultural resources;
- implement larger cultural resource survey areas for site-specific development actions (areas of potential effect); and
- intensify data collection efforts at affected high-value archaeological sites in exchange for disturbance of sites with less unique values.

5.1.9 Land Use/Livestock Grazing

The following actions could protect livestock from hazards associated with development:

- Operators could commit to work with BLM and affected livestock permittees to mitigate the loss of AUMs in the JIDPA through provision of range improvement projects to modify grazing distribution patterns (e.g., water developments, vegetation treatments, irrigation, fencing, use of herders, actions that improve carrying capacity) within the project-affected allotments;

- Operators could commit to reduce fugitive dust on all proposed roads to decrease the potential for dust pneumonia in cattle; and
- Operators could commit to converting project-developed water wells for livestock use when they are no longer required for the project.

5.1.10 Land Use/Recreation

The following actions could minimize adverse project effects to JIDPA recreation by providing a new tourism opportunity:

- provide one or more quality interpretive sites with public access and/or publications with public distributions to provide the general public and interested parties educational information regarding JIDPA developments and management actions for other area-specific natural resource values.

5.1.11 Land Use/Transportation

The following actions could reduce impacts to roads, the transportation network, the traveling public, air quality, soils, vegetation, wildlife, livestock grazing, and recreation:

- prepare road development and transportation management plans;
- utilize car pools and/or bus crews from communities of origin to the field to minimize commuting traffic;
- utilize existing roads in the JIDPA as collector and/or resource roads to the maximum extent possible to avoid new surface disturbance; and
- Operators could jointly develop and submit for BLM approval road maintenance and use agreements designating road development, maintenance, and use requirements by each Operator. These agreements could identify responsibilities for necessary preventative and corrective road maintenance throughout the LOP. Maintenance responsibilities could include, but not be limited to, blading, gravelling or aggregate-surfacing, cleaning ditches and drainage facilities, dust abatement, noxious weed control, culvert maintenance and repair, or other requirements.

5.1.12 Visual Resource

Additional measures identified for vegetation and wildlife habitat (reclamation actions) and transportation (reduced traffic volumes) could also benefit visual resources. The following measure could also reduce project impacts to the visual resource:

- funding a hosted worker (visual resource management specialist) to be assigned to the BLM PFO.

5.1.13 Health and Safety/Hazardous Materials

The following measures could protect public and worker health and safety and improve BLM's inspection and enforcement capability:

- provide the BLM copies of field- or lease-specific SWPPPs, SPCCPs, Spill Response Plans, and Emergency Response Plans;
- fill pipelines with clay or cement slurry at abandonment
- install highly visible signage on JIDPA access roads to
  - notify the public of the presence of potentially hazardous features in the area,
  - advise the public to stay on developed roads and avoid well pads and other facility sites, and/or
  - identify areas of no overnight camping, no discharge of firearms, no off-leash pets, and/or no off-road travel; and
- install and lock all gates at all non-major transportation routes in the JIDPA (e.g., well and facility site access roads) to control unauthorized access.

5.1.14 Other Actions

The following actions or recommendations could enhance various resource protections, facilitate field management, or assist other entities with management decisions. These actions include:

- implement Operator-committed practices under any approved alternative when not already committed to (see Appendix B, Exhibit B-1) or required by BLM;
- file valid copies of access and/or surface use agreements between Operators and the private surface owner with APDs and/or ROW grants with the BLM for all future development proposals on private surface with BLM mineral estate. This action could be beneficial for area transportation planning (optimization of road location and design, road maintenance planning) for single roads that cross both public and private surface by providing an opportunity for the BLM to coordinate agreement specifications;
- Operators could acquire the 640 acres of private land surface in the JIDPA. This action could reduce potential conflicts between Operators and the private landowner, and facilitate comprehensive management of the entire area as a contiguous block rather than a patchwork of separately owned sections with varying management protocols;
- utilize new drilling and development technologies (e.g., laser drilling, natural gas powered drill rig engines, micro-hole drilling, mat drilling) as they become available and feasible. This could decrease a variety of impacts and assist Operators in developing research or pilot projects to test new development technologies;

- utilize unknown technologies or technological innovations as they become available and feasible to minimize pad/road/pipeline/ancillary facility footprints and/or other adverse impacts;

- increase bond amounts for JIDPA developments. Such action could ensure that sufficient funds are available to reclaim disturbed areas in the event Operators inadequately implement reclamation;

- Operator surveyors could submit electronic data for wells, roads, pipelines, and other project infrastructures in a format suitable to the BLM. Provision of electronic data would allow for consistency among project data across Operators and would facilitate BLM database management. This action could benefit all area resources potentially affected by specific project development features (e.g., wildlife, habitats);

- Operators could provide hosted workers to the BLM as needed throughout the project development phase or LOP. If applied, this measure could facilitate efficient and timely BLM permitting;

- investigate the feasibility of providing gas from the JIDPA to area gas users (e.g., local residents and businesses). If applied this measure could provide area residents with reduced natural gas costs, potentially off-setting regional natural gas cost increases to local consumers;

- utilize smaller ROWs to disturb less surface area during pipeline construction. and initially install larger diameter pipelines to minimize pipeline disturbance corridor widths. If applied, this measure could reduce all impacts associated with linear surface disturbances; and

- develop a wildlife compensation fund to be administered by the State of Wyoming.

5.2 COMPENSATORY (OFF-SITE) MITIGATION IDEAS

The following list is not intended to be exhaustive. It is simply a list of the types of CM activities that could be undertaken to mitigate for impacts within the JIDPA that cannot be fully mitigated on-site, to substitute similar resources for those not able to be mitigated on-site in the JIDPA, or to provide tangible benefits similar to those that would have been provided with successful on-site mitigation in the JIDPA. The CM guidelines provided in Section 4.8 would apply to these or any other projects proposed for CM.

Assist with funding for a WDEQ mobile emissions inspector for the JIDPA for 5 years, or financially assist WDEQ and USFS with on-going air quality monitoring in the Upper Green River area; consultation with the USFS and WDEQ/AQD to develop and implement a consistent funding mechanism to continue existing on- and off-site air quality monitoring actions at Class I airsheds and sensitive lakes. Monitoring at local communities and/or at other potentially affected sites could also be implemented.

- Impacted resource potentially benefited: Air quality
- Cost estimate: $15,000 to $100,000 per year

Install a headcut stabilization structure in the Alkali Creek drainage outside the JIDPA

- Impacted resources potentially benefited: Soils, topography, surface water
- Cost estimate: $10,000 to $15,000

Purchase a conservation easement on an irrigated hay meadow adjacent to existing greater sage-grouse habitat that is as close to the JIDPA as possible, that is not encumbered by fluid mineral leases, and restore that meadow to sagebrush vegetation similar to the adjacent sagebrush community

- Impacted resources potentially benefited: Soils, vegetation, greater sage-grouse and other sagebrush-obligate species
- Cost estimate: Conservation easements could vary from a few thousand to several million dollars, depending on size and location; restoration costs, likely less than $500,000

Purchase right-of-way and install water improvement on an area near but outside the JIDPA where forage is underutilized for lack of water

- Impacted resources potentially benefited: Wildlife including TEP&C and BWS, soils, surface water, vegetation, livestock grazing
- Cost estimate: Rights-of-way could vary from several hundred to several thousand dollars, depending on size and location; water improvement costs, likely less than $100,000

Purchase a large block of sagebrush ecosystem land as close as possible to the JIDPA, that is unencumbered by fluid mineral leases and is adjacent to existing greater sage-grouse habitat, and enhance sagebrush habitat function on that land for LOP at a ratio of 3:1, or three acres enhanced for every acre impacted in the JIDPA

- Impacted resources potentially benefited: Wildlife including TEP&C and BWS, vegetation, soils
- Cost estimate: Land prices vary from several thousand to tens of millions of dollars, depending on existing use, location, and parcel size; enhancement activity costs, likely less than $500,000

Purchase development rights on grasslands in the area that are unencumbered by fluid mineral leases, and enhance forage production

- Impacted resources potentially benefited: Wildlife including TEP&C and BWS, vegetation, soils, visual, recreation, livestock grazing
- Cost estimate: Development rights costs vary considerably with location and parcel size, and could vary from several thousand to several million dollars; forage enhancement costs, likely less than $500,000

Assist local government with funding of public service projects such as city sewage treatment facility upgrade, mosquito abatement, or West Nile virus inoculation programs

- Impacted resource potentially benefited: Socioeconomic
- Cost estimate: Several thousand to several million dollars

Purchase conservation easement and establish and maintain 3 ferruginous hawk or bald eagle or burrowing owl nesting sites as close as possible to the JIDPA, and facilitate continued occupation of those nests for LOP

- Impacted resource potentially benefited: Wildlife
- Cost estimate: Cost of conservation easement + up to $10,000

Work with impacted communities to develop and fund "portable" infrastructure enhancements (infrastructure provided by Operators during "boom" peaks, removed by Operators during "bust" times)

- Impacted resource potentially benefited: Socioeconomic
- Cost estimate: Several thousand to several million dollars

Work with WyDOT and/or Sublette County Road and Bridge to install appropriate road-side signs outside the JIDPA that indicate potential hazards (e.g., school bus stops, high-traffic volume turnouts, trucks entering roadway)

- Impacted resource potentially benefited: Socioeconomic
- Cost estimate: Likely less than $10,000

Develop wildlife habitat improvements designed to increase huntable/viewable species populations

- Impacted resource potentially benefited: Socioeconomic, recreation, wildlife
- Cost estimate: Several thousand to several million dollars

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CHAPTER 6 — CONSULTATION AND PREPARERS

The list of preparers and participants, including BLM IDT members and cooperating State of Wyoming personnel and offices, is presented in Table 6.1.

Personnel contacted or consulted during preparation of this EIS and scoping respondents are listed in Table 6.2. All individuals and entities providing comment during scoping, as well as selected additional agency and media offices, will be provided copies or access to this Draft EIS or its abstract, if so requested. Those entities commenting via email will be directed to <www.wy.blm.gov/nepa/> for access to an electronic copy of the document.

Table 6.1 List of Preparers and Participants, Jonah Infill, Drilling Project, 2005.

Name	EIS Responsibility
BLM Interdisciplinary Team	
Denver Regional Office	
Craig Nicholls	Air Quality/Climate
Paul Sommers	Water Resources
State Office	
Roy Allen	Socioeconomics
Susan Caplan	Air Quality and Climate
Mark Gorges	Compliance Review
Dale Hanson	Paleontology
Ken Henke	Hazardous Materials
Janet Kurman	Compliance Review
Vickie Mistarka	Compliance Review
Brenda Vosika Neuman	Compliance Review
Ken Peackock	Water Resources
Tom Rinkes	Wildlife
Dave Roberts	Threatened, Endangered, Proposed, Candidate, and BLM Sensitive Species
Rick Schuler	Water Resources
Pinedale Field Office	
Keith Andrews	Wildlife; Threatened, Endangered, Proposed, Candidate, and BLM Sensitive Species
Frank Bain	Topography/Physiography, Geology, Paleontology
Steve Belinda	Threatened and Endangered Wildlife
Martin Hudson	Recreation, Visual Resources
Carol Kruse	Project Management/Team Lead, Entire Document
Bill Lanning	Assistant Project Management/Team Lead, Entire Document
Steve Laster	Vegetation/T&E Vegetation, Land Use/Agriculture/Grazing/Recreation
Richard Rieman	Mineral Resources
Karen Rogers	GIS Coordinator
Pauline Schuette	Wildlife/Threatened and Endangered Wildlife
Mike Stiewig	Writer/Editor
David Vlcek	Cultural Resources/Historic Resources
Bill Wadsworth	Land Use, Agriculture, Grazing, Recreation, Transportation
Rock Springs Field Office	
Rick Canterbury	Soils, Reclamation, Topography/Physiography

Table 6.1 (continued)

Name	EIS Responsibility
Dennis Doncaster	Water Resources, Soils
Jay D'Ewart	Land Use/Grazing
Jim Glennon	Vegetation/T&E Vegetation
John Henderson	Fisheries Resources
State of Wyoming Team	
Cara Casten	Air Quality/Climate
Susan Child	Project Management/Team Lead, Proposed Action and Alternatives
Don Christianson	Vegetation/T&E Vegetation, Land Use/Agriculture/Grazing/Recreation
Tom Collins	Wildlife Resources/T&E Wildlife/Wild Horses, Fisheries
Richard Currit	Cultural Resources/Historic Resources
Rod DeBruin	Geology/Geologic Hazards/Paleontology
Chris Fallbeck	Land Use/Agriculture/Grazing/Recreation
Kim Floyd	Cultural Resources/Historic Resources
Don Likwartz	Mineral Resources
Lisa Lindeman	Socioeconomics
Jeremy Lyon	Water Resources
Todd Parfitt	Noise/Odor
Darla Potter	Air Quality/Climate
Jodee Pring	Water Resources, Hazardous Materials
Scott Smith	Wildlife Resources/T&E Wildlife/Wild Horses, Fisheries
David Spencer	Socioeconomics
Timothy L. Stark	Transportation
TRC Environmental Corporation	
Susan Connell	Air Quality/Climate
Cassady Marshall	Air Quality/Climate
Jim Zapert	Air Quality/Climate
TRC Mariah Associates Inc.	
S.L. Tiger Adolf	Socioeconomics, Environmental Justice
Bill Batterman	Cultural Resources/Historic Resources
Randall Blake	Wildlife and Fisheries Resources, GIS
Karyn Coppinger	Geology/Minerals, Paleontology, Soils, Topography/Physiography, Ground Water
Larry DeBrey	Transportation, Hazardous Materials
Genial DeCastro	Document Production
Pete Guernsey	Project Management/Team Lead, Proposed Action and Alternatives, Natural Gas Resources
Jan Hart	Vegetation, Land Use/Grazing, Soils, Surface Water, TEP&C and BWS Plants
Chris Keefe	Wildlife Resources, TEP&C and BWS Animals, Recreation, Visual Resources
Tamara Keefe	Cartography, GIS
Tamara Linse	Technical Editor
James Lowe	Historic Resources
Lance McNees	Cultural Resources/Historic Resources
Russell Richard	Cultural Resources/Historic Resources
Roger Schoumacher	Quality Assurance
Diane Thomas	Wildlife Resources, Noise/Odor
HydroGeo, Inc.	
Joe Frank	Ground Water Modeling/Surface Water Depletions
Gabrielle Walser	Ground Water Modeling/Surface Water Depletions

Table 6.2 Personnel Contacted or Consulted During Preparation of the Jonah Infill EIS.

Agency/Organization	Individual	Position
Alliance for the Wild Rockies	Michael T. Garity	Executive Director
Banko Petroleum Management	David Banko	President
Barlow & Haun Inc.	--	--
Big Piney City Government	Dickie Brown	Town Clerk
Biodiversity Conservation Alliance	Jeff Kessler	--
	Erik Molvar	--
BJ Services Company	Dan Dells	District Manager
Bjork, Lindley, Danielson & Little, P.C.	Laura Lindley	Lawyer
BKS Environmental Association Inc.	Terri McGee	--
	Brenda Schladweiler	--
BLM Lands Foundation	G. Early	--
BLM Pinedale Field Office	Priscilla Mecham	Field Manager
BLM Rock Springs Field Office	John McDonald	Soils Specialist
BP America Production Company	Victor Vega	Project Manager
	Dalan D. Haase	Production Engineer
	Kirk Steinle	--
Brother Grimm Trucking	Mike Myers	--
Brown, Drew & Massey, LLP.	Drake D. Hill	--
Casper Star Tribune	Jeff Gearino	--
CAZA Drilling Inc.	Ed Kautz	Vice President
	Toni Schledwitz	General Manager
Center For Native Ecosystems	Erin Robertson	--
Circle Nine Ranch Inc.	Phelps H. Swift, Jr.	--
Defenders of Wildlife	Matt Niemerski	Public Lands Association
	Noah Matson	--
Duke Energy Field Services	Stephen McNair	Vice President
	George Courcier	General Manager Rocky Mountain Region
	Lew D. Hagenlock	--
Encana Oil and Gas (USA) Inc.	Gary R. Gardiner	Vice President Northern Rockies
	John Ricter	Field Supervisor
	Brandy Butler	--
	Cally McKee	--
Energy Analysts	Steve Fillingham	--
Environomics	Eric Williams	--
EOG Resources	C.C. Parsons	Division Operation Manager
Federal Energy Regulatory Commission	L.J. Sauter	--
Feed Barn, Inc.	Kelly F.	--
Flaming Gorge PFUSA	Betty Wilkinson	President
Frank's Construction	Frank Virden	--
Gene R. George & Associates Inc.	Gene R. George	--
Gordon Gregory Photography	Gordon Gregory	--
Greater Yellowstone Coalition	Tim Stevens	Issues and Outreach Director
	Scott Groene	--
	Lloyd Dorsey	Wyoming Representative
Gros Venture Investment Co.	Phil Selby	Ranch Manager/Rendezvous Ranch
	Sandra Wright	Manager

Table 6.2 (continued)

Agency/Organization	Individual	Position
Grouse Inc.	Clait E. Braun	--
Hayden-Wing Associates	Larry Hayden-Wing	--
HydroGeo, Inc.	Joe Frank	--
IPAMS	Deena McMullen	Manager of Government and Public Affairs
Jackson Hole Conservation Alliance	Pam Lichtman	Program Director
	Tom Darin	Public Lands Director
JFC	Joe Manatos	--
Johnson County Community College	Rebecca Cramer	Professor
KMG Consulting	Walter D. Lowry	President
Land Water Fund of Rockies	Bruce Driver	Executive Director
Larz Equipment	Brent Larsen	--
Marbleton City Government	Alice Griggs	Town Clerk
Marion County Humane Society	Barbara Warner	Secretary
Monmouth County Audubon Society	Linda Mack	Vice President
Mount Vernon Data Services	Michelle Poolet	President
Mountaintop Consulting, LLC	Robin M. Smith	--
Murdock Land and Livestock Company	--	--
National Park Service	Jere Krakow	--
	Lee Kreutzer	National Trails System
	Long Distance Trails Office Superintendent	--
Natural Resources Conservation Service, Sublette Co. Conservation District, Pinedale Field Office	Carrie Hatch	Water Quality Specialist
	Jennifer Hayward	Resource Conservationist/ GIS
	Ron Reckner	Soil Scientist
Natural Resources Defense Council	Johanna Wald	Senior Attorney
	Craig Dylan Wyatt	--
Nerd Enterprises Inc.	--	--
Office of Federal Land Policy	Lynne Boomgaarden	Director
Office of the Governor	Tracy Williams	Policy Analyst
Oregon-California Trails Association	Dave Welch	National Preservations Officer
Oregon-California Trails Association Preservation Officer	--	--
People for Wyoming	--	Executive Director
	Pat Hickerson	President
Petroleum Association of Wyoming	Dru Bower	Vice President
PFUSA	Dorothy Bartholomew	President
	Randy Shipman	President
Pinedale City Government	Rose Skinner	Mayor
	Patti Raisch	Town Clerk
Pinedale Properties	Cyd Goodrich	Realtor
Pinedale Ranger District	Terry Svalberg	Air Quality Specialist
Pittsburg & Midway	Don Lamborn	--
Questar Energy Services	Chris Thornhill	Director of Applied Technology
Questar Gas Management	Dee Findley	--
Williams Energy Services	--	--
Rendezvous Ranch & Gros Ventre Cattle Company	Paul Von Gontard	--
Rocky H. Ranch	Bill Phelps	--
Rocky Mountain Energy Reporter	Heather Anderson	Marketing Director

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Gerry Minick	Publisher
Sandy Crossing Enterprises Inc.	Curtis C. Martin	--
Schlumberger Oilfield Services	Cliff McKellar	Field Service Manager
	James Stewart	General Manager
	Vernon Higdon	Field Engineer
	Brandon Jones	Operations Manager
	Brenda Bray	Well Services Manager
	Jesus Espinoza	Field Service Manager
	Jim Cunningham	Bulk Plant Manager
	David G. Morris	--
Shell E&P Company	Aimee Davison	--
SOGO2/TRC Design, Inc.	Susan Goldin	--
South East Environmental Network	Keene Hueftle	Chairman
Southern Colorado AIM	Renee Still Day	Executive Director
Southern Ute Tribal Council	Neil B. Cloud	--
Southwest Wyoming Industrial Association	--	--
Southwest Wyoming Mineral Association	--	--
Steinaker Trucking	--	--
Sublette County Attorney's Office	Marilyn Filkins	County Attorney
Sublette County Courthouse	Mary Lankford	County Clerk
Sublette County Planning Office	--	--
Sublette County Road and Bridge	Dan Holgate	Supervisor
Sublette County Sheriff’s Office	Hank Ruland	Sheriff
Surveyor Scherbel, LTD	Paul N. Scherbel	President
Sweetwater County Conservation District	Mary E. Thoman	Chairman
Sweetwater County Library	--	--
TALCO Trucking	Aaron McCallister	--
The Wilderness Society	Peter Aengst	Program Director
Ultra Resources	Brian Ault	--
U.S. Air Force	Det Chief	--
U.S. EPA	Cynthia Cody	Director
U.S. Fish and Wildlife Service	Jodi L. Bush	Acting Field Supervisor
	Seedskadee Refuge	Manager
	Brian T. Kelly	Field Supervisor
U.S. Forest Service	Rocky Mountain Region	--
	Carole Hamilton	Forest Supervisor
U.S. Geological Survey	Ann H. Csonka	Environmental Educator
	John M. DeNoyer	Former Associate Director
	Rick Hutchinson	--
U.S. Natural Resources Conservation Office	District Office	--
	Dave Chase	--
	Roger Miller	Hydrogeologist
U.S. Natural Resources Conservation Service	--	--
U.S. Representative Barbara Cubin	Bonnie Cannon	Representative
U.S. Senator Mike Enzi	Lyn Shanaghy	Representative
U.S. Senator Craig Thomas	Pati L. Smith	Representative
University at Albany, SUNY	Kenneth P. Able	Professor
University of California Berkley	Luna B. Leopold	Professor of Geology

Table 6.2 (continued)

Agency/Organization	Individual	Position
University of Wyoming	David (Tex) Taylor	Professor of Agriculture Economics
Upper Green River Valley Coalition	Linda Baker	Organizer
Western Wyoming Community College	Achaeological Services	--
Wildlife Management Institute	Len H. Carpenter	Field Representative
	Rollin D. Sparrowe	--
Wind River Environmental Quality Comm.	Don Aragon	Executive Director
Wold Trona	--	--
	Jim Montuoro	--
Wyoming Advocates for Animals	Jeannine R. Stallings	--
Wyoming Department of Agriculture	John Etchepare	Director
Wyoming Department of Environmental Quality	Dan Olson	Air Quality Division Administrator
	John V. Corra	Director
	Rich Vincent	--
Wyoming Department of Revenue	Christie Yurek	Validation Supervisor
Wyoming Department of Transportation	Mark Ayen	Engineer
Wyoming Game and Fish Department	Bill Wichers	Deputy Director
	Dean Clause	Biologist
Wyoming Oil and Gas Commission	Dave Chase	Hydrogeologist
	Roger Miller	Hydrogeologist
Wyoming Outdoor Council	Kelly Matheson	Program Coordinator
	Meridith Taylor	Yellowstone Field Director
Wyoming State Board of Outfitters & Guides	Jane Flagg	--
Wyoming State Historic Preservation Office	Richard L. Currit	State Historic Preservation Officer
Wyoming State Representative	Stan Cooper	--
Wyoming State Senator	Larry Coller	--
	Delaine Roberts	--
Wyoming Wildlife Consultants	John Dahlke	--
Wyoming Wildlife Federation	Cathy Purves	Western Field Director
INDIVIDUALS	Lani J. Adams	Citizen
	Steve Agueda	Citizen
	Ken Aho	Citizen
	Jeremy Allen	Citizen
	Karrin Allen	Citizen
	Lonnie Allen	Citizen
	Matt Allen	Citizen
	Rosemary Alles	Citizen
	Christina Andersen	Citizen
	Martin Andersen	Citizen
	Neil & Lorna Anderson	Citizen
	Robert F. Anderson	Citizen
	Sarah Annarella	Citizen
	Jerry Arnold	Citizen
	Judy Arnold	Citizen
	Priscilla Atwood	Citizen
	Joan Bailey	Citizen
	Julianne Baker	Citizen
	Gene Ball	Citizen
	Joann Bally	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Craig Barber	Citizen
	David Barnett	Citizen
	Peter V. Barrett	Citizen
	Leslie Van Barselaar	Citizen
	Bryan Bates	Citizen
	Fred Baughman	Citizen
	Jay Beach	Citizen
	Eli Bebout	Citizen
	Kenny Becker	Citizen
	David J. Bell	Citizen
	Tom Bell	Citizen
	William Belveal	Citizen
	LeeAnn Bennett	Citizen
	R.G. Bennett	Citizen
	Leo Benson	Citizen
	Rosemary Benson	Citizen
	Kathy Berger	Citizen
	Henry Berkowitz	Citizen
	Linda Berkowitz	Citizen
	F. Bernolf	Citizen
	Michelle J. Biggins	Citizen
	Norman A. Bishop	Citizen
	Theresa Blair	Citizen
	Russel Blalack	Citizen
	Bill Blazich	Citizen
	Tim Blossom	Citizen
	Deniz Bolbol	Citizen
	Joseph Bolinger	Citizen
	Julie Bond	Citizen
	Scott Bondegard	Citizen
	Chris Bookless	Citizen
	John Bookless	Citizen
	Dan Boudrenault	Citizen
	Pat Bower	Citizen
	Dennis J. Brabec	Citizen
	Dan Brecht	Citizen
	Joe Brewer	Citizen
	Ned Brewer	Citizen
	Sarah Britt	Citizen
	Constance Brizuela	Citizen
	Kenly Brown	Citizen
	Vaughn Brown	Citizen
	Steve Brunelle	Citizen
	Marlis Brunson	Citizen
	Dave Bunning	Citizen
	David Burkhart	Citizen
	Candace Burlingame	Citizen
	James Burnett	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Barbara Burris	Citizen
	Tom Burns	Citizen
	Corlann Gee Bush	Citizen
	Robert Byers	Citizen
	James Callison	Citizen
	Mary Carlson	Citizen
	Robert D. Carney	Citizen
	Mary Lou Carroll	Citizen
	Michael Casey	Citizen
	Annette Chaudet	Citizen
	Geneva Chong	Citizen
	Scott Christensen	Citizen
	Anna Lee Clark	Citizen
	Ashley Ann Clark	Citizen
	Dallas Clark	Citizen
	Troy Clark	Citizen
	Duane Claypool	Citizen
	Jim Cleary	Citizen
	Trish Cleary	Citizen
	Audry J. Cleland	Citizen
	Frances M. Cone	Citizen
	John S. Connolly	Citizen
	David Constable	Citizen
	Patricia Constable	Citizen
	Calvin Cooley	Citizen
	Lonetta Cooley	Citizen
	Mike Cooney	Citizen
	Linda J. Cooper	Citizen
	Esther Cover	Citizen
	Jared Cox	Citizen
	Lydia Cressall	Citizen
	Anthony Criscola	Citizen
	Martie J. Crone	Citizen
	Larry Crowell	Citizen
	Bill Current	Citizen
	Hall Cushman	Citizen
	Jerry Dalton	Citizen
	Carl Daly	Citizen
	David L. Davidson	Citizen
	Andrea Dean	Citizen
	David R. Dean	Citizen
	Regina Dean	Citizen
	Paul DeBonis	Citizen
	Michael Deme	Citizen
	Laurie Ann Denison	Citizen
	Danny Dickinson	Citizen
	James Dillon	Citizen
	Marilyn Dinger	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Ed Dolinar	Citizen
	Rita Donham	Citizen
	Nick Downey	Citizen
	Larry Downs	Citizen
	Dana L. Dreinhofer	Citizen
	Donald J. Duerr	Citizen
	Loretta Dunne	Citizen
	Nathan Ebinger	Citizen
	Sol Eden	Citizen
	Kenneth B. Eldridge	Citizen
	Beth Enson	Citizen
	Dinda Evans	Citizen
	Donald Evans	Citizen
	Eric Fairbanks	Citizen
	Dale Fefzer	Citizen
	Carol Finan	Citizen
	Casey Fisher	Citizen
	James H. Fitch	Citizen
	D.R. Flock	Citizen
	Donna Foote	Citizen
	Dorothy Foster	Citizen
	Georgia J. Frazier	Citizen
	Jeff Frontz	Citizen
	John Geddie	Citizen
	James R. Goddard	Citizen
	Ed Golnitz	Citizen
	Tony Goodman	Citizen
	Machelle Gossett	Citizen
	Anne Grady	Citizen
	Steve Granada	Citizen
	Stephen M. Greenberg	Citizen
	Paul Grover	Citizen
	Ravi Grover	Citizen
	Gil Gudmend	Citizen
	Tanya Haanpac	Citizen
	Caitlin Hakiel	Citizen
	Joyce L. Harkness	Citizen
	Denise Harmon	Citizen
	Alan Hayes	Citizen
	James Henley	Citizen
	Phil Hernandez	Citizen
	Betty Jean Herner	Citizen
	Sanford Higginbotham	Citizen
	Ann Hinckley	Citizen
	Steve Hitshew	Citizen
	Fernanda E. Hittel	Citizen
	Sarah Hixson	Citizen
	Larry D. Honeycutt	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Daryl Hood	Citizen
	Jim Horner	Citizen
	Brendan Hughes	Citizen
	Guy Hulser	Citizen
	Jeanne Hum	Citizen
	William Houghton	Citizen
	Troy Householder	Citizen
	Chris Jacobs	Citizen
	Leah Jacobs	Citizen
	Lisa Jaeger	Citizen
	Anne Jemas	Citizen
	Jennifer Jensen	Citizen
	Paul Jensen	Citizen
	Roger Jensen	Citizen
	Trinni Jensen	Citizen
	Debbie Johnson	Citizen
	Gordon Johnson	Citizen
	Bob Johnston	Citizen
	Diana Jones	Citizen
	Kent Jordan	Citizen
	Les K.	Citizen
	Angelo Kallas	Citizen
	Larry Kaml	Citizen
	Linda Karon	Citizen
	Richard Karon	Citizen
	Robert L. Kay	Citizen
	Shari Kearney	Citizen
	Dennis Keeney	Citizen
	John Kesich	Citizen
	Brian Kettering	Citizen
	Jacob Kettering	Citizen
	James H. King	Citizen
	Paul Kita	Citizen
	Irene Kitzman	Citizen
	John F. Kohler	Citizen
	Mark Koplik	Citizen
	Elinore Krell	Citizen
	Corbett Kroehler	Citizen
	Roger Kruse	Citizen
	Jean Kwall	Citizen
	Stan Labbe	Citizen
	Londa Lamper	Citizen
	Laurie Latta	Citizen
	Jim Laybourn	Citizen
	Edith Leeper	Citizen
	Daryl LeFevre	Petroleum Engineer
	Carol J. Levitt	Citizen
	David A. Lien	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Thomas A. Linell	Citizen
	Jim Liskovec	Citizen
	Leonard Lovell	Citizen
	Judann Luening	Citizen
	Dave Luxem	Citizen
	Deb Luxem	Citizen
	Matt Lye	Citizen
	Audrey Lyke	Citizen
	Justin M.	Citizen
	Tami Ingraham Malchow	Citizen
	Rich Malone	Citizen
	Lisa Marshall	Citizen
	Paul Marsing	Citizen
	Richard Marsing	Citizen
	Shannon Marsing	Citizen
	Marissa Martin	Citizen
	Jonathan Mathews	Citizen
	T.J. Mathews	Citizen
	Lon Mayhew	Citizen
	Ellen McCallister	Citizen
	Lillian McCallister	Citizen
	Tammie McCallister	Citizen
	Jenny C. McCune	Citizen
	Stuart McKinley	Citizen
	Holmes P. McLish	Citizen
	Mimi McMillen	Citizen
	Stew McMillen	Citizen
	Page McNeill	Citizen
	John Meng	Citizen
	Jennifer S. Miller	Citizen
	Neil O. Miller	Citizen
	Kat Mills	Citizen
	Lonnie Moffitt	Citizen
	Jill Mogen	Citizen
	Kristin Mohney	Citizen
	Cory Munter	Citizen
	Mike Narramore	Citizen
	Debra Nishida	Citizen
	Paul Nordeen	Citizen
	Michael Normington	Citizen
	Karla Nye	Citizen
	Dave Obenchain	Citizen
	Gerald Orcholski	Citizen
	Jim Oriet	Citizen
	Larry Orzechowski	Citizen
	Jacob L. Overy	Citizen
	Catherine Palmer	Citizen
	Maggie Palmer	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Jean Palmeter	Citizen
	Mike Partansky	Citizen
	John Patanelli	Citizen
	Jim Paulsen	Citizen
	Sally Pederson	Citizen
	Larry Pennock	Citizen
	Laveta Pennock	Citizen
	Todd Perry	Citizen
	Lisa Persinger	Citizen
	Rodney Peterson	Citizen
	Troy Peterson	Citizen
	Clint A. Phillips	Citizen
	Brian Pierce	Citizen
	Lynn Pierce	Citizen
	Sandra Pierce	Citizen
	David Pitt	Citizen
	Vern Plentenbery	Citizen
	Keith Potter	Citizen
	Kelly Powers	Citizen
	Angelina Pryich	Citizen
	Stacey Putman	Citizen
	Daron Raines	Citizen
	Kevin Ramage	Citizen
	Paul Rana	Citizen
	Jonathan B. Ratner	Citizen
	Clem L. Rawlins	Citizen
	Kathy Rebescher	Citizen
	Joseph M. Reichert	Citizen
	Robin Reinholz	Citizen
	Jim Von Rembow	Citizen
	Mark Reneau	Citizen
	Frank D. Reno	Citizen
	Lavinia Reno	Citizen
	Stephen A. Reynolds	Citizen
	Stephen Reynolds	Citizen
	Louis D. Rhodes, Jr.	Citizen
	Jake Ribordy	Citizen
	Peggy Sue Richards	Citizen
	Nancy Richings	Citizen
	Ted Richings	Citizen
	Matt Ridenour	Citizen
	Austin Rider	Citizen
	Tim Rider	Citizen
	Bradley Ridgway	Citizen
	Jim Riley	Citizen
	Dorothy Roberts	Citizen
	Dean M. Roddick	Citizen
	Jim R. Rogers	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Justin L. Rogers	Citizen
	Justin Roghair	Citizen
	Craig Romero	Citizen
	Donald G. Romero	Citizen
	Jamie Rose	Citizen
	Paul W. Rosenberger	Citizen
	Dave Rosenfeld	Citizen
	James H. Ross	Citizen
	Kenneth Rouse	Citizen
	Ron Roy	Citizen
	Barbara Rugotzke	Citizen
	Dean Ruscoe	Citizen
	Chad Rutherford	Citizen
	Robert Rutkowski	Citizen
	Freddy Salgodo	Citizen
	Shane Sanchez	Citizen
	Justin Santhuff	Citizen
	Todd Sasse	Citizen
	Jim Schaefer	Citizen
	Sheron Schaeferle	Citizen
	C.W. Schertz	Citizen
	Floyd Schneider	Citizen
	Kelvin B. Sellers	Citizen
	Bev & Sam Sharp	Citizen
	Carole Shelby	Citizen
	Leslie Sheldon	Citizen
	Barbara A. Sherer	Citizen
	Roger Sherman	Citizen
	Joe Shubert	Citizen
	Greg Simcakoski	Citizen
	Christopher P. Simms	Citizen
	Steve Simon	Citizen
	Rebecca A. Skinner	Citizen
	Boyd Smiley	Citizen
	Jeffrey J. Smith	Citizen
	Mike Smith	Citizen
	Robin Smith	Citizen
	Ruth Smith	Citizen
	Ana Yong Soler	Citizen
	Albert Sommers	Citizen
	Mario Soto	Citizen
	G. Sozio	Citizen
	Shawn Steed	Citizen
	Alice Stephens	Citizen
	Alta Stephens	Citizen
	Edward R. Stewart	Citizen
	Jeanne Sugel	Citizen
	Dan Sullivan	Citizen

Table 6.2 (continued)

Agency/Organization	Individual	Position
	Dave Surette	Citizen
	Paul Szymanowski	Citizen
	Nick F. Tabler	Citizen
	Thomas Tennyson	Citizen
	Michael Teply	Citizen
	D. Tetre	Citizen
	Duane Thompson	Citizen
	Brian Thomson	Citizen
	Erik Tomasik	Citizen
	Terry Ann Towers	Citizen
	Michael R. Traq	Citizen
	Jeff Troxel	Citizen
	Sauwah Tsang	Citizen
	Dennis Urbatsch	Citizen
	Cat Urbigkit	Citizen
	Jim Urbigkit	Citizen
	Daniel R. Vice	Citizen
	Tom Volner	Citizen
	John Wahl	Citizen
	Russell Wakefield	Citizen
	Bucky Walker	Citizen
	Judith B. Walker	Citizen
	Ronald P. Walker	Citizen
	Sunny Walter	Citizen
	A.J. Warner	Citizen
	Mary Warner	Citizen
	Billie Watkins	Citizen
	Sally Weidemann	Citizen
	Fredrick Wen	Citizen
	Janet Westbrook	Citizen
	Howard Weston	Citizen
	Tara Whittaker	Citizen
	James Wilkins	Citizen
	Robert E. Williams	Citizen
	David W. Williamson	Citizen
	Rachel Winer	Citizen
	Lyle Woelich	Citizen
	Jackie Woods	Citizen
	Mary Lynn Worl	Citizen
	James Wright	Citizen
	Bryan Wyberg	Citizen
	Gretchen Dawn Yost	Citizen
	Peter Zadis	Citizen
	John Zickel	Citizen

CHAPTER 7 — REFERENCES

Ahern, J., M. Colletine, and S. Cooke. 1981. Occurrence and Characteristics of Groundwater in the Green River Basin and Overthrust Belt, Wyoming. Prepared for U.S. Environmental Protection Agency by Water Resources Institute, University of Wyoming, Laramie. 123 pp. + appends.

Air Resource Specialists. 2002. Green River Basin Visibility Study: Monitored Air Quality Data. Air Resource Specialists, Fort Collins, Colorado.

American Gas Association. 2003. Fueling the Future. New Gas and New Technology for a Cleaner 21st Century. <www.aga.org>. Accessed on January 12, 2004.

Amoco Production Company. 1993. Environmental, Occupational Health and Safety Policy. Mimeo. 2 pp.

_______. 1995. Safety Manual, U.S. Operations, 1995 edition. Mimeo.

Baxter and Stone. 1980. Amphibians and Reptiles of Wyoming. Wyoming Game and Fish Department. 137 pp.

Bingaman, M., T. Thibodeau, W. Gribb, J. Teichert, N. Gribb, C. McManus, S. Tessman. 2003. The 2003-2008 Wyoming Statewide Comprehensive Outdoor Recreation Plan. Wyoming Division of State Parks and Historic Sites, Cheyenne, Wyoming.

BKS Environmental Associates, Inc. 2003. Soil Mapping Results for T29N, R107W, Sections 28-31; T29N, R108W, Sections 25, 32, 36, Jonah Infill Area, Sublette County, Wyoming. Unpublished. Prepared for TRC Mariah Associates Inc., Laramie, Wyoming, by BKS Environmental, Gillette, Wyoming.

Blevins, A., K. Jensen, M. Coburn, and S. Utz. 2004. Executive Summary. *In* Social and Economic Impact Assessment of Oil and Gas Development in Sublette and Sweetwater Counties. Prepared for Shell Exploration and Production Company by University of Wyoming, Department of Sociology, Laramie.

BP America Production Company. 2004. Jonah Field wind data (unpublished).

Braun, C.E. 1986. Changes in Sage-grouse Lek Counts With Advent of Surface Coal Mining. Proceedings: Issues and Technology in the Management of Impacted Western Wildlife, Thorne Ecological Institute 2:227-231.

_______. 1987. Current Issues in Sage-grouse Management. Proceedings of the Western Association of Fish and Wildlife Agencies 67: 134-144.

_______. 1995. Distribution and Status of Sage-grouse in Colorado. Prairie Naturalist 27:1-9.

_______. 1998. Sage-grouse Declines in Western North America: What Are the Problems: Proceedings of the Western Association of State Fish and Wildlife Agencies 78:139-156.

_______. 2002. A Review of Sage-Grouse Habitat Needs and Sage-Grouse Management Issues for the Revision of the BLM's Pinedale District Resource Management Plan. Prepared by Grouse Inc., Tucson, Arizona, for the Wilderness Society, Wyoming Outdoor Council, and Greater Yellowstone Coalition. 14 pp.

Braun, C.E., M.G. Baker, R. L. Eng, J.S. Gashwiler, and M.H. Schroeder. 1976. Conservation Committee Report on the Effects of Alteration of Sagebrush Communities on the Associated Avifauna. Wilson Bulletin 88:165-171.

Brown, C.G. 1992. Movement and Migration Patterns of Mule Deer in Southeastern Idaho. Journal of Wildlife Management 56:246-253.

Bruce, B.W. 1993. Hydrochemistry of the Wasatch/Green River Aquifer System, Northeastern Green River Basin, Wyoming. Unpublished master's thesis, Department of Geology and Geophysics, University of Wyoming, Laramie. 137 pp.

Bureau of Economic Analysis. 2002. Regional Accounts Data, Local Area Personal Income, Regional Economic Information System. Table CA34 Average Wage per Job, Wyoming (dollars). <http://www.bea.doc.gov/bea/regional/reis>. December 2002. Accessed June 19, 2003.

_______. 2003a. Regional Accounts Data, Local Area Personal Income, Regional Economic Information System. Tables CA05(SIC) and SA1-3. Personal Income by Major Source and Earnings by Industry. May 2003. <http://www.bea.doc.gov/bea/regional/reis>. Accessed December 15, 2003.

_______. 2003b. Personal Dividend Income, Personal Interest Income, and Rental Income of Persons. <http://www.bea.doc.gov/bea/regional/articles/lapi2001/pdf/dir.pdf>, May 6, 2003. Accessed December 15, 2003.

_______. 2003c. Regional Accounts Data, Local Area Personal Income, Regional Economic Information System. Table CA25 Total Full-time And Part-time Employment by Industry. U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division. May 2003. <http://www.bea.doc.gov/bea/regional/reis>. Accessed June 19, 2003.

_______. 2003d. Regional Accounts Data, Local Area Personal Income, Regional Economic Information System. Table C1-3 Per Capita Personal Income. May 2003. <http://www.bea.doc.gov/bea/regional/reis>. Accessed June 19, 2003.

_______. 2003e. Regional Accounts Data, Local Area Personal Income, Regional Economic Information System. Table CA25 Total Full-time and Part-time Employment by Industry--Wyoming (number of jobs). May 2003. <http://www.bea.doc.gov/bea/regional/reis>. Accessed June 23, 2003.

_______. 2003f. Gross State Product (GSP), for States and Regions in Current-Dollar GSP and Real Chained-Dollar GSP, and GSP by Industry, for 1977–2001 (Annual).

U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division--May 2003. <http://www.bea.gov/bea/regional/gsp/>. Accessed July 8, 2003.

Bureau of Labor Statistics. 2003. Consumer Price Index--All Urban Consumers. U.S. Department of Labor, Bureau of Labor Statistics. <http://data.bls.gov/servlet/SurveyOutputServlet>. Accessed on December 23, 2003.

Bureau of Land Management. 1983. Riley Ridge Natural Gas Project Air Resources Technical Report. U.S. Department of the Interior, Bureau of Land Management, Kemmerer Field Office, Kemmerer, Wyoming, in cooperation with Environmental Research and Technology Inc.

_______. 1985. Manual 9113-Roads. Engineering Rel. 9-247. U.S. Department of the Interior, Bureau of Land Management.

_______. 1987a. Pinedale Resource Area Draft Resource Management Plan/Environmental Impact Statement. Bureau of Land Management, Rock Springs District, Rock Springs, Wyoming, and Pinedale Resource Area, Pinedale, Wyoming.

_______. 1987b. Pinedale Resource Area Final Resource Management Plan/Environmental Impact Statement. Bureau of Land Management, Rock Springs District, Rock Springs, Wyoming, and Pinedale Resource Area, Pinedale, Wyoming. Government Printing Office, Washington, D.C.

_______. 1988a. National Environmental Policy Act Handbook, H-1790-1. U.S. Department of the Interior, Bureau of Land Management.

_______. 1988b. Record of Decision and Resource Management Plan for the Pinedale Resource Area. U.S. Department of the Interior, Bureau of Land Management, Pinedale Resource Area, Rock Springs District, Rock Springs, Wyoming. 118 pp.

_______. 1990a. Bureau of Land Management Manual Section 9112.

_______. 1991a. Wyoming Supplement to the Bureau 9113 Manual. U.S. Department of the Interior, Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming. 16 pp.

_______. 1991b. PG&E Resource Company Fontenelle II Unit Infill Drilling Program Environmental Assessment. U.S. Department of the Interior, Bureau of Land Management, Green River and Kemmerer Resource Areas, Kemmerer, Wyoming. WY-048-EA-91-54.

_______. 1992. Green River Resource Area Resource Management Plan and Draft Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, Rock Springs District, Rock Springs, Wyoming. BLM-WY-ES-92-019-4410. 910 pp.

_______. 1994a. McMurry Oil Company Jonah Prospect Field natural gas development, Decision Record and Finding of No Significant Impact. Bureau of Land Management, Pinedale and Green River Resource Area, Rock Springs, District Office, Rock Springs, Wyoming. WY-046-EA-94-049.

_______. 1994a. McMurry Oil Company Jonah Prospect Field natural gas environmental assessment. Bureau of Land Management, Pinedale and Green River Resource Area, Rock Springs, District Office, Rock Springs, Wyoming. WY-046-EA-94-049.

_______. 1994c. Guidelines for Assessing and Documenting Cumulative Impacts. Information Bulletin 94-310. Washington, D.C. 70 pp.

_______. 1996a. Green River Resource Area Resource Management Plan and Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, Rock Springs District, Rock Springs, Wyoming, and Green River Resource Area, Rock Springs, Wyoming.

_______. 1997a. Draft Environmental Impact Statement, Jonah Field II Natural Gas Project. Bureau of Land Management, Pinedale and Green River Resource Areas, Rock Springs District, Rock Springs, Wyoming.

_______. 1997b. Record of Decision for the Green River Resource Area Management Plan and Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, Rock Springs District, Rock Springs, Wyoming.

_______. 1998a. Final Environmental Impact Statement, Jonah Field II Natural Gas Project. Bureau of Land Management, Pinedale and Green River Resource Area, Rock Springs District, Rock Springs, Wyoming.

_______. 1998b. Record of Decision for Jonah Field II Natural Gas Project, Environmental Impact Statement, Sublette County, Wyoming. Bureau of Land Management, Pinedale and Green River Resource Areas, Rock Springs District, Rock Springs, Wyoming.

_______. 1999a. Interim Guidance: Changes to the List of Critical Elements of the Human Environment in BLM's National Environmental Policy Act (NEPA) Handbook. Instruction Memorandum No. 99-178. Washington, D.C. 3 pp.

_______. 1999b. Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County. Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming, in cooperation with the U.S. Army Corps of Engineers, U.S. Forest Service, and State of Wyoming.

_______. 1999c. Draft Environmental Impact Statement, Continental Divide/Wamsutter II Natural Gas Project, Sweetwater and Carbon Counties, Wyoming. U.S. Department of the Interior, Bureau of Land Management, Rawlins and Rock Springs Field Offices. DES-99-10. April 1999. BLM/WY/PL-98/02Y+1320.

_______. 2000a. Environmental Assessment and Finding of No Significant Impact for the Modified Jonah Field II Natural Gas Project, Sublette County, Wyoming. Bureau of Land Management. Pinedale Field Office, Pinedale, Wyoming, and Rock Springs Field Offices, Rock Springs, Wyoming.

_______. 2000b. Decision Record and Finding of No Significant Impact for the Modified Jonah Field II Natural Gas Project, Sublette County, Wyoming. Bureau of Land Management. Pinedale Field Office, Pinedale, Wyoming, and Rock Springs Field Office, Rock Springs, Wyoming.

_______. 2000c. Record of Decision, Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming. Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, and Pinedale Field Office, Pinedale, Wyoming. BLM/WY/PL-00/026+1310. RODEIS-00-018. 53 pp. + append.

_______. 2001. Decision Record and Finding of No Significant Impact for the Late Winter Gathering of Wild Horses in the Rock Springs Field Office Area. BLM-WY-040-EA01-019. U.S. Department of the Interior, Bureau of Land Management, Rock Springs Field Office, Rock Springs, Wyoming. 33 pp.

_______. 2002a. Geologic and Reservoir Analysis of Proposal for 20-acre Infill Drilling of Selected Upper Cretaceous Lance Formation Wells in Four Pilot Areas, Jonah Field Area, Sublette County, Wyoming. BLM Reservoir Management Group, Wyoming State Office. Signed June 2002. 10 pp. + tables.

_______. 2002b. Technical Support Document, Air Quality Impact Assessment for the Montana Final Statewide Oil and Gas EIS and Proposed Amendment of the Powder River and Billings Resource Management Plans and the Wyoming Final EIS and Planning Amendment for the Powder River Basin Oil and Gas Development Project. Prepared for U.S. Department of the Interior, Bureau of Land Management, Montana and Wyoming State Offices, by Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

_______. 2003a. Supplemental Draft EIS for the Jack Morrow Hills Coordinated Activity Plan/Draft Green River RMP Amendment. BLM/WY/PL-03/008+1610. Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, Rock Springs Field Office, Rock Springs, Wyoming, and Lander Field Office, Lander, Wyoming.

_______. 2003b. Wyoming BLM Sensitive Species by Field Office. <http://www.wy.blm.gov/botany/fieldoffices/pfo.htm>. Accessed December 2003.

_______. 2003c. Payments in Lieu of Taxes, Search Payments and Acres. U.S. Bureau of Land Management, Office of Public Affairs, Washington, D.C. <http://www.blm.gov/pilt/search. html>. Accessed July 10, 2003.

_______. 2003d. Socioeconomic Profile for the Pinedale Resource Management Plan (Draft). Prepared by Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming. 37 pp. <http://www.pinedalermp.com/documents/Pinedale_Socioeconomic Profile.pdf>. Accessed May 7, 2003.

_______. 2004a. Jonah Infill Drilling Project Development Procedures Technical Support Document. Appendix G in this EIS. U.S. Department of the Interior, Bureau of Land Management, Pinedale and Rock Springs Field Offices, Pinedale and Rock Springs, Wyoming.

_______. 2004b. Little Colorado Herd Management Area, Rock Springs Field Office. U.S. Department of the Interior, Bureau of Land Management, Rock Springs Field Office, Rock Springs, Wyoming. 2 pp.

_______. 2004c. Draft Socioeconomic Technical Support Document for the Jonah Infill Drilling and South Piney Projects Environmental Impact Statements. Prepared for Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, and Pinedale Field Office, Pinedale, Wyoming; Jonah Infill Drilling Project Operators; and South Piney Natural Gas Development Project Companies. Prepared by TRC Mariah Associates Inc., Laramie, Wyoming.

_______. 2004d. Finding of No Significant Impact, Decision Record and Environmental Assessment for the Questar Year-Round Drilling Proposal, Sublette County, Wyoming. U.S. Department of the Interior, Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming. WY-100-EAS-034.

_______. 2005. Socioeconomic Analysis Technical Support Document for the Jonah Infill Drilling and South Piney Projects Environmental Impact Statements. Prepared for Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming; Bureau of Land Management Pinedale Field Office, Pinedale, Wyoming; Jonah Infill Drilling Project Operators; South Piney Natural Gas Development Project Companies by TRC Mariah Associates Inc., Laramie, Wyoming. 232 pp. + appends.

Call, M.W. 1978. Nesting Habitats and Surveying Techniques for Common Western Raptors. U.S. Department of the Interior, Bureau of Land Management, Technical Note No. 316. 115 pp.

Campbell, P. 1997. Population Projections: States, 1995-2025. Current Population Reports, P25-1131. Prepared for Census Bureau. <http://www.census.gov/prod/2/pop/p25/p25-1131.pdf>. Accessed on December 15, 2003.

Case, J.C. 1997. Earthquakes and Active Faults in Wyoming. Wyoming State Geological Survey Preliminary Hazards Report 97-2. 58 pp.

Case, J.C., and C. Boyd. 1987. Preliminary Map of Wind Blown Sand Areas in Wyoming. Wyoming Geological Survey Open File Report 87-9.

Case, J.C., L.L. Larsen, C.S. Boyd, and J.C. Cannia. 1995. Earthquake Epicenters and Suspected Active Faults With Surficial Expression in Wyoming. The Geological Survey of Wyoming Preliminary Hazards Report 97-1. Map.

Clark, T.W., and M.R. Stromberg. 1987. Mammals in Wyoming. University of Kansas, Museum of Natural History. 314 pp.

Colorado River Basin Salinity Control Forum. 2002. 2002 Review Water Quality Standards for Salinity Colorado River System. Prepared by Colorado River Basin Salinity Control Forum. October 2002.

Connelly, J.W., and C.E. Braun. 1997. Long-term Changes in Sage-grouse *Centrcercus urophasianus* Populations in Western North Amercia. Wildlife Biology 3/4:123-128.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agenceis. Unpublished Report. Cheyenne, Wyoming.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to Manage Sage-Grouse Populations and Their Habitats. Wildlife Society Bulletin, 2B(4): 967-985.

Consensus Revenue Estimating Group. 2003. Wyoming State Government Revenue Forecast Fiscal Year 2003–Fiscal Year 2008. January 2003.

_______. 2004. Wyoming State Government Revenue Forecast Fiscal Year 2004–Fiscal Year 2008. January 2004.

Cooperative Institute for Research in the Atmosphere. 2003. Interagency Monitoring of Protected Visual Environments (IMPROVE). Summary data provided by Scott Copeland, Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, October 2003.

Council on Environmental Quality. 1997. Considering Cumulative Effects Under the National Environmental Policy Act. 64 pp. + append.

Coupal, R., T. Taylor, and T. Foulke. 2003. Wyoming Economic Atlas: PILT. University of Wyoming Department of Agricultural and Applied Economics. <http://agecon. uwyo.edu/ econdev/PILT1.htm>.

Davis-Peterson Associates, Inc. 1995. The Economic Impact of Expenditures by Tourists in Wyoming: York, Maine. April 1995.

Dorn, J.L., and R.D. Dorn. 1999. Wyoming Birds. Second Edition. Mountain West Publishing. Cheyenne, Wyoming. 187 pp.

Dorn, R.D. 1992. Vascular Plants of Wyoming. Mountain West Publishing, Cheyenne, Wyoming.

Dynamac Corporation. 2002. Preliminary Groundwater Characterization Study, Pinedale Anticline Production Area (PAPA), Sublette County, Wyoming. Submitted to Bureau of Land Management, Pinedale Field Office.

Easterly, T.E., A.W. Wood, and T Litchfield. 1991. Responses of Pronghorn and Mule Deer to Petroleum Development On Crucial Winter Range in the Rattlesnake Hills. Wyoming Game and Fish Department.

Eckerle, W., and M. Taddie. 1997. Archaeological Sensitivity Model for the Bureau of Land Management, Burma Road Soil Survey Area. Jonah Natural Gas Field, Sublette County, Wyoming. Submitted to Bureau of Land Management, Pinedale. Western GeoArch Research, Salt Lake City.

Edwards, C.C. 1969. Winter Behavior and Population Dynamics of American Eagles in Utah. Ph. D. dissertation, Brigham Young University, Provo, Utah. 156 pp.

EnCana Oil & Gas (U.S.A.), Inc. 2002a. Contractor Expectations for Environment, Health and Safety. U.S. Rockies Region Booklet.

_______. 2002b. Spill Prevention Control and Countermeasure Plan for Yellow Point Area, Jonah Field, Sublette County, Wyoming. Prepared for EnCana Oil & Gas (U.S.A.), Inc., Denver, Colorado, by LESAIR Environmental, Inc., Littleton, Colorado. 22 pp.

_______. 2003. An Application for a Bio Remediation Cell Pad Facility to be Located in the Jonah Field Adjacent and Contiguous to McMurry Oil Company Stud Horse Butte #7-36 Production Battery Which is Located in the SWNE/4, Section 36, T29N, R108W Sublette County, Wyoming. Submitted by EnCana Oil & Gas (USA), Inc., Denver, Colorado, to the Wyoming Oil and Gas Conservation Committee, Casper. Prepared by L.C. Roberts, ASCE #320326. 8 pp. + append.

_______. 2004. Jonah Infill Drilling Project Evaluation of Directional Drilling. Prepared for EnCana Oil and Gas (U.S.A.) Inc., Denver, Colorado, by Reservoir Management Services, Inc. 22 pp.

Energy Information Administration. 2001. Energy in the United States: A Brief History and Current Trends. United States Department of Energy, Energy Information Administration. June 2001. <http://www.eia.doe.gov/emeu/aer/eh1999/eh1999.html>. Accessed July 10, 2003.

_______. 2004. Natural Gas Annual 2002. <http://www.eia.doe.gov>. Accessed April 2004.

Eng, R.L., and P. Schladweiler. 1972. Sage Grouse Winter Movements and Habitat Use in Central Montana. Journal of Wildlife Management 36: 141-146.

Environmental Protection Agency. 1990. New Source Review Workshop Manual (Draft). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

_______. 1997. National Air Toxics Information Clearinghouse (NATICH) database. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

_______. 2002. Air Toxics Database. Dose-response Assessment for Assessing Health Risks Associated with Exposure to Hazardous Air Pollutants, Table 2. Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics website.. <http://www.epa.gov/ttn/atw/toxsource/summary.html>. Accessed June 20, 2003.

_______. 2003. EnviroMapper for Environmental Justice. <http://map10.epa.gov/enviromapper/>. Accessed September 9, 2003.

Eratham-Vanir Geological Consultants. 1997. Paleontologic Resource Evaluation, Proposed Jonah Field II Project, Sublette County, Wyoming. Prepared for TRC Mariah Associates Inc., Laramie, Wyoming, by Erathem-Vanir Geological Consultants, Pocatello, Idaho. 29 pp. + append.

ERO Resources Corporation. 1988. Burma Road Soil Survey. Prepared for the U.S. Department of the Interior, Bureau of Land Management, Pinedale Resource Area, Rock Springs

District by ERO Resources Corporation, Golden Colorado. February 1988. 157 pp. + append.

Federal Land Managers' Air Quality Related Values Workgroup. 2000. Federal Land Managers' Air Quality Related Workgroup (FLAG) Phase I Report. USDA Forest Service - Air Quality Program, National Park Service - Air Resources Division, U.S. Fish and Wildlife Service - Air quality Branch.

Fertig, W. 1993. Survey of Plant Species of Special Concern in the Yellow Point Ridge area, Sublette County, Wyoming. Prepared for McMurry Oil Company, Casper, Wyoming, and Bureau of Land Management, Pinedale Resource area by Wyoming Natural Diversity Database, Laramie, Wyoming. 5 pp.

_______. 1994. Wyoming Rare Plant Field Guide. Prepared for U.S. Bureau of Land Management, U.S. Forest Service, and U.S. Fish and Wildlife Service, by Wyoming Rare Plant Technical Committee.

Forman, R.T.T., and L.E. Alexander. 1998. Roads and Their Major Ecological Effects. Annual Review of Ecological Systems 29:207-231.

Forrest, S.C., T.W. Clark, L. Richardson, and T.M. Campbell III. 1985. Black-footed Ferret Habitat: Some Management and Reintroduction Considerations. Wyoming Bureau of Land Management Wildlife Technical Bulletin No. 2. 49 pp.

Foulke, T., R. Coupal, and D. Taylor. 2001. Economic Trends in Wyoming's Mineral Sector: Gas and Oil. Editor, Hattie Penny. University of Wyoming College of Agriculture Department of Agricultural and Applied Economics, Laramie. B-1112, August 2001. 22 pp.

Fox, D., A.M. Bartuska, J.G. Byrne, E. Cowling, R. Fisher, G.E. Likens, S.E. Lindberg, R.A. Linthurst, J. Messer, and D.S. Nichols. 1989. A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas. General Technical Report RM-168. USDA Forest Service, Rocky Mountain Forest and Range Experiement Station, Fort Collins, Colorado. 36 pp.

Frison, G.C. 1991. Prehistoric Hunters of the High Plains. 2nd edition. Academic Press, New York.

_______. 1993. The Wardell Buffalo Trap 48SU301: Communal Procurement in the Upper Green River Basin, Wyoming. Anthropological Papers of the Museum of Anthropology No. 48. University of Michigan, Ann Arbor.

Gee, G.W., A. Bauer, and R.S. Decker. 1978. Physical Analyses of Overburden Material and Mine Land Soils. *In* F.W. Schaller and P. Sutton (eds), Reclamation of Drastically Disturbed Lands. American Society of Agronomy. Madison, Wisconsin. 742 pp.

Grande, L. 1984. Paleontology of the Green River Formation, With a Review of the Fish Fauna. Second Edition. Geological Survey of Wyoming, Bulletin 63. 333 pp.

Greater Yellowstone Winter Wildlife Working Group. 1999. Effects of Winter Recreation On Wildlife on the Greater Yellowstone Area: A literature review and assessment. Yellowstone National Park, Wyoming. 161 pp. + append.

Guenzel, R.J. 1987. Rattlesnake Antelope. Pages 146-183 *In* District 7, 1987 Annual Big Game Herd Unit Reports. Wyoming Game and Fish Department, Cheyenne.

Gusey, W.F. 1986. Terrestrial Wildlife and Petroleum Industry: Interactions and Relationships. Draft report. Shell Oil Company, Houston, Texas.

Hallsten, G.P., Q.D Skinner, and A.A. Beetle. 1987. Grasses of Wyoming. Research Journal 202, Agricultural Experiment Station, University of Wyoming. September 1987. 431 pp.

Harris, R.E. 1996. Industrial Minerals and Construction Materials Map of Wyoming. Wyoming State Geological Survey Map Series 47.

_______. 1997. Radioactive Mineral Occurrences in Sublette County, Wyoming. Wyoming State Geological Survey Radioactive Mineral Report RM-97-01. 23 pp.

Hausel, W.D. 1997. Copper, Lead, Zinc, Molybdenum, and Associated Metal Deposits of Wyoming. Wyoming State Geological Survey Bulletin 70.

Holloran, M. and S.H. Anderson. 2003. Potential Impacts of Natural Gas Field Development on Sage-Grouse Behavior, Preliminary Progress Report, December 3, 2003. Wyoming Cooperative Research Unit, University of Wyoming, Laramie, Wyoming. 7 pp.

Holloran, M.J. 1999. Sage-grouse (*Centrocercus urophasianus*) Seasonal Habitat Use Near Casper, Wyoming. M.S., Department of Zoology and Physiology, University of Wyoming.

HydroGeo, Inc. 2004. Groundwater Flow Model and Hydrologic Impact Assessment, Jonah Infill Project EIS. Prepared for TRC Mariah Associates Inc., Laramie, Wyoming, by HydroGeo, Inc., Crested Butte, Colorado. 17 pp.

Ingelfinger, F. 2001. The effects of natural gas development on sagebrush-steppe passerines in Sublette County, Wyoming. M.S. thesis. University of Wyoming, Laramie. 110 pp.

Intermountain Ecosystems LC. 1996. McMurry Oil Company Jonah Natural Gas Field EIS, Special Plant Inventory. Prepared for McMurry Oil Company, Casper, Wyoming, by Intermountain Ecosystems LC., Springfield, Utah. 5 pp.

Jones, R.W. 1991. Coal Map of Wyoming. Wyoming Geological Survey. Map Series 34.

Keinath, D., B. Heidel, and G.P. Beauvais. 2003. Wyoming Plant and Animal Species of Concern, Wyoming Natural Diversity Database, Species of Concern Plant Abstracts (2003). Prepared by the Wyoming Natural Diversity Database - University of Wyoming, Laramie, Wyoming <http://uwadmnweb.uwyo.edu/wyndd>.

Kohler, T., Hays, H.G., and K.W. Thompson. 2003. Class III Cultural Resources Inventory and Subsurface Investigations for Paulsson Geophysical Services 3-D Seismic Project, Sublette County, Wyoming. Prepared for Paulsson Geophysical Services, Inc., Denver. SWCA Environmental Consultants, Westminster, Colorado.

Lindzey, F. 2002. Energy and Conservation: Does Big Oil Mix With Big Game? Opening Remarks. Transactions, North American Wildlife and Natural Resources Conference. 27:311-312.

Lummis, C.M., S. Garland, and G. Shaffer. 2000. Annual Report of the Treasurer of the State of Wyoming For the Period July 1, 1999 through June 30, 2000. Prepared by Cynthia M. Lummis, State Treasurer; Sharon Garland, Deputy State Treasurer; and Glenn Shaffer, Chief Investment Officer.

_______. 2001. Annual Report of the Treasurer of the State of Wyoming For the Period July 1, 2000 through June 30, 2001. Prepared by Cynthia M. Lummis, State Treasurer; Sharon Garland, Deputy State Treasurer; and Glenn Shaffer, Chief Investment Officer.

_______. 2002. Annual Report of the Treasurer of the State of Wyoming For the Period July 1, 2001 through June 30, 2002. Prepared by Cynthia M. Lummis, State Treasurer; Sharon Garland, Deputy State Treasurer; and Glenn Shaffer, Chief Investment Officer.

_______. 2003. Annual Report of the Treasurer of the State of Wyoming For the Period July 1, 2002 through June 30, 2003. Prepared by Cynthia M. Lummis, State Treasurer; Sharon Garland, Deputy State Treasurer; and Glenn Shaffer, Chief Investment Officer.

Lyon, A.G. 2000. The Potential Effects of Natural Gas Development on Sage-grouse (*Centrocercus urophasianus*) Near Pinedale, Wyoming. M.S. Department of Zoology and Physiology, University of Wyoming, May 2000.

Lyon, A.G., and S.H Anderson. 2003. Potential Gas Development Impacts on Sage-grouse Nest Initiation and Movement. Wildlife Society Bulletin 31: 486-491.

Malm, W.C. 2000. Spatial and Seasonal Patterns and Temporal Variability of Haze and Its Constituents in the United States, Report III, Cooperative Institute for Research in the Atmosphere, Colorado State University, ISSN 0737-5352-47.

Martin, J.W., and B.A. Carlson. 1998. Sage sparrow. The birds of North America 326:1-19.

Mast, T. 2004. Labor shortages vary across state. Casper Star-Tribune. November 7, 2004.

McKern, S.T., and B. Current. 2002. Archaeological Investigation of the McKeva Ryka Site (Site 48SU2094): A Multi-occupational Waystation on Sand Draw. Prepared for McMurry Oil Company by Current Archaeological Research, Rock Springs, Wyoming.

_______. 2003. Archaeological Investigation of Jonah's House Site, Site 48SU2324: A Multi-occupational Waystation on Sand Draw. Prepared for McMurry Oil Company by Current Archaeological Research, Rock Springs, Wyoming.

_______. 2004. Archaeological Investigation of the J. David Love Site (48SU4479): Another Multi-occupational Waystation on Sand Draw. Prepared for McMurry Oil Company by Current Archaeological Research, Rock Springs, Wyoming.

McKern, S.T., and L.L. Harrell. 2004. Archaic Way Stations: A Prelude of Things to Come? Photocopy.

McNees, L.M. 1992. Implications of the Current Investigations for the Culture Historic Chronology of Southwest Wyoming. *In* Data Recovery Investigations at the Black Butte and Leucite Hills Mine Permit Areas, Sweetwater County, Wyoming, by L.M. McNees, T.P. Reust, R. Weathermon, C. Smith, R. Anduze, B. McClelland, W. Harding, K. Kibler, F. Oglesby, and C. Webb, pp. 30-1 to 30-46. Prepared for the Black Butte Coal Company, Point of Rocks, Wyoming. Mariah Associates, Inc., Laramie, Wyoming.

_______. 1998. Cultural Resource Overview of the Continental Divide/Wamsutter II Environmental Impact Statement Project Area. Prepared for the Bureau of Land Management, Great Divide and Green River Resource Areas, Rawlins and Rock Springs. TRC Mariah Associates Inc., Laramie, Wyoming..

McNees, L.M., T.P. Reust, R. Weathermon, C. Smith, R. Anduze, B. McClelland, W. Harding, K. Kibler, F. Oglesby, and C. Webb. 1992. Data Recovery Investigations at the Black Butte and Leucite Hills Mine Permit Areas, Sweetwater County, Wyoming. Prepared for the Black Butte Coal Company, Point of Rocks, Wyoming. Mariah Associates, Inc., Laramie, Wyoming.

McMurry Oil Company. 2003. Storm Water Pollution Prevention Plan, Jonah Field. Prepared for McMurry Oil Company, an affiliate of EnCana Oil & Gas (U.S.A.), Inc., Denver, Colorado, by Lesair Environmental, Inc., Littleton, Colorado. 7 pp. + append.

Metcalf, M.D. 1987. Contributions to the Prehistoric Chronology of the Wyoming Basin. *In* Perspectives on Archaeological Resources Management in the "Great Plains," edited by A.J. Osborn and R.C. Hassler, pp. 233-261. I & O Publishing Company, Omaha, Nebraska.

Miner, T.L. 2001. Phase II, Cultural Resource Inventory of the BP Amoco Production Company, Sections 12 and 13, T29N, R108W, Sublette County, Wyoming. Prepared for BP Amoco Production Company and Bureau of Land Management, Pinedale Field Office. Current Archaeological Research, Inc., Rock Springs.

Munn, L.C., and C.S. Arneson. 1999a. Draft 1:100,000 Scale Digital Soils Map of Sublette County: University of Wyoming Agricultural Experimental Station. <http://www.sdv.uwyo.edu/100k/ soil100.html>.

_______. 1999b. Draft 1:100,000 Scale Digital Soils Map of Sweetwater County: University of Wyoming Agricultural Experimental Station. <http://www.sdv.uwyo.edu/100k/soil100.html>.

National Agriculture Statistical Service. 1999. 1997 Census of Agriculture Volume 1: Part 50, Chapter 2, Wyoming County-Level Data. Table 1: County Summary Highlights. AC97-A-51. U.S. Department of Agriculture, National Agriculture Statistical Service, Washington, D.C. March 1999.

National Center for Education Statistics. 2003. Common Core of Data, America's Public Schools. Data obtained from "Build a Table" <http://nces.ed.gov/ccd/bat/index.asp>. Accessed July 3, 2003.

National Park Service. 2001. Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds. National Park Service and U.S. Fish and Wildlife Service. National Park Service Air Resources Division. <http://www.aqd.nps.gov/ard/flagfree/2001>, Data accessed July 2003.

_______. 2004. Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds. U.S. Department of the Interior, National Park Service. ParkNet, NatureNet: Nature and Science. <http://www2.nature.nps.gov/air/Permits/flag/NSDATGuidance.htm>. Accessed July 2004. 6 pp.

National Petroleum Council. 2003. Balancing Natural Gas Policy - Fueling the Demands of a Growing Economy. Volume 1. Summary of Findings and Recommendations. A report of the National Petroleum Council. Prepared for the Secretary of Energy, Washington D.C.

Natural Resources Conservation Service. 2003. Soil Mapping Results, Unpublished, for T29N, R108W, Sections 32 and 36, Jonah Infill Area, Sublette County, Wyoming, by Ron Reckner, Natural Resources Conservation Service, Pinedale, Wyoming.

Nelson, M.A., and R. Richard. 2004. Archaeological Excavations at Site 48SU3835, Sublette County, Wyoming. Prepared for BP America Production Company, Wamsutter, Wyoming. TRC Mariah Associates Inc., Laramie, Wyoming.

Nicholoff, S.H. (compiler). 2003. Wyoming Bird Conservation Plan, Version 2.0. Wyoming Partners in Flight. Wyoming Game and Fish Department, Lander, Wyoming.

Noss, R.F., and B. Csuti. 1994. Habitat Fragmentation. Pages 237-264. *In* G.K. Meffe and C.R. Carroll, eds. Principles of Conservation Biology. Sinauer Associates, Sunderland, Massachussetts.

Office of Management and Budget. 1987. 1987 Standard Industrial Classification Manual. Office of Management and Budget. Washington, D.C.

Patterson, R.L. 1952. The Sage Grouse in Wyoming. Sage Books, Inc., Denver, Colorado.

Peterson, A. 1986. Habitat Suitability Index Models: Bald Eagle (Breeding Season). U.S. Fish and Wildlife Service Biological Report 82(10.126). 25 pp.

Pinedale Online. 2002. <http://pinedaleonline.com>. Designed and maintained by Wind River Web Services and Office Outlet in Pinedale, Wyoming. Accessed January 2, 2003.

Plastino, A.T. 1999. McMurry Oil Company Stud Horse Butte 5-32 Well, Access, and Pipeline Class III Cultural Resource Inventory (99-CAR-41). Prepared for McMurry Oil Company, Casper, Wyoming. Current Archaeological Research, Rock Springs.

Plastino, A.T., and J. Randolph. 2000. McMurry Oil Company Stud Horse Butte 3-32 Well, Access Road and Pipeline, Monitor of Construction (99-CAR-175). Prepared for McMurry Oil Company, Casper, Wyoming. Current Archaeological Research, Rock Springs.

Reeve, A.F. 1984. Environmental Influence on Male Pronghorn Home Range And Pronghorn Behavior. Unpublished Ph.D. dissertation, University of Wyoming, Laramie. 172 pp.

Rock Springs Chamber of Commerce. 2004. <http://www.rockspringswyoming.net/>. Accessed February 24, 2004.

Royster, W. 2004. Growth strains social services. Casper Star-Tribune. November 7, 2004.

Sawyer, H., F. Lindzey, D. McWhiter, and K. Andrews. 2001. Potential Effects of Oil and Gas Development on Mule Deer and Pronghorn Populations in Western Wyoming. Transactions of the 67th North American Wildlife and Natural Resource Conference. 18 pp.

Scheffe, R. D. 1988. VOC/NO_x Point Source Screening Tables. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. August 1988.

Schlumberger Oil Field Services Companies. 2003. Scoping Comment Letter. Letter to Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming from James Stewart, General Manager, U.S. Land Western Region, Schlumberger Oil Field Services Company, Greenwood Village, Colorado. April 25, 2003. 4 pp.

Schroeder, M.A., J.R. Young, and C.E. Braun. 1999. Sage-grouse (*Centrocercus urophasianus*). The Birds of North America 425: 1-28.

Sheets, R.G., R.L. Linder, and R.B. Dahlgren. 1972. Food Habits of Two Litters of Black-footed Ferrets in South Dakota. American Midland Naturalist 87:249-251.

Sines, T. and S. Roufs. 2001. McMurry Oil Company Stud Horse Butte 1-28 Well Pad and Access Road Monitor of Construction Preliminary Report (00-CAR-023). Prepared for McMurry Oil Company, Denver. Current Archaeological Research, Rock Springs.

Slater, S.J. 2003. Sage-grouse (*Centrocercus urophasianus*) Use of Different-aged Burns and the Effects of Coyote Control in Southwestern Wyoming. M.S., Department of Zoology and Physiology, University of Wyoming.

Smith, C.S. 2003. Hunter-Gatherer Mobility, Storage, and Houses in a Marginal Environment: An Example from the Mid-Holocene of Wyoming. Journal of Anthropological Research.

Snow, C. 1973. Habitat Management Series for Endangered Species. Report No. 1: American Peregrine Falcon (*Falco peregrinus anatum*) and Arctic Peregrine Falcon (*F. p. tundris*).

U.S. Department of the Interior, Bureau of Land Management, Technical Note No. 167. 35 pp.

Soil Conservation Service. 1978. Soil Reconstruction Material for Drastically Disturbed Areas. National Soil Handbook. Notice 24. Washington, D.C.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service, and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Stahlmaster, M.V. 1987. The Bald Eagle. Universe Books, New York, New York. 227 pp.

State of Wyoming. 1990. 1990 Wyoming State Comprehensive Outdoor Recreation Plan. Department of Commerce, State Parks and Historical Sites. Cheyenne, Wyoming.

Steenhof, K. 1978. Management of Wintering Bald Eagles. U.S. Fish and Wildlife Service FWS/OBS-78/79. 59 pp.

Stubbendieck, J., S.L. Hatch, and C.H. Butterfield. 1997. North American Range Plants. Fifth edition. University of Nebraska Press, Lincoln, Nebraska. 501 pp.

Sublette County Board of Commissioners and Sublette County Planning Commission. 2003. Sublette County Comprehensive Plan: County Vision, Goals and Policies. 64 pp.

Sublette County Sheriff's Department. 2002. <http://www.sublette.com/government/sheriff>. Accessed January 2, 2003.

Sublette.Com. 2001. <http://www.sublette.com>. Designed and maintained by Wind River Web Services and Office Outlet in Pinedale, Wyoming. Accessed January 2, 2003.

Swenson, J.E., K.L. Alt, and R.L. Eng. 1986. The Ecology of the Bald Eagle in the Greater Yellowstone Ecosystem. Journal of Wildlife Management 42:506-513.

Tax Reform 2000 Committee. 1999. Building Wyoming's Tax Structure for the 21st Century, Report of the State of Wyoming Tax Reform 2000 Committee, June 1999. Presented to Honorable Jim Geringer, Governor, State of Wyoming; Honorable Jim Twiford, President, Wyoming State Senate; and Honorable Eli D. Bebout, Speaker of the House, Wyoming House of Representatives.

Taylor, D.T., and S. Lieske. 2002. Population Change in Wyoming, 1990-2000. Wyoming Open Spaces Research Group. B-1121, April 2002.

Thompson, K.W. and J.V. Pastor. 1995. People of the Sage: 10,000 Years of Occupation in Southwest Wyoming. Cultural Resources Management Report No. 67. Archaeological Services-Western Wyoming College, Rock Springs.

Thuman, A., and R.K. Miller. 1996. Fundamentals of Noise Control Engineering. Prentice-Hall, Englewood Cliffs, New Jersey. 287 pp.

Tipler, P.A. 1991. Physics for Scientists and Engineers. Third Edition. P.A. Tipler. 1,167 pp. + append.

TRC Environmental Corporation. 2004. Draft Air Quality Technical Support Document for the Jonah Infill Drilling Project Environmental Impact Statement. Prepared for Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, and the Jonah Infill Drilling Project Operators. Prepared by TRC Environmental Corporation.

TRC Mariah Associates Inc. 1999. 1997 and 1998 Wildlife Studies Jonah Field II Natural Gas Development Project. Prepared for U.S. Bureau of Land Management Pinedale Field Office, Pinedale, Wyoming, and Rock Springs Field Office, Rock Springs, Wyoming, by TRC Mariah Associates Inc., Laramie, Wyoming. 32 pp. + append.

_______. 2001a. 1999-2000 Wildlife Studies. Jonah Field II Natural Gas Project. Prepared for U.S. Bureau of Land Management Pinedale Field Office, Pinedale Wyoming, and Rock Springs Field Office, Rock Springs, Wyoming by TRC Mariah Associates Inc., Laramie, Wyoming. 47 pp. + append.

_______. 2001b. 2001 Wildlife Studies, Jonah Field II Natural Gas Development Project. Prepared for U.S. Bureau of Land Management, Pinedale Field Office and Rock Springs Field Office and Jonah Field II Operators. 53 pp. + append.

_______. 2001c (revised 2004). Preliminary Working Draft Historic Context/Discovery Plan/Cultural Resource Management Plan for the Pinedale Anticline and Jonah Field II, Sublette County, Wyoming. Prepared for Pinedale Anticline and Jonah Field II Operators and Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming, by TRC Mariah Associates Inc., Laramie, Wyoming.

_______. 2001d**.** Noise Monitoring and Noise Curve Data from the Bird Canyon Sage Grouse Lek near the Bird Canyon Compressor Station, 2001. Letter report prepared for Jonah Gas Gathering, Pinedale, WY, Wyoming Game and Fish Department Pinedale and Green River Offices, and Bureau of Land Management, Pinedale Field Office and Rock Springs Field Office. 5 pp. + attachments and tables.

_______. 2002. 2002 Wildlife Studies, Jonah Field II Natural Gas Development Project. Prepared for U.S. Bureau of Land Management, Pinedale Field Office and Rock Springs Field Office and Jonah Field II Operators. 54 pp. + append.

_______. 2003a. Noise Monitoring at Greater Sage-Grouse Leks Near the Bird Canyon, Luman, Falcon, and Paradise Compressor Stations, 2001 and 2003. Prepare for U.S. Bureau of Land Management, Rock Springs Field Office, Rock Springs, Wyoming, and Pinedale Field Office, Pinedale, Wyoming, and Duke Energy Field Services/Jonah Gas Gathering, Greeley, Colorado, by TRC Mariah Associates Inc., Laramie, Wyoming. 21 pp. + appends.

_______. 2003b. Final Socioeconomic Analysis Protocol for the Jonah Infill Drilling Project Environmental Impact Statement. Prepared for Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming; Bureau of Land Management Pinedale Field Office, Pinedale, Wyoming, and Jonah Infill Drilling Project Operators by TRC Mariah Associates Inc., Laramie, Wyoming. 17 pp.

_______. 2003c. 2002 Wildlife Studies, Pinedale Anticline Project. Prepared for U.S. Bureau of Land Management Pinedale Field Office, Pinedale, Wyoming, and Rock Springs Field Office, Rock Springs, Wyoming, by TRC Mariah Associates Inc., Laramie, Wyoming. 83 pp. + append.

_______. 2004a. 2003 Wildlife Studies, Jonah Field II Natural Gas Development Project. Prepared for U.S. Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming, Rock Springs Field Office, Rock Springs, Wyoming, and Jonah II Area Operators, by TRC Mariah Associates Inc., Laramie, Wyoming.

_______. 2004b. 2003 Wildlife Studies, Pinedale Anticline Project. Prepared for U.S. Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming and Pinedale Anticline Operators, by TRC Mariah Associates, Laramie, Wyoming.

University of Wyoming, Agricultural Economics Department. 1995. Southwest Wyoming Bureau of Land Management Area (Including Wyoming Counties of: Carbon, Lincoln, Sublette, Sweetwater, and Uinta): Economic Growth, Economic Diversity, Valuation, Fiscal Revenue, and Average Daily Membership. Prepared for Bureau of Land Management, Cheyenne, Wyoming.

_______. 1997. Southwest Wyoming Resource Evaluation Socio/Economic Evaluation (SWREE), Final Report, Parts I and II. Prepared for Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, by the University of Wyoming, College of Agriculture, Cooperative Extension Service, Agricultural Economics Department.

_______. 2003. Jack Morrow Hills Coordinated Activity Plan: Economic Analysis. Summary of an analysis of the regional economic effects on Southwest Wyoming associated with the resource use alternatives for the Jack Morrow Hills Coordinated Activity Plan and follow-up to the Southwest Wyoming Resource Evaluation, Socio/Economic Evaluation (1997). Prepared for the Bureau of Land Management, Wyoming State Office, Cheyenne, Wyoming, by the University of Wyoming, College of Agriculture, Cooperative Extension Service, Agricultural Economics Department. <http://agecon.uwyo.edu/econdev/PubStorage/JMHCAP.pdf> Accessed October 21, 2003.

_______. 2004. Summary of an analysis of the regional economic effects on Southwest Wyoming associated with the resource use alternatives for the Pinedale Resource Management Plan and follow-up to the Southwest Wyoming Resource Evaluation, Socio/Economic Evaluation. Prepared for the BLM Wyoming State Office; BLM Pinedale Field Office; and State of Wyoming, Wyoming Business Council, by the University of Wyoming, College of Agriculture, Cooperative Extension Service, Agricultural Economics Department.

U.S. Army Corps of Engineers. 1987. Wetlands Delineation Manual. Technical Report Y-87-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 100 pp. + append.

U.S. Census Bureau. 1981. U.S. Census Bureau 1980 Census of Population and Housing. Table 080A: Median Household Income in 1979. U.S. Census Bureau, Washington, D.C.

_______. 1990. U.S. Census Bureau 1990 Census of Population and Housing. Table 080A: Median Household Income in 1989. www.factfinder.gov. Accessed June 20, 2003.

_______. 2000a. State and County QuickFacts. www.census.gov. Last Revised: Friday, 24-Sep-2002 11:19:39 EDT. Accessed December 26, 2002.

_______. 2000b. U.S. Census Bureau 1990 Census of Population and Housing <http://factfinder.census.gov>. Accessed December 26, 2002.

_______. 2000c. American Fact Finder, Census 2000 Quick Tables. DP-3: Profile of Selected Economic Characteristics: 2000. <http://factfinder.census.gov>. Accessed January 2, 2003.

_______. 2000d. American Fact Finder, Census 2000 Detailed Tables. P-5: Urban and Rural Population (Total Population) (Final National File Only): 2000. <http://factfinder.census.gov>. Accessed April 24, 2003.

_______. 2000e. American Fact Finder, Census 2000 Detailed Tables. P-8: Sex by Age. <http://factfinder.census.gov>. Accessed June 18, 2003.

_______. 2000f. American Fact Finder, Census 2000 Detailed Tables. P-41. Age By Types Of Disability For The Civilian Noninstitutionalized Population 5 Years And Over With Disabilities. <http://factfinder.census.gov>. Accessed June 19, 2003.

U.S. Department of Agriculture, Forest Service 1989. A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas. General Technical Report RM-168. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 36 pp.

_______. 2000. Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide. U.S. Department of Agriculture (USDA) Forest Service, Rocky Mountain Region. January 2000.

_______. 2003. Unpublished lake water chemistry data provided by Terry Svalberg, USDA Forest Service, Fall 2003.

U.S. Department of Energy. 1998. Comprehensive National Energy Strategy: National Energy Policy Plan pursuant to Section 801 of the Department of Energy Organizational Act. Viii + 60 pp.

U.S. Department of the Interior. 2004. Environmental Quality Programs Part 516: National Environmental Policy Act of 1969, Chapter 11: Managing the NEPA Process--Bureau of Land Management. Effective Date 5/27/04. U.S. Department of the Interior, Washington, D.C.

U.S. Fish and Wildlife Service. 1987. Final Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. U.S. Department of the Interior, Fish and Wildlife Service, Region 6, Denver, Colorado.

_______. 1989. Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act. U.S. Fish and Wildlife Service, Denver, Colorado and Albuquerque, New Mexico. April 1989. 10 pp.+ append.

_______. 1992. Interim Survey Requirements for *Spiranthes diluvialis*. November 23, 1992 U.S. Fish and Wildlife Service, Ecological Services, Wyoming Field Office, Cheyenne, Wyoming.

_______. 1997. National Wetlands Inventory – A System for Mapping Riparian Areas in the Western United States. Washington, D.C.

_______. 2002. Mountain Plover Survey Guidelines. U.S. Fish and Wildlife Service, March 2002. 7 pp.

_______. 2003. Memorandum regarding scoping comments for the Jonah Infill Drilling Project from Jodi L. Bush, Acting Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, to Priscilla Mecham, Field Manager, Bureau of Land Management, Pinedale Field Office, Pinedale, dated May 9, 2003. ES-6141/W.02/ WY7064.

_______. 2004. Letter to Interested Party from Brian T. Kelly, Field Supervisor, Wyoming Field Office. U.S. Department of the Interior, Fish and Wildlife Service, Cheyenne, Wyoming. ES-61411/BFF/wY7746. 3 pp. + attach.

Vlcek, D.T. 1997. Jonah/Pinedale Anticline Gas Field Research Design-An Archaic Laboratory. Draft Manuscript. Bureau of Land Management, Pinedale.

Wakkinen, W.L. 1990. Nest Site Characteristics and Spring-Summer Movements of Migratory Sage Grouse in Southeastern Idaho. Thesis, University of Idaho, Moscow, Idaho.

Welder, G.E. 1968. Groundwater Reconnaissance of the Green River Basin, Southeastern Wyoming. U.S. Geological Survey Hydrologic Investigations. Atlas HA-290. 5 pp.+ 2 sheets.

Weller, C., J. Thompson, P. Morton, and G. Aplet. 2002. Fragmenting Our Lands: The Ecological Footprint from Oil and Gas Development. A Spatial Analysis of a Wyoming Gas Field. The Wilderness Society. 24 pp.

Western EcoSystems Technology Inc. 2003. An Evaluation of the 1988 BLM Pinedale Resource Management Plan, 2000 BLM Pinedale Anticline Final EIS and Recommendations for the Current Revision of the Pinedale Resource Management Plan, January 22, 2003. Prepared for Peter Aengst, The Wilderness Society, Bozeman, Montana, Kelly Matheson, The Wyoming Outdoor Council, Lander, Wyoming, and Scot Groene, The Greater Yellowstone Coalition, Jackson, Wyoming, by Western EsoSystems Technology Inc., Cheyenne, Wyoming. 57 pp.

Western Regional Climate Center. 2004. Climate and Weather Information, Kemmerer, Wyoming. Online, Western Regional Climate Center. <http://www.wrcc.dir.edu>.

Wetlands Training Institute, Inc. 1995. Field Guide for Wetland Delineation. 1987 Corps of Engineers Manual. Poolesville, Maryland. WTI 95-3. 143 pp.

Wheeler, C.W., G.S. Firebaugh, W.L. Shields, and E.K. Wade. 1986. 5500 Years on the Great Plains-Great Basin Frontier: An Excavation of Sites in Section 14. Western Cultural Resources Management, Inc., Fort Collins, Colorado.

Wilderness Society. 2002. Fragmenting Our Lands: The Ecological Footprint from Oil and Gas Development. 24 pp.

Workman, J.P. 1986. Range Economics. McMillan Publishing, Inc. New York, New York.

Wyoming Agricultural Statistics Service. 2003. Wyoming Agricultural Statistics 2003. Issued cooperatively by the Wyoming Business Council; University of Wyoming, College of Agriculture, Agricultural Experiment Station, and Department of Agricultural and Applied Economics; and U.S. Department of Agriculture, National Agricultural Statistics Service. Wyoming Agricultural Statistics Service, Cheyenne, Wyoming.

Wyoming Business Council. 2002a. Interactive Business Center. Salaries. <http://wyomingbusiness.org>. Accessed June 23, 2003.

_______. 2002b. Interactive Business Center. Quality of Life Category: Crime. <http://wyomingbusiness.org>. Accessed June 23, 2003.

_______. 2002c. Interactive Business Center. Quality of Life Category: Health Care. <http://wyomingbusiness.org>. Accessed June 23, 2003.

_______. 2002d. Interactive Business Center. Quality of Life Category: Housing. <http://wyomingbusiness.org>. Accessed June 23, 2003.

_______. 2002e. Wyoming Sales, Use, and Lodging Tax Report. 27th Edition. Prepared by Wyoming Department of Administration and Information, Economic Analysis Division, Cheyenne, Wyoming.

Wyoming Community College Commission. 2003. Press Release. April 4, 2003. <http://commission.wcc.edu/WCCC/press.htm>. Accessed July 7, 2003.

Wyoming Department of Administration and Information. 2001a. Historical Decennial Census Population for Wyoming Counties, Cities, and Towns. <http://eadiv.state.wy.us/demog_data/ cntycity_hist.htm> Accessed June 17, 2003.

_______. 2001b. Median Household Income By County: 1969, 1979, 1989 <http://eadiv.state.wy.us/demog_data/CNTY_INCOME70_90.htm>. Accessed June 17, 2003.

_______. 2002a. Equality State Almanac 2000, 8th Edition. Prepared by Economic Analysis Division, Department of Administration and Information, State of Wyoming, Cheyenne, Wyoming. May 2002.

_______. 2002b. Wyoming Population Estimates and Forecasts for Counties, Cities, and Towns: 1991 to 2010. Prepared by Wyoming Department of Administration and Information, Division of Economic Analysis, October 1, 2002. <http://eadiv.state.wy.us/ pop/wyc&sc10.htm>. Accessed December 30, 2002.

_______. 2003a. Wyoming and County Population Estimates and Components of Changes: 2000 to 2002. <http://eadiv.state.wy.us/pop/CO-02EST.htm>. Accessed June 17, 2003.

_______. 2003b. Wyoming Cost of Living for The Fourth Quarter 2002, Table Va: Average Rental Rates - 2Q02 & 2Q01. Department of Administration and Information, Economic Analysis Division, Cheyenne, Wyoming. March 27, 2003. Contact: Justin Ballard, Senior Economist.

Wyoming Department of Education Assessment and Accountability Office. 2003. WyCAS Test Results and Released Items. Wyoming Department of Education Assessment and Accountability Office, Hathaway Building, 2nd Floor, 2300 Capitol Avenue Cheyenne, Wyoming 82002-0050. <http://www.asme.com/wycas/TestResults/ TestResults.htm>. Accessed September 8, 2003.

Wyoming Department of Employment, Research, and Planning. 1999. Identifying Wyoming's Oil & Gas Dependent Counties. Wyoming Department of Employment, Research & Planning, Cheyenne, Wyoming. Prepared by David Bullard, Economist. Last modified on January 9, 2003 by Valerie A. Davis. <http://doe.state.wy.us/ lmi/1099/a3.htm>. Accessed April 23, 2003.

_______. 2002a. 1979 Wyoming Benchmark Labor Force Estimates. Wyoming Department of Employment, Research & Planning. <http://doe.state.wy.us/ lmi/laus/79bmk.htm>. Accessed June 20, 2003.

_______. 2002b. 1989 Wyoming Benchmark Labor Force Estimates. Wyoming Department of Employment, Research & Planning. <http://doe.state.wy.us/ lmi/laus/89bmk.htm>. Accessed June 20, 2003.

_______. 2002c. 2002 Wyoming Benchmark Labor Force Estimates. Wyoming Department of Employment, Research & Planning. <http://doe.state.wy.us/lmi/ laus/02bmk.htm>. Accessed June 20, 2003.

_______. 2003. Tables 8, 83, 86, and 89. *In* ES-202 Report (Second Run date: September 2003). Preliminary Wyoming Statewide Employing Units, Employment, and Wages by NAICS Sector, First Quarter 2003. Prepared by Nancy Brennan, 09/09/2003. <http://doe.state.wy.us/lmi/03Q1_202/toc.htm>. Accessed February 25, 2004.

Wyoming Department of Environmental Quality. 1990. Water Quality Rules and Regulations. Chapter I. Wyoming Department of Environmental Quality, Water Quality Division. 87 pp.

_______. 1993. Wyoming Air Quality Standards and Regulations, including revisions through 1993. Cheyenne, Wyoming.

_______. 2001. Oil and Gas Production Facilities Chapter 6, Section 2 Permitting Guidance, Wyoming Department of Environmental Quality-Air Quality Division. June 1997 with revisions through August 2001.

_______. 2003. Section 303(2) Data Files. <http://deq.state.wy.us/wqd/downloads/events/2-2227-doc.pdf>. Accessed December 2003.

_______. 2004. Letter to Prill Mecham, Pinedale Field Office Manager, U.S. Bureau of Land Management, from John Corra, Director, Wyoming Department of Environmental Quality. Dated October 14, 2004.

Wyoming Department of Environmental Quality, Air Quality Division. 2003. Wyoming’s Long Term Strategy for Visibility Protection 2003 Review Report – Appendix E, Visibility Monitoring Data Assessment. Wyoming Department of Environmental Quality, Air Quality Division. May 29, 2003.

Wyoming Department of Environmental Quality, Land Quality Division. 1981. Guideline No. 1, Topsoil and Overburden. J.K.W. and D.F./January 1981. 34 pp.

Wyoming Department of Environmental Quality, Water Quality Division. 1993. Water Quality Rules and Regulations. Chapter I. Wyoming Department of Environmental Quality, Water Quality Division. 87 pp.

_______. 2001. Water Quality Division. Water Quality Division Surface Water Standards. <http://deq.state.wy.us/wqd/surface standards>.

_______. 2004. Wyoming's 2004 305(b) State Water Quality Assessment Report and 2004 303(d) List of Waters Requiring TMDLs. June 2004. Wyoming Department of Environmental Quality, Water Quality Division. <http://deq.state.wy.us/wdeq/watershed/index.asp>. Accessed December 21, 2004.

Wyoming Department of Revenue. 1998. State of Wyoming Department of Revenue 1998 Annual Report. Wyoming Department of Revenue, Cheyenne, Wyoming. 131 pp.

_______. 1999. State of Wyoming Department of Revenue 1999 Annual Report. Wyoming Department of Revenue, Cheyenne, Wyoming. 131 pp.

_______. 2000. State of Wyoming Department of Revenue 2000 Annual Report. Wyoming Department of Revenue, Cheyenne, Wyoming. 103 pp.

_______. 2001. State of Wyoming Department of Revenue 2001 Annual Report. Wyoming Department of Revenue, Cheyenne, Wyoming. 110 pp.

_______. 2002. State of Wyoming Department of Revenue 2002 Annual Report. Wyoming Department of Revenue, Cheyenne, Wyoming. 122 pp.

_______. 2003. Sales & Use Tax, New Tax Rates Effective 4/1/03. Last Updated On: 3/26/2003 2:35:23 PM. <http://revenue.state.wy.us/>. Accessed July 10, 2003.

Wyoming Game and Fish Commission. 1998. Mitigation Policy. Pgs. E3-E13 *In:* Policy Manual. Wyoming Game and Fish Department, Cheyenne, Wyoming.

Wyoming Game and Fish Department. 1996. Wyoming Wildlife Observation System Records. Biological Services, Wyoming Game and Fish Department, Cheyenne, Wyoming.

_______. 1999. Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming. Wyoming Game and Fish Department, Wildlife Division. 190 pp. + append.

_______. 2001. Green River Region, Annual Big Game Herd Unit Reports, 2001. Wyoming Game and Fish Department, Cheyenne, Wyoming. 479 pp.

_______. 2002. Annual Report of Game Harvest, 2002. Wyoming Game and Fish Department, Biological Services Department. 2 CDs.

_______. 2003a. 2002 Annual Report of Big and Trophy Game Harvest. Data Tables and Summaries on CD-ROM.

_______. 2003b. 2002 Annual Report of Small and Upland Game Harvest. Data Tables and Summaries on CD-ROM.

_______. 2003c. 2003 Annual Report. Pages 56-58, 60, 67, and 73. Facsimile from Walt Gasson, WGFD, Cheyenne, Wyoming to C. Keefe, TRC Mariah Associates Inc., Laramie, Wyoming, January 2004.

_______. 2003d. Hunter/Angler/Wildlife Watcher Expenditures, By Species, Per BLM FO Administrative Areas. Facsimile from Tom Christiansen, Wyoming Game and Fish Department, Green River, Wyoming to C. Keefe, TRC Mariah Associates Inc., Laramie, Wyoming, January 23, 2004.

Wyoming Geographic Information Science Center. 2002. U.S. Census TIGER files, 199711, Wyoming Roads - TIGER: Spatial Data and Visualization Center, Laramie, Wyoming. <http://www.sdvc.uwyo.edu/clearinghouse/road/quad.html>.

_______. 2003a. Surface and Bedrock Geology Files and Geologic Hazards Data. Spatial Data and Visualization Center, Laramie, Wyoming. Accessed October, 2003, <www.sdvc.uwyo.edu/clearinghouse>.

_______. 2003b. Analysis, Wyoming Gap, 1996, Hydrography and Land Cover for Wyoming: Spatial Data and Visualization Center, Laramie, Wyoming. Accessed December 2003. <http://www.sdvc.uwyo.edu/24k/hydro100.html> and <http://www.sdvc.uwyo.edu/24k/landcov.html>.

_______. 2003c. Watersheds: 5th and 6th Level Hydrologic Unit Boundaries for Wyoming. Wyoming Watershed Boundary Dataset Edition 1. Wyoming Geologic Information Science Center. University of Wyoming, Laramie. <http://www.wygisc.uwyo.edu/clearinghouse/>. Accessed October 2003.

Wyoming Housing Database Partnership. 2003. A Profile of Wyoming Demographics, Economics, and Housing Semiannual Report, Ending June 30, 2003, Final Report. August 28, 2003. Prepared by Western Economic Services, LLC, Portland Oregon.

Wyoming Natural Diversity Database. 2003. August, 2003 Data Compilation for the Proposed Jonah Infill Drilling Project. Unpublished report. WYNDD, University of Wyoming, Laramie, Wyoming.

Wyoming Office of State Lands and Investments. 2002. Annual Report for Fiscal Year Ending June 30, 2002. Office of State Lands and Investments, Cheyenne, Wyoming. 49 pp.

Wyoming Oil and Gas Conservation Commission. 2003. Multiple Data Files. <http://wogcc.state.wy.us>. Accessed December 2003.

_______. 2004. Multiple Data Files. <http://wogcc. state.wy.us>. Accessed March and October 2004.

Wyoming State Land Use Commission. 1979. Wyoming State Land Use Plan. 180 pp.

CHAPTER 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 (acre-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.

aeolian: The erosive action of the wind and deposits that are transported by the wind.

affected environment: The resource values potentially affected by the Proposed Action and alternatives analyzed in a NEPA document.

aggregate: Composed of a mixture of substances, separable by mechanical means.

agrillic: Soils rich in clay.

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 air: The portion of the atmosphere, external to buildings, to which the public has general access (40 C.F.R. 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).

ambient: The environment as it exists at the point of measurement and against which changes or impacts are measured.

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): The amount of forage necessary to sustain one cow/calf pair 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 Interior 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 ground water, although it does not readily yield water.

archaeological: The scientific studies of past peoples and cultures by analysis of physical remains (artifacts).

Ardisols: Soils formed in arid climates; they are often dry and have little organic accumulation in the upper layers.

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.

bedding material: Any material, often sand, used to prevent rocks in the bottom of the reserve pit from puncturing the synthetic pit liner.

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.

calcareous: Containing calcium carbonate.

Cambic: Soils composed of very fine sand, loamy fine sand, or finer materials.

casing: Steel pipe placed in an oil or gas well to prevent the hole from collapsing.

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.

commercial reserves: Commercial reserves of oil and gas are restricted to volumes recoverable at an acceptable profitability.

commercial well: A well capable of producing profitably.

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 gas stream, 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: Sandstone's derivation 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.

corridor: A narrow strip of land.

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 (SO_2), 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.

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 C.F.R. 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.

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.

ecosystem: An interacting system of organisms considered together with their environment--for example, marsh, watershed, and stream ecosystems.

effluent: Mixture of oil, gas, water, and sand discharged from a well.

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.

Entisols: Recently derived soils that show little profile development; formed from river deposits, sand dunes, or recent glacial deposits.

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.

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.

evaporitic: Sediments that are deposited from aqueous solution as a result of extensive or total evaporation of the solvent.

exploratory well: A well that is drilled to evaluate the gas or oil resources that may be present.

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.

Fluvaquents: Entisols with aquic moisture regimes that occur on floodplains. Usually very deep, somewhat poorly drained soils that have grass-shrub cover.

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.”

frigid: Very cold in temperature.

fugitive dust: Airborne particles emitted from any source other then 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.

ground water: Water contained in the pore spaces of consolidated and unconsolidated material.

grus: An accumulation of angular coarse-grained fragments resulting from the granular disintegration of crystalline rocks (especially granite) generally in an arid or semiarid region.

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.

Haplaquepts: Fine-loamy soils.

Haplargids: Simple clay like soils (Aridosols). Moderately deep with argillic horizons often having grass-shrub cover.

Haplocalcids: Soils that have a lithic (usually limestone) contact within 50 cm of the soil surface.

Haplocambids: Shallow, cambic soils.

Haplosalids: Ardisols that are high in saline content (see playa).

Haplostolls: Coarse, loamy mixed mollisols. Deep dark-colored soils with thick surface layers often having grass-shrub cover.

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 60^{o}F.

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.

hydrophytic plants: Those species that either require or tolerate wet or saturated soils and are therefore indicative of these conditions.

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 C.F.R. 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 water of gas in order to maintain pressure or to bring a field back under pressure.

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.

intertonguing: Irregular/overlapping boundaries among rock formations.

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.

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.

leaching: To cause a liquid to percolate through something.

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 (LOP): 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% clay, 28% to 50% silt and less than 50% 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.

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 downhole 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 measures: Actions taken to reduce or minimize potential impacts to the environment.

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.

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.

Modified Mercalli (MM) Intensity Scale of 1931: A scale designed to describe the effects of an earthquake, at a given place, on natural features, on industrial installations, and on human beings.

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 pubic 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.

Natrargids: Soils with a clay accumulation horizon and alkali (sodium) accumulation.

natural gas: Those hydrocarbons, other than oil and other than natural gas liquids 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.

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 electrical spark through air or oxygen (O_2).

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, and mist).

passerine: Passerines are the perching birds, and most are also songbirds.

paraglacial: Refers to glacier-related processes and phenomena such as soil deposition and lake formation.

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.

physiographic province: A region having a pattern of relief features or landforms that differs significantly from adjacent regions.

physiographic: Pertaining to the genesis and evolution of landforms.

playa: The shallow central basin of a desert plain in which water gathers and is evaporated.

Pleistocene: Pertaining to the geologic epoch forming the earlier half of the Quaternary Period, characterized by the advent of modern humans.

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.

potentiometric surface: An imaginary surface that represents the static head of groundwater and is defined by the level to which water will rise.

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 occur in 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 et seq.).

produced water: Water brought to the surface through the borehole.

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 other mineral resources.

production: Phase of commercial operation of an oil field.

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 C.F.R. 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: Something remaining after removal of a part; a residue.

resource roads: Spur roads that provide point access, as to a well site, and connect to local or collector roads.

revegetation: The re-establishment and development of self-sustaining plant cover. On disturbed sites, human assistance will speed natural processes by seed bed preparation, reseeding, and mulching.

rig: A collective term to describe the permanent equipment needed when drilling a well.

right-of-way (ROW): The legal right for use, occupancy, or access across land or water areas for a specified purpose or purposes.

riparian: Land areas which are directly influenced by water. They usually have visible vegetative or physical characteristics showing this water influence. Streamsides and lake borders are typical riparian areas.

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.

site-specific environmental assessments: Environmental assessments generally completed for small projects such as individual wells, designed to address issues associated with small projects, and generally under the guidance of a more comprehensive NEPA document.

slope wash: Soil and rack 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.

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).

special management area: An area to which a given management objective and prescriptions are applied.

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.

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.

synclinal axis: The axis of a fold where the youngest rocks are in the interior of the fold.

terrestrial: Consisting of or pertaining to the land.

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*.

thrust fault: A low angle fault in which the rocks above the fault plane move up relative to the rocks below. The rocks that move up are the thrust sheet.

topographic basin: A large depression of erosional origin.

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.

Torrispamments: Sandy soils in arid regions, soils associated with sandy uplands. Very deep soils often having a grass-shrub cover.

total dissolved solids (TDS): Total amount of dissolved material, organic or inorganic, contained in a sample of water.

Total Energy Efficiency (TEE): A measurement of energy efficiency that takes into account all energy used or lost in the production, processing, and delivery steps involved in supplying energy to the user, plus the efficiency of the energy-using product itself.

transpiration: The process by which water vapor escapes from a living plant and enters the atmosphere.

tuff(aceous): 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.

typic: Being or serving as an illustration of a type. For soil classification, it is used as a root word meaning typical (see subgroups).

unconformity: A break in the stratigraphic sequence.

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 range: The distance at which a black object just disappears from view.

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 ground water aquifer.

watershed: The total land area that drains to a given watercourse or body of water.

watershed (6th level): The watershed and subwatershed hydrologic unit boundaries provide a uniquely identified and uniform method of subdividing large drainage areas. The smaller-sized level sub-watersheds (up to 250,000 acres) are useful for application programs.

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: Areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

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 characteristic.