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 are identified. "Significance," as defined in CEQ guidelines (40 CFR 1508.27), considers both the degree of intensity and the context of the project. Significant impacts would be the most substantial and therefore should receive the greatest attention in decision-making. 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 intensity of an impact, either beneficial or negative, within the context of the human 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 readers, the significance of an impact is often framed in terms of personal experience (i.e., how they perceive impact intensity within their own context). For instance, persons who benefit directly from the positive economic impacts of the project are likely to consider that impact significant. Conversely, someone who recreates in the JIDPA is likely to find the negative environmental impacts of project-related activities significant. 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 and B, 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 C).
- 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. Cumulative Impact Assessment Areas (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 C (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, except for air quality.

Alternative-specific mitigation and monitoring measures for the Preferred Alternative are identified in Section 2.4.5. 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 compensatory mitigation (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 surface area can be reclaimed. This fact must, however, be weighed against the potential for faster development to lead to accelerated impacts to other resources such as air quality and water resources.

4.1 PHYSICAL RESOURCES

4.1.1 Climate

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

4.1.2 Air Quality

Direct, indirect, and cumulative air quality analyses were performed to predict maximum near-field (surrounding the JIDPA) and far-field (sensitive Class I and Class II areas) ambient air pollutant concentrations, as well as maximum impacts to visibility (regional haze) and atmospheric deposition, including "acid rain." Analyses were also performed to predict maximum mid-field (regional communities of Big Piney, Big Sandy, Boulder, Daniel, Farson, LaBarge, Merna, and Pinedale; see Map 3-1) visibility impacts and maximum in-field (within the JIDPA) concentrations.

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.

Although WDEQ has the regulatory authority for air quality in Wyoming, BLM also has responsibility in regard to air quality. For example, 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] 2006) 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 will be controlled or otherwise limited in accordance with mitigations, goals, and performance objectives set forth in Sections 2.4.5 and 5.1, and Appendices A and C. Actual air quality impacts 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).

This air quality impact assessment is based on the operations and engineering data and assumptions available at the time of the analysis, the best available meteorology data, and currently accepted 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, analyzed compression was assumed to operate at 90% of permitted capacity, and drilling engines were assumed to operate at an average of 42% of maximum capacity. Parameters for which most likely field operating projections were not provided by Operators were assumed to occur at maximum proposed levels. For example, impact assessments assume that all proposed wells would be productive (no dry holes), well completion flaring activities would be required for 20% of the completed wells, and flaring would occur daily throughout the year.

The assessment of direct project impacts includes a near-field analysis and a far-field analysis, which were completed separately for project alternatives. The near-field analyses include impact assessments for comparison to applicable ambient air quality standards and for comparison to

PSD increments. All NEPA PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis, which may be completed as necessary by the WDEQ-AQD; preliminary results from a WDEQ PSD increment consumption analysis may be reviewed at http://deq.state.wy.us/aqd. The near-field analyses also include assessments of HAP impacts for comparison to applicable health-based levels for non-cancer compounds and cancer risk for carcinogens. 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 in-field analyses are additional near-field impact assessments of field-wide source emissions for comparison to applicable ambient air quality standards and for comparison to PSD increments. The mid-field analyses assess potential changes to regional haze within Wyoming regional community locations, however these areas are classified as PSD Class II areas where no visibility protection exits under local, state, or federal law. The far-field analyses include impact assessments for comparison to applicable ambient air quality standards and for comparison to PSD increments. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis. In addition, the far-field analyses assess potential change to regional haze and acid deposition at sensitive Class I and Class II areas, and potential increase in acidification of acid sensitive lakes within the sensitive Class I and Class II areas. 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.

A summary of direct project potential near-field and far-field impacts across alternatives is provided in Table 4.1. Table 4.2 provides a detailed summary of potential direct project and cumulative impacts for each alternative compared with applicable ambient air quality standards, PSD increments, and levels of concern (LOC). Table 4.3 provides a summary of potential direct project and cumulative acid deposition impacts for each alternative compared with deposition analysis thresholds (DAT) and LOC, and lake acidity levels of acceptable change (LAC). Table 4.4 provides a summary of potential direct project and cumulative visibility impacts for each alternative.

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. The EPA proposed guideline dispersion model, AERMOD was used to assess near-field impacts of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2, and to estimate short-term and long-term HAP impacts. Impacts were assessed from the phase of single-well pad construction or field production that produced the highest emissions. The 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 HAP impacts were modeled for 3,100-well developments to reflect the maximum number of wells in production under any alternatives. NO_2 and CO impact 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 TRC EC (2006).

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. In recognition of the importance of potential ozone concentrations resulting from the increase in natural gas development activities within and nearby the JIDPA, ozone monitoring was initiated in the Jonah Field area as well as near Daniel and Boulder. Further detail on O_3 is provided in the Air Quality Technical Support Document (TRC EC 2006).

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 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 J, Tables J-1 through J-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 J, Tables J-1, J-2, J-3, J-4, J-5, and J-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 J-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. Background NO_2 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 PSD increment, and preliminary results of a WDEQ increment consumption analysis show that the current increment consumption for NO_2 in Bridger Wilderness is 5.6% (see http://deq.state.wy.us/aqd). A comparison of the maximum modeled PM_{10} and SO_2 impacts to PSD Class II increments is not presented because 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.

Table 4.1. Summary of Primary Additional Air Quality Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

IMPACT	NO ACTION	PROPOSED ACTION	ALTERNATIVE A	ALTERNATIVE B	PREFERRED ALTERNATIVE
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 near-field concentrations could exceed the Prevention of Significant Deterioration (PSD) 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential near-field concentrations could exceed the PSD 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential near-field concentrations could exceed the PSD 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential near-field concentrations would be below PSD increments; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.
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 4 days per year; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 3 days per year; impairment at Bridger Wilderness only
Visibility (regional haze) (mid-field communities)	No impact above existing levels; no new developments	Maximum of 23 days per year >1.0 dv at Big Sandy	Maximum of 23 days per year >1.0 dv at Big Sandy	Maximum of 6 days per year >1.0 dv at Big Sandy	Maximum of 4 days per year >1.0 dv at Big Sandy
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 at Bridger Wilderness, Popo Agie Wilderness, and Wind River Roadless Area, 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 at Bridger Wilderness, Popo Agie Wilderness, and Wind River Roadless Area, 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 at Bridger Wilderness, and Popo Agie Wilderness, 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 at Bridger Wilderness, and Popo Agie Wilderness, and less than DAT at all other analyzed areas
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) at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes

Table 4.2. Summary of Air Quality Concentrations Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Air Quality Component	Criteria	Source Group & Impact Area	No Action	Maximum Production (3100 wells)	Proposed Action and Alternative A	Alternative B	Preferred Alternative
Concentrations	Air Quality Standards	Project: Near-Field	N/A	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS
		Cumulative: Near-Field	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS
		Project: Far-Field	N/A	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS CO < NAAQS&WAAQS O_3 < NAAQS/WAAQS
		Cumulative: Far-Field	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS	PM_{10} < NAAQS&WAAQS $PM_{2.5}$ < NAAQS&WAAQS NO_2 < NAAQS&WAAQS SO_2 < NAAQS&WAAQS
	PSD Class I Increments [2]	Project: Far-Field	N/A	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
		Cumulative: Far-Field	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
	PSD Class II Increments [2]	Project: Near-Field	N/A	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
		Cumulative: Near-Field	PM_{10} < increment NO_2 < increment SO_2 < increment	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	**PM_{10} 24-hr > increment** PM_{10} Annual < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
		Project: Far-Field	N/A	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
		Cumulative: Far-Field	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment	PM_{10} < increment NO_2 < increment SO_2 < increment
	HAP Risk Assessment	Project: Near-Field	**N/A**	All < Health Based LOC	All < Health Based LOC	All < Health Based LOC	All < Health Based LOC
		Project: Far-Field	**N/A**	All < Health Based LOC	All < Health Based LOC	All < Health Based LOC	All < Health Based LOC

[1] Results shown in normal text indicate impacts are below ambient air quality standards, PSD increments, and BLM-recognized significant threshold values and levels of concern. Results shown in bold text indicate that potential impacts are above these levels.

[2] The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment consumption analysis.

Table 4.3. Summary of Acid Deposition Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Air Quality Component	Criteria	Source Group & Impact Area	No Action	Maximum Production (3100 wells)	Alternative A	Alternative B	Preferred Alternative
Atmospheric Deposition	N Deposition	Project: Far-Field	**N/A**	**Bridger WA, N > DAT** Fitzpatrick WA, N < DAT Popo Agie WA, N < DAT Wind River RA, N < DAT Grand Teton NP, N < DAT Teton WA, N < DAT Yellowstone NP, N < DAT Washakie WA, N < DAT	**Bridger WA, N > DAT** Fitzpatrick WA, N < DAT **Popo Agie WA, N > DAT** **Wind River RA, N > DAT** Grand Teton NP, N < DAT Teton WA, N < DAT Yellowstone NP, N < DAT Washakie WA, N < DAT	**Bridger WA, N > DAT** Fitzpatrick WA, N < DAT **Popo Agie WA, N > DAT** Wind River RA, N < DAT Grand Teton NP, N < DAT Teton WA, N < DAT Yellowstone NP, N < DAT Washakie WA, N < DAT	**Bridger WA, N > DAT** Fitzpatrick WA, N < DAT **Popo Agie WA, N > DAT** Wind River RA, N < DAT Grand Teton NP, N < DAT Teton WA, N < DAT Yellowstone NP, N < DAT Washakie WA, N < DAT
		Total: Far-Field	N < LOC, All Areas	N < LOC, All Areas	N < LOC, All Areas	N < LOC, All Areas	N < LOC, All Areas
	S Deposition	Project: Far-Field	**N/A**	N < DAT, All Areas	N < DAT, All Areas	N < DAT, All Areas	N < DAT, All Areas
		Total: Far-Field	S < LOC, All Areas	S < LOC, All Areas	S < LOC, All Areas	S < LOC, All Areas	S < LOC, All Areas
	Sensitive Lakes	Project: Far-Field	N/A	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes
		Cumulative: Far-Field	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes	ANC Change < LAC, All Lakes

[1] Results shown in normal text indicate impacts are below recognized thresholds and levels. Results shown in bold text indicate that potential impacts are above these levels.

Table 4.4. Summary of Visibility (Regional Haze) Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Air Quality Component	Impact Area	Source Group	No Action	Maximum Production (3100 wells)	Alternative A	Alternative B	Preferred Alternative
Visibility (Regional Haze)	PSD Class I and Sensitive Class II Areas	Project	**N/A**	**Bridger WA, >1.0dv 1 days, max dv = 1.14** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.15 Popo Agie WA, >1.0dv 0 days, max dv = 0.24 Wind River RA, >1.0dv 0 days, max dv = 0.20 Grand Teton NP, >1.0dv 0 days, max dv = 0.08 Teton WA, >1.0dv 0 days, max dv = 0.03 Yellowstone NP, >1.0dv 0 days, max dv = 0.04 Washakie WA, >1.0dv 0 days, max dv = 0.06	**Bridger WA, >1.0dv 10 days, max dv = 3.48** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.64 Popo Agie WA, >1.0dv 0 days, max dv = 0.62 Wind River RA, >1.0dv 0 days, max dv = 0.52 Grand Teton NP, >1.0dv 0 days, max dv = 0.33 Teton WA, >1.0dv 0 days, max dv = 0.14 Yellowstone NP, >1.0dv 0 days, max dv = 0.16 Washakie WA, >1.0dv 0 days, max dv = 0.24	**Bridger WA, >1.0dv 4 days, max dv = 1.90** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.32 Popo Agie WA, >1.0dv 0 days, max dv = 0.34 Wind River RA, >1.0dv 0 days, max dv = 0.28 Grand Teton NP, >1.0dv 0 days, max dv = 0.17 Teton WA, >1.0dv 0 days, max dv = 0.07 Yellowstone NP, >1.0dv 0 days, max dv = 0.08 Washakie WA, >1.0dv 0 days, max dv = 0.12	**Bridger WA, >1.0dv 3 days, max dv = 1.66** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.33 Popo Agie WA, >1.0dv 0 days, max dv = 0.29 Wind River RA, >1.0dv 0 days, max dv = 0.26 Grand Teton NP, >1.0dv 0 days, max dv = 0.14 Teton WA, >1.0dv 0 days, max dv = 0.06 Yellowstone NP, >1.0dv 0 days, max dv = 0.06 Washakie WA, >1.0dv 0 days, max dv = 0.10
		Cumulative	**Bridger WA, >1.0dv 3 days, max dv = 1.94** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.49 Popo Agie WA, >1.0dv 0 days, max dv = 0.58 Wind River RA, >1.0dv 0 days, max dv = 0.81 Grand Teton NP, >1.0dv 0 days, max dv = 0.33 Teton WA, >1.0dv 0 days, max dv = 0.14 Yellowstone NP, >1.0dv 0 days, max dv = 0.16 Washakie WA, >1.0dv 0 days, max dv = 0.17	**Bridger WA, >1.0dv 4 days, max dv = 2.26** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.56 Popo Agie WA, >1.0dv 0 days, max dv = 0.66 Wind River RA, >1.0dv 0 days, max dv = 0.92 Grand Teton NP, >1.0dv 0 days, max dv = 0.35 Teton WA, >1.0dv 0 days, max dv = 0.16 Yellowstone NP, >1.0dv 0 days, max dv = 0.17 Washakie WA, >1.0dv 0 days, max dv = 0.20	**Bridger WA, >1.0dv 17 days, max dv = 4.01** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.87 Popo Agie WA, >1.0dv 0 days, max dv = 0.99 **Wind River RA, >1.0dv 2 days, max dv = 1.21** Grand Teton NP, >1.0dv 0 days, max dv = 0.50 Teton WA, >1.0dv 0 days, max dv = 0.24 Yellowstone NP, >1.0dv 0 days, max dv = 0.25 Washakie WA, >1.0dv 0 days, max dv = 0.34	**Bridger WA, >1.0dv 7 days, max dv = 2.71** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.61 Popo Agie WA, >1.0dv 0 days, max dv = 0.78 **Wind River RA, >1.0dv 1 days, max dv = 1.01** Grand Teton NP, >1.0dv 0 days, max dv = 0.36 Teton WA, >1.0dv 0 days, max dv = 0.18 Yellowstone NP, >1.0dv 0 days, max dv = 0.18 Washakie WA, >1.0dv 0 days, max dv = 0.25	**Bridger WA, >1.0dv 6 days, max dv = 2.62** Fitzpatrick WA, >1.0dv 0 days, max dv = 0.57 Popo Agie WA, >1.0dv 0 days, max dv = 0.75 Wind River RA, >1.0dv 0 days, max dv = 0.96 Grand Teton NP, >1.0dv 0 days, max dv = 0.35 Teton WA, >1.0dv 0 days, max dv = 0.17 Yellowstone NP, >1.0dv 0 days, max dv = 0.18 Washakie WA, >1.0dv 0 days, max dv = 0.23
	Wyoming Regional Communities	Project	**N/A**	Big Piney, >1.0dv 0 days, max dv = 0.66 Big Sandy, >1.0dv 0 days, max dv = 0.85 Boulder, >1.0dv 0 days, max dv = 0.56 Bronx, >1.0dv 0 days, max dv = 0.36 Cora, >1.0dv 0 days, max dv = 0.69 Daniel, >1.0dv 0 days, max dv = 0.57 Farson, >1.0dv 0 days, max dv = 0.55 Labarge, >1.0dv 0 days, max dv = 0.30 Merna, >1.0dv 0 days, max dv = 0.22 **Pinedale, >1.0dv 1 days, max dv = 1.07**	**Big Piney, >1.0dv 6 days, max dv = 2.01** **Big Sandy, >1.0dv 23 days, max dv = 3.05** **Boulder, >1.0dv 12 days, max dv = 2.39** **Bronx, >1.0dv 1 days, max dv = 1.70** **Cora, >1.0dv 1 days, max dv = 3.20** **Daniel, >1.0dv 1 days, max dv = 2.56** **Farson, >1.0dv 6 days, max dv = 2.33** **Labarge, >1.0dv 2 days, max dv = 1.32** Merna, >1.0dv 0 days, max dv = 0.79 **Pinedale, >1.0dv 3 days, max dv = 4.27**	**Big Piney, >1.0dv 1 days, max dv = 1.04** **Big Sandy, >1.0dv 6 days, max dv = 1.79** **Boulder, >1.0dv 3 days, max dv = 1.24** Bronx, >1.0dv 0 days, max dv = 0.85 **Cora, >1.0dv 1 days, max dv = 1.66** **Daniel, >1.0dv 1 days, max dv = 1.32** **Farson, >1.0dv 3 days, max dv = 1.21** Labarge, >1.0dv 0 days, max dv = 0.66 Merna, >1.0dv 0 days, max dv = 0.42 **Pinedale, >1.0dv 1 days, max dv = 2.39**	Big Piney, >1.0dv 0 days, max dv = 0.92 **Big Sandy, >1.0dv 4 days, max dv = 1.45** **Boulder, >1.0dv 2 days, max dv = 1.10** Bronx, >1.0dv 0 days, max dv = 0.89 **Cora, >1.0dv 1 days, max dv = 1.75** **Daniel, >1.0dv 1 days, max dv = 1.37** **Farson, >1.0dv 1 days, max dv = 1.19** Labarge, >1.0dv 0 days, max dv = 0.57 Merna, >1.0dv 0 days, max dv = 0.35 **Pinedale, >1.0dv 1 days, max dv = 2.37**
		Cumulative	**Big Piney, >1.0dv 7 days, max dv = 2.18** **Big Sandy, >1.0dv 2 days, max dv = 1.45** **Boulder, >1.0dv 4 days, max dv = 2.92** Bronx, >1.0dv 0 days, max dv = 0.74 Cora, >1.0dv 0 days, max dv = 0.85 Daniel, >1.0dv 0 days, max dv = 0.79 **Farson, >1.0dv 3 days, max dv = 1.48** **Labarge, >1.0dv 6 days, max dv = 1.86** Merna, >1.0dv 0 days, max dv = 0.98 **Pinedale, >1.0dv 2 days, max dv = 1.78**	**Big Piney, >1.0dv 11 days, max dv = 2.26** **Big Sandy, >1.0dv 9 days, max dv = 1.88** **Boulder, >1.0dv 5 days, max dv = 3.04** Bronx, >1.0dv 0 days, max dv = 0.77 Cora, >1.0dv 0 days, max dv = 0.93 Daniel, >1.0dv 0 days, max dv = 0.89 **Farson, >1.0dv 8 days, max dv = 1.69** **Labarge, >1.0dv 6 days, max dv = 2.05** **Merna, >1.0dv 1 days, max dv = 1.01** **Pinedale, >1.0dv 5 days, max dv = 1.94**	**Big Piney, >1.0dv 20 days, max dv = 2.62** **Big Sandy, >1.0dv 34 days, max dv = 3.62** **Boulder, >1.0dv 21 days, max dv = 3.70** **Bronx, >1.0dv 1 days, max dv = 1.79** **Cora, >1.0dv 8 days, max dv = 3.32** **Daniel, >1.0dv 11 days, max dv = 2.67** **Farson, >1.0dv 12 days, max dv = 2.75** **Labarge, >1.0dv 12 days, max dv = 2.90** **Merna, >1.0dv 5 days, max dv = 1.13** **Pinedale, >1.0dv 10 days, max dv = 4.41**	**Big Piney, >1.0dv 14 days, max dv = 2.34** **Big Sandy, >1.0dv 16 days, max dv = 2.43** **Boulder, >1.0dv 9 days, max dv = 3.17** Bronx, >1.0dv 0 days, max dv = 0.94 **Cora, >1.0dv 3 days, max dv = 1.80** **Daniel, >1.0dv 2 days, max dv = 1.44** **Farson, >1.0dv 10 days, max dv = 2.04** **Labarge, >1.0dv 6 days, max dv = 2.37** **Merna, >1.0dv 1 days, max dv = 1.05** **Pinedale, >1.0dv 8 days, max dv = 2.55**	**Big Piney, >1.0dv 13 days, max dv = 2.28** **Big Sandy, >1.0dv 12 days, max dv = 2.13** **Boulder, >1.0dv 9 days, max dv = 3.09** Bronx, >1.0dv 0 days, max dv = 0.97 **Cora, >1.0dv 2 days, max dv = 1.86** **Daniel, >1.0dv 2 days, max dv = 1.47** **Farson, >1.0dv 10 days, max dv = 1.87** **Labarge, >1.0dv 6 days, max dv = 2.30** **Merna, >1.0dv 1 days, max dv = 1.03** **Pinedale, >1.0dv 6 days, max dv = 2.50**

[1] Results shown in normal text indicate impacts are below 1.0 dv. Results shown in bold text indicate that potential impacts are above 1.0 dv.

Appendix J, Tables J-7 and J-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 presumptively acceptable risk range of 1×10^{-4} to 1×10^{-6} as stated by EPA (EPA 1999).

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, and at in-field locations within the JIDPA. The analysis also included an assessment of maximum mid-field (regional community) visibility impacts for the Wyoming regional community locations of Big Piney, Boulder, Bronx, Cora, Daniel, Farson, LaBarge, Merna, and Pinedale although these communities are classified as PSD Class II areas where no visibility protection exits under local, state, or federal law.

The air emissions modeled for project and non-project sources in the far-field analysis are presented in Appendix J, Table J-9. Modeling scenarios were developed to approximate a range of project development including the No Action Alternative, Proposed Action, Alternative A, Alternative B, and the Preferred Alternative. These modeling scenarios assumed the 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. The maximum emissions scenarios are based on an estimate of what the maximum field emissions could be on any day during the year, and these emissions are modeled for each day of the year. Therefore, annual concentration and deposition estimates are reasonable but conservative. A well development rate of 250 wells per year (WDR250) was assumed for the Proposed Action, Alternative A and Preferred Alternative. Alternative B assumed a 75 well per year development rate (WDR75). WDR250 assumes simultaneous operation of 20 drilling rigs and three pit flares, and WDR75 assumes simultaneous operation of 6 drilling rigs and one pit flare. Development rates considered both straight and

directional drilling operations generally consistent with the various proposed project alternatives. The Proposed Action and Alternative A assumed all straight-hole drilling. Alternative B assumed all directional drilling, and the Preferred Alternative assumed a combination of 50% straight hole drilling and 50% directional drilling operations. Details on modeling methodology are presented in the Air Quality Technical Support Document (TRC EC 2006).

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 potential 1.0-dv change to be a significant adverse impact. Although there are no applicable local, state, tribal, or federal regulatory visibility standards, the BLM has the responsibility under the Clean Air Act to assess visibility impacts. 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 2006).

The NPS, USFS, and USFWS have published the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report* (FLAG 2000) that prescribes several methods 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 areas. 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. BLM recognizes that federal agencies may use different methods to calculate visibility impairment. Further detail can be found in TRC EC (2006: Section 4.6.4 and Appendix J).

Potential changes to regional haze resulting from project source emissions were also estimated for nearby communities (mid-field) although these communities are classified as PSD Class II areas where no visibility protection exits under local, state, or federal law. 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 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. Because anthropogenic emissions (traffic, wood stoves, furnaces, etc.) exist in the residential locations it is likely that the visibility data measured in the Bridger Wilderness Area are more pristine than what would be measured in the residential areas. Therefore, because visibility impacts are calculated as percent increases of modeled concentrations above background values, the use of these data may overestimate the potential visibility impacts at these communities.

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.

Far-field Impacts Summary

An overall summary of maximum direct project far-field impacts by alternative is provided in Tables 4.1, 4.2, and 4.3. Pollutant concentrations under all project alternatives would be below applicable ambient air quality standards and PSD increments at far-field locations (see Appendix J, Tables J-10 through J-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, and would be below the SILs at all other sensitive areas. The SILs are defined under the New Source Review (NSR) program and are applicable to impacts from a single facility only. The SILs are used to determine the need for further modeling analyses, and are not an indicator of "significance" as defined within a NEPA analysis.

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 (see Appendix J, Tables J-17 and J-18). FLAG (2000) identifies a goal that any specific project combined with cumulative new source growth will have no days of visibility impairment at or above 1.0 dv in any Class I area. 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 J, Tables J-19 through J-21). The predicted maximum deposition impacts (Appendix J, Table J-20) from the Proposed Action are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. Under the Proposed Action and Alternative B scenarios, 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. For Alternative B and the Preferred Alternative, the maximum predicted N impacts are above the 0.005 kg/ha-yr DAT at the Bridger and Popo Agie Wilderness Areas, 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 J, Tables J-22 and J-23.

Estimated direct project impacts at in-field locations are below the applicable ambient air quality standards (see Appendix J, Table J-24). For the Proposed Action, Alternative A, and Alternative B scenarios, potential in-field (near-field) concentrations could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants. However, this PSD comparison is for information purposes only and does not constitute a regulatory PSD increment consumption analysis.

A presentation of the aforementioned results for each alternative and for cumulative source impacts is presented below.

4.1.2.1 No Action Alternative

Near-field Impacts

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 and air quality would remain similar to existing levels.

Far-field Impacts

No new project-related development would occur under the No Action Alternative; therefore, air quality would remain similar to existing levels.

Mid-field and In-field Impacts

No project-related mid-field and in-field impacts beyond currently approved levels would occur in the JIDPA under the No Action Alternative. As a result, mid-field and in-field air quality impacts and air quality would remain similar to existing levels.

4.1.2.2 Proposed Action

Near-field Impacts

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 J, Tables J-1, J-2, J-3, J-4, J-5, and J-6, respectively. Appendix J, Table J-1 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, NAAQS, and PSD increments.

Appendix J, Tables J-7 and J-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 2006). The emissions modeled are provided in Appendix J, Table J-1. Appendix J, Tables J-10, J-11, J-12, and J-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 J, Tables J-14, J-15, and J-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 J, Table J-17 for the FLAG background visibility data, and in

Table J-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 J, Table J-19). The predicted maximum S deposition impacts (Appendix J, Table J-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 J, Table J-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 J, Table J-22 for the FLAG visibility data and Table J-23 for the IMPROVE visibility data.

In-field Impacts

Appendix J, Table J-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. Potential in-field (near-field) concentrations could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants.

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 J, Tables J-1, J-2, J-3, J-4, J-5, and J-6, respectively. Appendix J, Table J-1 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, NAAQS and PSD increments.

Appendix J, Tables J-8 and J-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 J, Table J-9. Appendix J, Tables J-10, J-11, J-12, and J-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 J, Tables J-14, J-15, and J-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 J, Table J-17 for the FLAG background visibility data and in Table J-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 J, Table J-19). The predicted maximum S deposition impacts (Appendix J, Table J-20) from Alternative A sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. The predicted N impacts (Appendix J, Table J-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.

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 J, Tables J-22 for the FLAG visibility data and J-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 J, Table J-24. The estimated project-related impacts are less than applicable ambient air quality standards. Potential in-field (near-field) concentrations could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants.

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 J, Tables J-1, J-2, J-3, J-4, J-5, and J-6, respectively. Appendix J, Table J-1 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, NAAQS and PSD increments.

Appendix J, Tables J-7 and J-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 J, Table J-9. Appendix J, Tables J-10, J-11, J-12, and J-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 J, Tables J-14, J-15, and J-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 J, Tables J-17 (FLAG) and J-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 J, Table J-19). Predicted maximum S deposition impacts (Appendix J, Table J-20) from Alternative B sources are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. The predicted N impacts (Appendix J, Table J-21) 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 J, Tables J-22 (FLAG) and J-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 J, Table J-24. The estimated project-related impacts are below applicable ambient air quality standards.

Potential in-field (near-field) concentrations could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants.

4.1.2.5 BLM Preferred Alternative

Various configurations of the Preferred Alternative were modeled to provide a representation of the range of possible impacts (low and high emissions scenarios) and of impacts that could occur using various mitigation methods (see AQTSD Appendix J, Section J-2; TRC EC 2006). Impacts from the Preferred Alternative as described herein are those potentially occurring from the high emissions scenario (i.e., 250 wells developed per year, 50% directionally drilled wells, 80% Tier 0 [AP-42] [EPA 1995] and 20% Tier 1 drilling rig emission levels) with an 80% reduction in emission levels.

Near-field Impacts

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 J, Tables J-1, J-2, J-3, J-4, J-5, and J-6, respectively. Appendix J, Table J-1 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 J, Tables J-7 and J-8 summarize modeled HAP impacts based on emissions from Preferred Alternative 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 Preferred Alternative scenarios are provided in Appendix J, Table J-9. Appendix J, Tables J-10, J-11, J-12, and J-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 J, Tables J-14, J-15, and J-16 present the maximum modeled Preferred Alternative 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 Preferred Alternative 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 the Preferred Alternative 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 J, Tables J-17 (FLAG) and J-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 the Preferred Alternative would not result in an increase in ANC above any LAC at the acid-sensitive lakes (Appendix J, Table J-19). Predicted maximum deposition impacts (Appendix J, Table J-20) from the Preferred Alternative are below the 0.005 kg/ha-yr DAT at all sensitive PSD Class I and Class II areas. The predicted N impacts (Appendix J, Table J-21) are above the 0.005 kg/ha-yr threshold at the Bridger and Popo Agie Wilderness Areas, 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 Preferred Alternative scenarios are shown in Appendix J, Tables J-22 (FLAG) and J-23 (IMPROVE).

In-field Impacts

Model predicted concentrations of NO_2, SO_2, $PM_{10,}$ and $PM_{2.5}$ resulting from Preferred Alternative source emissions at locations within the JIDPA are shown in Appendix J, Table J-24. The estimated project-related impacts are below applicable ambient air quality standards. Potential in-field (near-field) concentrations are below PSD increments.

Preferred Alternative Air Quality Mitigation Measures

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 2.4.5).

4.1.2.6 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 J, Table J-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 30, 2003. June 30, 2003 became the end-date of the source inventory because the dispersion modeling analysis began on July 1, 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 J, Table J-9. RFD projects included in the cumulative analysis are listed in Appendix J, Table J-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 because these developments are speculative and would likely require WDEQ/AQD permit analysis 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).

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 J, Tables J-26 through J-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 J, Tables J-26, J-27, J-28, and J-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 J, Tables J-30, J-31, and J-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 J, Table J-33 for the FLAG background visibility data, and in Appendix J, Table J-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 J, Table J-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 J, Table J-36 (S) and Table J-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 J, Table J-38 for the FLAG background visibility data and in Table J-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 J, Table J-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 J, Tables J-26, J-27, J-28, and J-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 J, Tables J-30, J-31, and J-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 J, Table J-33 for the FLAG background visibility data and in Table J-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 (3-day maximum) 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 J, Table J-35) are below the ANC change LACs. In addition, cumulative total N (Appendix J, Table J-36) and S deposition (Appendix J, Table J-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 J, Table J-38 (FLAG) and Table J-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. The maximum number of days with a "just noticeable

visibility change" are predicted to occur at Big Piney (7-day maximum), approximately 18 miles northwest of the JIDPA.

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 J, Table J-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 J, Tables J-26, J-27, J-28, and J-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 J, Tables J-30, J-31, and J-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 J, Table J-33 (FLAG) and in Table J-34 (IMPROVE). Visibility impacts are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area (7-day maximum) and Wind River Roadless Area (2-day maximum) 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 J, Table J-35) are below the ANC change LACs. In addition, cumulative total N (Appendix J, Table J-36) and S deposition (Appendix J, Table J-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 J, Table J-38 (FLAG) and Table J-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 The maximum number of days with a "just noticeable visibility change" are predicted to occur at Big Sandy (34-day maximum), approximately 16 miles northeast of the JIDPA.

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 J, Table J-24. The maximum impacts shown are compared to ambient air quality standards after adding monitored background concentrations. The estimated impacts are below applicable ambient air quality standards. Potential cumulative in-field (near-field) concentrations could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants.

Preferred Alternative Far-field Cumulative Impacts. Modeling was performed for the Preferred Alternative 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 J, Tables J-26, J-27, J-28, and J-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 J, Tables J-30, J-31, and J-32 present the maximum modeled cumulative impacts of NO_2, SO_2, and PM_{10}, respectively, from Preferred Alternative and regional sources for comparison to applicable PSD increments. As shown in these tables, pollutant concentrations from Preferred Alternative and regional source emissions scenarios would be below applicable ambient air quality standards and PSD increments.

The cumulative visibility impacts for the Preferred Alternative are provided in Appendix J, Table J-33 (FLAG) and in Table J-34 (IMPROVE). Visibility impacts are predicted to be above the "just noticeable visibility change" (1.0-dv) threshold at the Bridger Wilderness Area (6-day maximum) 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 J, Table J-35) are below the ANC change LACs. In addition, cumulative total N (Appendix J, Table J-36) and S deposition (Appendix J, Table J-37) are well below the 5 kg/ha-yr (S) and 3 kg/ha-yr (N) levels of concern.

Preferred Alternative Mid-field Cumulative Impacts. The maximum visibility impacts at nearby Wyoming towns are shown in Appendix J, Table J-38 (FLAG) and Table J-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. The maximum number of days with a "just noticeable visibility change" are predicted to occur at Big Piney (13-day maximum), approximately 18 miles northwest of the JIDPA.

Preferred Alternative In-field Cumulative Impacts. Model predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ resulting from Preferred Alternative and regional source emissions at locations within the JIDPA are shown in Appendix J, Table J-24. The maximum impacts shown are compared to ambient air quality standards after adding monitored background concentrations. The estimated cumulative impacts are below applicable ambient air quality standards and PSD increments.

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. Potential cumulative in-field (near-field) concentrations from other project alternatives could exceed the PSD 24-hour PM_{10} increment but are below the annual PM_{10} increment and below the PSD increments for all other pollutants. 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. Predicted visibility impacts from the other project alternatives are less than or equivalent to the Proposed Action Alternative and greater than the Preferred Alternative. The cumulative far-field modeling results for all project alternatives are summarized in Appendix J, Tables J-26 through J-40.

4.1.2.7 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 C.

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 total disturbance, of which 2,811 acres would be short term and 1,409 acres would be long term over the LOP (see Table 2.2). No significant impacts are anticipated. The duration of impacts would be approximately 63 years (see Table 2.1) and until areas are adequately reclaimed (see Appendix B).

4.1.3.2 The Proposed Action

An estimated maximum of 20,409 acres of total disturbance would occur under the Proposed Action (see Table 2.3), 14,388 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 6,043 acres and is anticipated to last for approximately 76 years and until successful reclamation is achieved (see Table 2.1). An approximate 385% increase in total disturbance and 329% increase in LOP disturbance above the No Action Alternative 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 those described for the Proposed Action, except that 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). Significant impacts are anticipated.

4.1.3.4 Alternative B

An estimated maximum of 7,431 acres of total disturbance would occur under Alternative B (see Table 2.4), 4,848 acres of which would be short term. LOP disturbance would be 2,602 acres and is anticipated to last for approximately 105 years, plus the time needed for successful reclamation (see Table 2.1). An approximate 77% increase in total disturbance and 85% increase in LOP disturbance above the No Action Alternative would occur under Alternative B; impact duration would be extended at least an additional 42 years (105-year LOP). No significant impacts are anticipated.

4.1.3.5 BLM Preferred Alternative

Under the Preferred Alternative, an estimated maximum of 14,030–20,334 acres of disturbance would occur (see Table 2.5), 9,782–14388 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, road ROWs, and entire pipeline ROW areas). Long-term LOP disturbance is estimated at 4,267–6,020 acres and is anticipated to last for approximately 76 years and until successful reclamation is achieved (see Table 2.1). An approximate 233–386% increase in total disturbance and 203–327% increase in LOP disturbance above the No Action Alternative would occur under the Preferred Alternative; impact duration would be extended at least an additional 13 years (76-year LOP), and significant impacts such as those described under Section 4.1.3 are anticipated.

Impacts to topography would be similar to those of the Proposed Action, except that the BLM Preferred Alternative would limit total surface disturbance at any given time to a maximum of 14,030 acres. Additional mitigation measures would also be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.4.5). Even with the application of these measures, significant impacts may occur to topography for the LOP.

4.1.3.6 Cumulative Impacts

The CIAA for topography includes the combined 10 watersheds that drain the JIDPA, which encompass approximately 210,300 acres. Approximately 1.6% (3,355 acres) of the CIAA has been previously disturbed (see Table 3.11).

RFD (total new 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 Canyon is estimated at 18 acres.

Maximum cumulative disturbance (i.e., the combined existing, proposed [under the Proposed Action, Alternative A, and the BLM Preferred Alternative], and RFD disturbance) could be on the order of 22,900 acres (10.9% of the CIAA) 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 Alternative A, with somewhat less

impact under the BLM Preferred Alternative because of the limit on disturbance allowable at any one time. Alternative B would result in the least impact on topography due to the associated reduction in surface disturbance.

4.1.3.7 Unavoidable Adverse Impacts

Unavoidable adverse impacts to topography would include long-term changes in landform throughout the JIDPA. Because reclamation activities would be performed such that the reclaimed landscape emulates predisturbance conditions, no notable permanent changes (post-LOP) in topography are anticipated. Minor differences from the predisturbance 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 4.5), and significant impacts are anticipated under most alternatives because these are non-renewable resources. The economic impacts from natural gas and oil recovery are described in Section 4.4.

Because 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.

Table 4.5. Anticipated Gas and Condensate Recovery Volumes for Each Alternative, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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)
Preferred Alternative[2]	4,824–7,947	45.83–75.50	(3,123)–0	(29.67)–0

[1] Assumes approximately 12,800 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).

4.1.4.1 No Action Alternative

Under the No Action Alternative, an estimated 3,366 BCF of natural gas and 31.98 MBO would be recovered. Compared to the Proposed Action, this would leave approximately 4,581 BCF of gas and 43.52 MBO unrecovered (see Table 4.5).

The No Action Alternative could result in substantial volumes of unrecovered resource. Because 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. Because 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 4.5). These amounts represent an increase in 4,825 BCF of gas and 45.83 MBO of oil that would be recovered under the No Action Alternative. Compared to the Proposed Action, an additional 244 BCF of gas and 2.31 MBO would be recovered. Because 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. Compared to the Proposed Action, Alternative B would leave approximately 1,823 BCF of gas and 17.32 MBO unrecovered. Because considerable unrecovered reserves would remain available and could be potentially extracted at a future date, no significant impacts are anticipated.

4.1.4.5 BLM Preferred Alternative

Under the Preferred Alternative, impacts on gas and oil resources would equal that of the Proposed Action if the Operators maximize ongoing reclamation as described in Section 2.4.5 (i.e., 4,824–7,947 BCF of gas and 45.83–75.50 MBO would be produced). An estimated 1,458–4,581 BCF more gas and 13.85–43.52 MBO more oil would be produced than for 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 2.4.5); however, because most natural gas resources would be recovered and would no longer be available, significant effects would occur.

4.1.4.6 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 3.5). This project is proposed in part to maximize natural gas and condensate recovery from the known reserves in this area. Because additional development beyond that described herein is not anticipated in the CIAA, cumulative impacts to mineral resources would be the same as described for the No Action Alternative, Proposed Action, Alternatives A and B, and the BLM Preferred Alternative.

4.1.4.7 Unavoidable Adverse Impacts

Unavoidable adverse impacts to mineral resources would include the permanent loss of the extracted mineral resource (e.g., natural gas), which would no longer be available. This would occur under the Proposed Action, Alternative A, and the BLM Preferred Alternative. Under the No Action Alternative and Alternative B 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 loss of royalties. These effects could lead to unavoidable adverse impacts to other resources in the future.

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. 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 C), 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 2.4.5).

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 paleontological resources:

- to expand the opportunities for scientific study and educational and interpretive uses of paleontological resources,
- to protect and preserve important paleontological resources and/or their historic record for future generations, and
- to resolve conflicts between paleontological 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 because Pleistocene paleontological materials were previously unknown for the JIDPA. Other geologic formations within the JIDPA are known to contain significant fossils throughout their occurrence in the Green River Basin. Therefore, 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 C). As additional mitigation, a synthesis and/or overview of paleontological resources found within

the JIDPA could be generated. 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 because up to 20,409 acres of disturbance would occur—16,200 acres more than for the No Action Alternative (see Table 2.3). There would be an increase in human activity and it would occur for a longer duration (approximately 13 years longer than No Action), 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 2.3).

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 3,222 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 BLM Preferred Alternative

Under the Preferred Alternative, impacts to paleontological resources would be increased from those of the No Action Alternative. The Preferred Alternative would result in 9,821–16,125 acres of additional surface disturbance and 2,858–4,611 acres more LOP disturbance. The Preferred Alternative would have a direct impact duration of approximately 13 years longer than the No Action Alternative. Total surface disturbance would be comparable to that of the Proposed Action if the Operators maximize ongoing reclamation as described in Section 2.4.5; however, under the Preferred Alternative, additional inventory and mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.4.5).

4.1.6.6 Cumulative Impacts

The CIAA for paleontological resources is a 310,000-acre area (surrounding the JIDPA (see Map 3.5). Approximately 1.1% (3,331 acres) of the CIAA has been previously 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 [the Proposed Action, Alternative A, and the BLM Preferred Alternative], and RFD disturbance) could be on the order of 22,900 acres (7.4% of the CIAA). Alternative B would have less activity and surface disturbance, therefore, would 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 because little paleontological inventory or evaluation has been conducted in the JIDPA.

4.1.6.7 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 water and groundwater 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 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 C); therefore, impacts to soils would also be dependent on the effectiveness of this mitigation. Cumulative acreage of disturbance in each CIAA watershed and percent of watersheds affected are shown in Tables 4.6 and 4.7. respectively. Significant impacts to soils resulting from surface disturbance are anticipated under all 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 Application for Permit to Drill (APD) and/or ROW application, and Storm Water Pollution Prevention Plans (SWPPPs) (see also Appendix B). 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.

Because the extent of erosion in the JIDPA under any alternative is undefined, the BLM determined that modeling would be performed to quantify sediment loss and transport (load) at the JIDPA boundary. The modeling looked at the sediment loss experienced during individual storms of varying size, with the amount of erosion experienced proportional to the size of the storm. Modeling was done for two alternatives analyzed in this EIS: the No Action Alternative and the Proposed Action.[1] Potential impacts were extrapolated for the other project alternatives. Modeled impacts for each action alternative were assessed by looking at the total sediment loss (in kilograms) resulting from new disturbance above and beyond that of the No Action Alternative. Table 4.8 shows the total sediment loss, by watershed, for each alternative for 5-year and 150-year storms. Complete results of the modeling are reported in Appendix E, *Erosion, Sediment Transport, and Salinity Modeling Technical Report: Jonah Infill Drilling Project, Sublette County, Wyoming* (HydroGeo 2005).

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, groundwater 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 total and LOP disturbance associated with the various project alternatives within each project-affected watershed are presented in Tables 4.6–4.8 and are discussed under each alternative.

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 B). 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 C) would be required under all project alternatives to minimize impacts to soil resources.

[1] In addition to the No Action Alternative and the Proposed Action, HydroGeo (2005) modeled an undisturbed condition and the Preferred Alternative as configured in the JIDP DEIS.

4.1.7.1 No Action Alternative

Under the No Action Alternative, no additional activities would occur that would potentially affect soil resources other than those previously approved for the area (BLM 1998b, 2000b)—2,811 acres of short-term and 1,409 acres of LOP disturbance, or 9.2% and 4.6% of the JIDPA, respectively. Total disturbance would equal 4,209 acres. The duration of impacts would be approximately 63 years and until areas are adequately reclaimed. No additional significant impacts to soils beyond those of previously authorized actions are expected under the No Action Alternative.

4.1.7.2 The Proposed Action

Compared to the No Action Alternative, the Proposed Action would result in an estimated increase of 16,200 acres of new 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 and new disturbance under the Proposed Action would be 20,409 acres (see Table 4.6). Approximately 70.4% (14,388 acres) of this disturbance would be reclaimed and reseeded as soon as practical after disturbance (see Appendix B). Disturbance would not occur all at once, but would increase as development occurs (for approximately 13 years). Simultaneously, disturbance would decrease in some areas as some disturbed lands are reclaimed. Significant impacts to soils are anticipated under the Proposed Action; however, 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 6,043 acres would be disturbed for the LOP (i.e., approximately 76 years and until successful reclamation is achieved).

As shown in Table 4.8, under the Proposed Action, a 5-year storm results in an 802% increase in soil loss over the No Action Alternative, while a 150-year storm results in a 55% increase over the No Action Alternative. (In general, the 150-year storm is such a powerful event that erosion will happen whether or not ground has been disturbed; thus, the No Action Alternative itself sees relatively high erosion rates, and the total increase under the Proposed Alternative is a smaller percentage.) In terms of actual soil loss, the 5-year storm yields 224,000 kilograms more than the No Action Alternative, and the 150-year storm yields approximately 5.1 million kilograms more than the No Action Alternative.

The greatest impacts occur to the watersheds contributing to the Big Sandy River (see Table 4.8). The Long Draw and Bull Draw watersheds account for 79% of the 5-year soil loss, and 72% of the 150-year soil loss. Sand Draw, which accounts for 45% of the JIDPA area, yields relatively little sediment under any storm condition: no sediment during the 5-year event, and only 10% of the 150-year soil loss.

No formal estimates of disturbance to the 17 soil map units defined for the JIDPA (see Map 3.7) 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 and SU03 soil mapping units comprise over 99% of the JIDPA. These soil units are impacted approximately the same under the Proposed Action. During the 5-year storm, 59% of the lost soil is from soil mapping unit SU03 and 41% of the lost soil is from soil mapping unit SU05. During the 150-year storm, 43% is from SU03 and 57% is from SU05.

Table 4.6. Cumulative Acreage of Disturbance in each CIAA Watershed and Including RFD, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Watershed/ Major River Drainage	Total Acreage of Watershed	Acres of Watershed within JIDPA	Existing Disturbance in CIAA but Outside JIDPA	RFD	JIDP Disturbance											
					No Action[1]			Proposed Action and Alternative A[2] (3,100 Wells/Pads)			Alternative B[3] (3,100 Wells/497 Pads)			Preferred Alternative[4] (3,100 Wells/Pads)		
					JIDP Total	LOP	Cumulative[5]	JIDP Total	LOP	Cumulative[5]	JIDP Total	LOP	Cumulative[5]	JIDP Total	LOP	Cumulative[5]
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	6,220–9,057	1,841–2,682	6,775–9,612
Granite Wash	12,212	1,312	36	0	172	58	208	866	256	902	311	109	347	595–866	175–256	630–902
Reduced Upper Alkali Creek-Green River	26,797	3,782	239	0	496	167	735	2,496	739	2,735	896	315	1,135	1,714–2,496	507–739	1,953–2,735
Upper Eighteenmile Canyon	35,212	1,958	477	18	257	87	752	1,292	386	1,787	464	163	959	887–1,291	265–386	1,382–1,787
Southeast New Fork River-Blue Rim	11,746	0	23	126	0	0	149	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	0	0	269
Subtotal	124,809	20,776	1,203	540	2,725	919	4,469	13,710	4,063	15,453	4,920	1,731	6,663	9,416–13,710	2,788–4,063	11,159–15,453
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	1,645–2,395	486–709	1,915–2,666
Long Draw	18,521	5,028	281	0	660	222	941	3,318	982	3,599	1,191	419	1,472	2,278–3,318	674–982	2,559–3,599
Subtotal	38,281	8,658	498	54	1,136	382	1,688	5,713	1,691	6,265	2,050	721	2,603	3,923–5,713	1,160–1,691	4,475–6,265
Closed Basins																
Jonah Gulch	22,652	318	127	0	42	14	169	210	62	337	75	26	202	144–210	42–62	271–337
1.40401E+11	24,558	747	122	0	98	33	220	493	146	615	177	62	299	339–493	100–146	460–615
Subtotal	47,210	1,065	249	0	140	47	389	703	208	952	252	89	501	483–703	142–208	731–952
Total[6]	210,300	30,500	1,950	594	4,001	1,348	6,545	20,126	5,962	22,670	7,223	2,541	9,767	13,822–20,126	4,090–5,962	16,364–22,671
Additional associated disturbance[7]					208	61	208	283	81	283	208	61	208	208	61	208
Grand Total[6]			--	--	4,209	1,409	6,753	20,409	6,043	22,953	7,431	2,602	9,975	14,030–20,334	4,151–6,023	16,574–22,878
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	6.79.7	2.0–2.9	7.9–10.9

[1] Assumes total and LOP disturbance as currently authorized.
[2] Assumes 20,126 acres of total and 5,962 acres of LOP disturbance in the JIDPA.
[3] Assumes 7,223 acres of total and 2,539 acres of LOP disturbance in the JIDPA.
[4] Assumes 13,822 acres of total and 4,090 acres of LOP disturbance in the JIDPA. With successful reclamation, could increase to 20,126 acres of total and 5,962 acres of LOP disturbance.
[5] Cumulative disturbance = New + existing + RFD.
[6] Columns may not total due to rounding error.
[7] Assumes new total and LOP disturbance associated with selected ancillary facilities which may be constructed outside the JIDPA (e.g., Burma Road upgrade, compressor stations).

Table 4.7. Percent of Watersheds Affected, Including Existing Disturbance, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[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/ 3,100 Pads)			Alternative B (3,100 Wells/ 497 Pads)			Preferred Alternative (3,100 Wells/ 3,100 Pads)		
				JIDP Total [3]	LOP[3]	Cumulative	JIDP Total [3]	LOP[3]	Cumulative	JIDP Total [3]	LOP[3]	Cumulative	JIDP Total [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	27.1–39.5	8.0–11.7	29.5–41.9
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	4.9–7.1	1.4–2.1	5.2–7.4
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	6.4–9.3	1.9–2.8	7.3–10.2
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	2.5–3.7	0.8–1.1	3.9–5.1
Southeast New Fork River-Blue Rim	11,746	0.0	0.2	--	--	1.3	--	--	1.3	--	--	1.3	0	0	1.3
North Alkali Draw	15,911	0.0	0.6	--	--	1.7	--	--	1.7	--	--	1.7	0	0	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	8.3–12.1	2.5–3.6	9.7–13.5
Long Draw	18,521	27.1	0.7	3.6	1.2	5.1	17.9	5.3	19.4	6.4	2.3	7.9	12.3–17.9	3.6–5.3	13.8–19.4
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	0.6–0.9	0.2–0.3	1.2–1.5
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	1.4–2.0	0.4–0.6	1.9–2.5

[1] Percent of watershed affected is calculated using potential acreage affected (refer to Table 4.6) divided by the total watershed acreage multiplied by 100.
[2] As described in Table 3.11.
[3] Provides percent of the watershed within the JIDPA that would be disturbed.

Table 4.8. Total Sediment Loss in Kilograms by Alternative, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

	Return Period 5 Years				Return Period 150 Years			
	No Action[1] (4,209 acres)[3]	Proposed Action[1] Alternative A[1] (20,409 acres)	Alternative B[2] (7,431 acres)	Preferred Action[2] (14,030–20,334 acres)	No Action[1] (4,209 acres)[3]	Proposed Action[1] Alternative A[1] (20,409 acres)	Alternative B[2] (7,431 acres)	Preferred Action[2] (14,030–20,334 acres)
Green River/New Fork River								
Upper Eighteenmile Canyon	406	3,154	965	2,072	240,984	341,313	261,403	301,807
Granite Wash	27	2,430	516	1,484	286,727	478,232	325,702	402,824
Expanded Sand Draw-Alkali Creek	0	0	0	0	439,567	1,433,122	641,774	1,041,894
North Alkali Draw	7,485	26,512	11,357	19,020	1,156,586	1,624,999	1,251,917	1,440,554
Big Sandy River								
Big Sandy River-Bull Draw	2,944	36,798	9,834	23,467	1,835,340	2,878,764	2,047,696	2,467,900
Long Draw	15,331	175,512	47,931	112,438	5,181,675	7,472,309	5,647,861	6,570,337
Closed Basins								
140401040603	1,688	7,110	2,791	4,975	182,220	238,606	193,696	216,403
Total	**27,881**	**251,516**	**73,395**	**163,456**	**9,323,099**	**14,467,345**	**10,370,048**	**12,441,719**
Total Increase over No Action	**0**	**223,635**	**45,514**	**135,575**	**0**	**5,144,246**	**1,046,949**	**3,118,620**

[1] Based on erosion and sediment transport modeling, HydroGeo (2005); see Appendix E.
[2] No modeling conducted. Interpolated based on surface area impacts as a percentage of Proposed Action.
[3] Acreage refers to maximum amount of acreage disturbed at any one time under each alternative

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 4.6 and 4.7) and would result in increased soil impacts and disturbance over those of the No Action Alternative. However, because 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 Long Draw and Bull Draw watersheds, due to increased erosion and/or sedimentation (see Table 4.8). As with the Proposed Action, not all areas would be disturbed at the same time, rather, disturbance would accumulate as development occurs. As with the Proposed Action, the rate of development would be 250 wells/year, resulting in a LOP of approximately 76 years or until successful reclamation.

4.1.7.4 Alternative B

Compared to the No Action Alternative, Alternative B would result in an estimated increase of 3,222 acres of new disturbance, for a total disturbance of 7,223 acres in the JIDPA (23.7% of the JIDPA), and an additional 208 acres for ancillary facilities that may be constructed outside the JIDPA (see Table 4.6). Existing and new disturbance under Alternative B would total 7,431 acres. Disturbance would not occur all at once, but would increase as development occurs (for approximately 42 years). Simultaneously, disturbance would decrease in some areas as some disturbed lands are reclaimed. Significant impacts to soils are anticipated under Alternative B; however, 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 2,602 acres would be disturbed for the LOP (i.e., approximately 105 years and until successful reclamation is achieved).

Erosion modeling was not conducted for Alternative B; the estimates shown in Table 4.8 are based on interpolation and the amount of surface disturbance. The greatest impact would likely still occur in the Long Draw and Bull Draw watersheds, which would have 11% surface area impacted, compared to 16% under the Proposed Action, and less than 1% under the No Action Alternative. Based on area of surface disturbance and interpolating from the two modeling scenarios (No Action and Proposed Alternatives), the amount of soil loss during the 5-year storm would be approximately 73,000 kilograms (representing a 163% increase over the No Action Alternative) and during the 150-year storm would be approximately 10.3 million kilograms (representing an 11% increase over the No Action alternative).

4.1.7.5 BLM Preferred Alternative

Impacts to soils under the Preferred Alternative would be similar to those described for all other alternatives and would be significant. While the total impacted acreage under the Preferred Alternative is 14,030–20,334 acres, not all of this acreage would be impacted at any given time. For soil loss estimates, the maximum disturbed acreage at any one time is the important measure. Implementation of the Preferred Alternative would result in a maximum 14,030 acres of additional surface disturbance, at any given time, 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 13 years); therefore, all surface disturbance would not be present at any one time.

As with Alternative B, no erosion modeling was conducted for the Preferred Alternative as presently configured. Rather, the estimates presented in Table 4.8 are based on the amount of surface disturbance expected under the Preferred Alternative and interpolation from the four scenarios that were modeled (undisturbed condition, No Action, Proposed Action, and the DEIS Preferred Alternative). Using this approach, the amount of soil loss during the 5-year storm would be approximately 163,000 kilograms (representing a 486% increase over the No Action Alternative) and during the 150-year storm would be approximately 12.4 million kilograms (representing a 33% increase over 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 2.4.5).

4.1.7.6 Cumulative Impacts

The CIAA for soil resources is the 10 watersheds that drain the JIDPA, which encompass approximately 210,300 acres. Areas east 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 4.6), 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, Alternative A, and the BLM Preferred Alternative (i.e., the combined existing, proposed, and RFD disturbance) could be on the order of 22,900 acres (10.9%) in the combined watersheds (see Table 4.6). Under Alternative B, maximum cumulative disturbance would be increased from the No Action Alternative to 9,975 acres, 4.8% of the combined watersheds.

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 4.6 and 4.7). Based on erosion modeling, the greatest soil loss would be experienced in watersheds contributing to the Big Sandy River (Long Draw and Bull Draw). 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 in the Expanded Sand Draw-Alkali Creek watershed is estimated to be 3,805 acres (16.6%) under Alternative B. Maximum cumulative disturbance as a result of the Preferred Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 6,775–9,612 acres (29.5–41.9% of the watershed). The Long Draw watershed, which

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.

4.1.7.7 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 Groundwater

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 water and groundwater 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 water and groundwater quality/resources when land uses are planned or proposed, particularly near watercourses and lakes;
- to ensure land uses and developments do not accelerate long-term groundwater depletion; and
- to comply with water quality standards (e.g., salinity) set forth by the Colorado River Basin Salinity Control Act.

Impacts to surface water or groundwater 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 groundwater 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 use of or depletion of surface waters associated with the project. No impacts to and/or from flooding are anticipated because areas adjacent to drainages would be avoided.

The erosion modeling conducted by HydroGeo (2005) indicates that even under the 150-year storm event, runoff originating on the JIDPA infiltrates or evaporates before reaching either the Green River or Big Sandy River (see Appendix E). However, because sediment lost from the watershed is redeposited downstream, a succession of storm events will eventually transport a portion of this sediment to perennial surface waters. With successful reclamation (including interim reclamation occurring during the LOP [Appendix B]) 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 addition to sediment load, water quality can be impacted by dissolved constituents imparted by the transported sediments. Concentrations of dissolved solids in water in contact with soils in the project area have been estimated at 300 to 1,300 milligrams per liter (mg/L). However, this assumes that the contact time with the soils is long enough for waters to reach equilibrium with the salinity of the soil. In reality, the relatively rapid dissipation of storm flows indicated by the erosion modeling may not provide this opportunity. Because no runoff from the JIDPA reaches perennial waters, even during the 150-year storm event, salinity impacts likely are not significant.

Potential impacts to local surface water and/or groundwater 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; and cross-aquifer mixing. No direct discharge of unsuitable quality produced water or pipeline test water is planned. 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. 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, groundwater 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 total and LOP disturbance associated with the Proposed Action and each of the alternatives within each project-affected watershed are presented in Tables 4.6 and 4.7 and discussed under each alternative. Development activities in the JIDPA such as roads and well pads could affect natural overland flow patterns and groundwater infiltration. Compacted areas (e.g., roads and well pads) could reduce groundwater 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, groundwater at depths less than approximately 2,300 feet below ground surface is relatively fresh, and the aquifer is extensive. Proposed groundwater consumption of fresh water would result in the temporary partial depletion of this aquifer. An estimated maximum of 4.9 acre-ft of new groundwater would be required to drill and complete each well (Table 4.9), and this water would be obtained from approximately 41 (25 existing, 16 new) water wells drilled to the top 600 feet of the aquifer.

Water wells pumping water out of an aquifer create a cone of depression, where groundwater levels are lowered near the pumping wells. The groundwater model MODFLOW was used to simulate the cone of depression created by pumping of all proposed groundwater 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 feet or less) (HydroGeo, Inc. 2004). Two development rates were modeled: development of 75 wells per year over 41.3 years and 250 wells per year over 12.4 years (see Table 4.9).

Table 4.9. Summary of Groundwater Pumping Scenarios (3,100 total wells), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

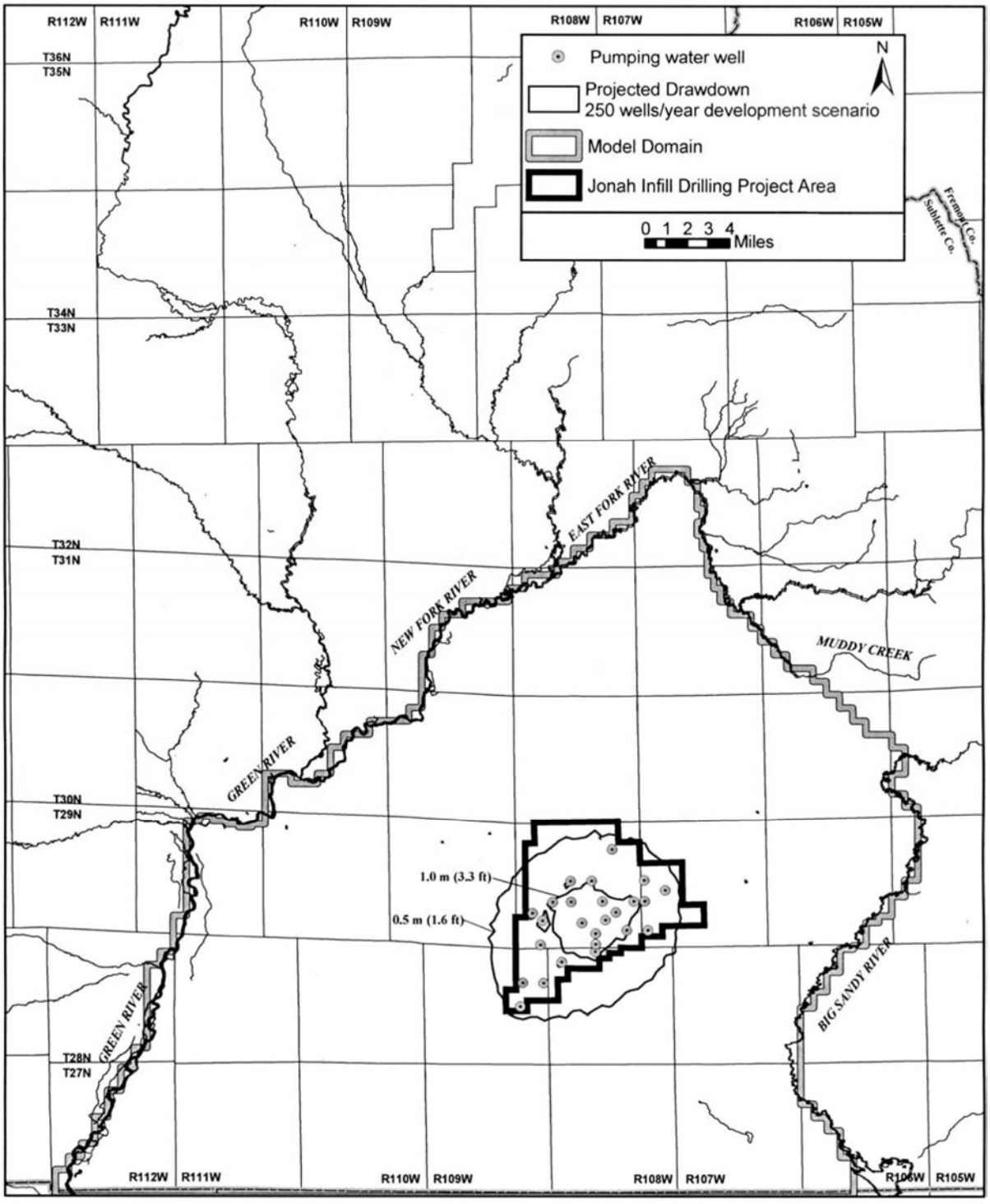
Gas Wells/ Year	Water Need per Gas Well (acre-ft/yr)	Water Need for All Gas Wells (acre-ft/yr)	Length of Drilling Program (years)	Number of Pumping Water Wells	Water per Pumping Well (acre-ft/yr)	Water per Pumping Well (gpm)
75	4.9	367.5	41.3	25	14.7	9.1
250	4.9	1,225.0	12.4	25	49.0	30.4

Groundwater 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 feet in the JIDPA (HydroGeo, Inc. 2004). The results also showed that the aquifer would fully recover within 0.5 to 6 years following the cessation of pumping (Table 4.10). Outside the JIDPA, no notable impacts to surface water or groundwater would occur due to pumping. Groundwater quality would not be impacted as a result of freshwater pumping because the freshwater aquifers from which proposed waters would be obtained are 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 4.10. Groundwater Recovery Time (3,100 Wells), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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
250	12.4	6.0	18.4

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 cleanup program, the scope of which would be determined by WDEQ should a reportable incident occur (see Appendix B).



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.

Gas wells are expected to produce 0.5–10.0 barrels of water per day, which would be disposed of as described in Appendix B. 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 and disposal is not likely to impact the quantity or quality of fresh groundwater. 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 water or groundwater 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 *Onshore Oil and Gas Order No. 7*. Considerable volumes of produced water could be purified and reused to the extent technically and economically feasible for project operations (see Appendix B).

Impacts to surface water resources could be significant under any project alternative, except the No Action Alternative. Under all alternatives, Operators would be required to implement management requirements and mitigation measures (see Appendices A and C); therefore, impacts to surface water also would be relative to the effectiveness of these additional requirements.

No significant impacts to groundwater resources are anticipated under any alternative.

4.1.8.1 No Action Alternative

Under the No Action Alternative, no additional activities would occur that would potentially affect water resources other than those previously approved for the area (BLM 1998b, 2000b)—2,811 acres of short-term and 1,409 acres of LOP disturbance (see Table 2.2), or 9.2% and 4.6% of the JIDPA, respectively. Total disturbance would equal 4,209 acres. Some ephemeral drainages would remain prone to flooding 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 2.1) and until areas are adequately reclaimed. Further groundwater 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 water or groundwater resources (BLM 1998b, 2000b).

4.1.8.2 The Proposed Action

Compared to the No Action Alternative, the Proposed Action would result in an estimated additional 16,200 acres of new 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 4.6). Approximately 70.5% (14,388 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 6,043 acres would be disturbed for the LOP (approximately 76 years and until successful reclamation is achieved); thus, surface water impacts would last approximately 13 years longer than under the No Action Alternative. As a result of this surface disturbance, impacts to surface water could be significant.

Estimates of potential total and LOP disturbance acreages associated with the Proposed Action and each of the alternatives within each project-affected watershed are presented in Tables 4.6 and 4.7. Based on modeled sediment erosion, the Long Draw and Bull Draw watersheds would suffer the greatest impact to surface water resources due to sediment transport and increased salinity. Under the Proposed Action, LOP impacts to these watersheds increases from 1,136 acres under the No Action Alternative to 5,713 acres, or from 13% to 66% of the area of these two watersheds within the JIDPA. However, modeling indicates that runoff from the JIDPA does not reach the Big Sandy River, even during the 150-year event.

Under the Proposed Action, types of impacts to groundwater 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 groundwater would be consumed and more poor-quality water would be produced because more gas wells would be drilled. Under the Proposed Action, the duration of groundwater impacts would be approximately 13 years longer than under the No Action Alternative (i.e., the development phase [see Table 2.1]) plus 6 years required to recharge the aquifer (see Table 4.10).

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 4.6 and 4.7). However, because 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 the Big Sandy watersheds, 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 occur throughout the LOP, would last approximately 13 years longer than under the No Action Alternative, and could be significant.

Implementation of Alternative A is anticipated to result in the same types of impacts to groundwater as described for the Proposed Action.

4.1.8.4 Alternative B

Implementation of Alternative B would result in an estimated additional 3,222 acres of new disturbance above that of the No Action Alternative, for a total of 7,223 acres in the JIDPA (23.7% of the JIDPA) and 208 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under Alternative B would be 7,431 acres (see Table 4.6). Approximately 65.2% (4,848 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 (approximately 42 years). The remaining 2,602 acres would be disturbed for the LOP (approximately 105 years and until successful reclamation is achieved); thus, surface water impacts would last approximately 42 years longer than under the No Action Alternative, depending on the rate of development. These impacts could be significant.

Based on modeled sediment erosion, the Long Draw and Bull Draw watersheds would have the greatest impact to surface water resources due to sediment transport and increased salinity. Under Alternative B, LOP impacts to these watersheds increases from 1,136 acres under the No Action Alternative to 2,050 acres, or from 13% to 24% of the area of these two watersheds within the

JIDPA. However, modeling indicates that runoff from the JIDPA does not reach the Big Sandy River, even during the 150-year event.

Implementation of Alternative B would result in the same types of impacts to groundwater as the No Action Alternative; however, more fresh groundwater 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 groundwater impacts would range from approximately 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 BLM Preferred Alternative

Implementation of the Preferred Alternative would result in an estimated additional 9,821–16,125 acres of new disturbance above that of the No Action Alternative, for a total of 13,822–20,126 acres in the JIDPA (45.3–66.0% of the JIDPA) and 208 acres for ancillary facilities that may be constructed outside the JIDPA. Total disturbance under the Preferred Alternative would be 14,030–20,334 acres (see Table 4.6). If the Operators maximize ongoing reclamation as described in Section 2.4.5, total acres affected would be comparable to that of the Proposed Action (20,334 acres vs. 20,409 acres). However, at any one time, only 14,030 acres would be disturbed under the Preferred Alternative, as successful reclamation would be required for additional disturbance. Disturbance would not occur all at once but would accumulate as development occurs (for approximately 13 years); thus, surface water impacts would last approximately 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 and could be significant; however, impacts are expected to be proportional to the amount of disturbance present at any one time. Potential impacts to surface water from the Preferred Alternative (14,030 acres of disturbance at any one time) would likely be somewhat less than the Proposed Action and Alternative A, where the disturbance at one time would not be regulated. 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 Alternative B, where maximum total disturbance is estimated at 7,431 acres. Impacts are anticipated to be greatest in areas developed with the highest well pad densities.

Based on modeled sediment erosion, the Long Draw and Bull Draw watersheds would have the greatest impact to surface water resources due to sediment transport and increased salinity. Because of concurrent reclamation, the amount of disturbance at any one time within these watersheds is not known. However, modeling indicates that runoff from the JIDPA does not reach the Big Sandy River, even during the 150-year event.

Implementation of the Preferred Alternative would result in the same types of impacts to groundwater as the No Action Alternative. Larger volumes of fresh water would be needed to drill directional wells and more wells would be drilled, so groundwater consumption would be greater than for the No Action Alternative and comparable to the Proposed Action and Alternatives A and B. The duration of groundwater impacts would be approximately 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 2.4.5).

4.1.8.6 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 east of Big Sandy River, 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 4.6). 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 4.6. 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 4.6 and 4.7). 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 in the Expanded Sand Draw-Alkali Creek watershed is estimated to be 3,805 acres (16.6%) under Alternative B. Maximum cumulative disturbance as a result of the Preferred Alternative in the Expanded Sand Draw-Alkali Creek watershed is estimated at 6,775–9,612 acres (29–41.9% of the watershed). The Long Draw watershed, which 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 groundwater includes the JIDPA and adjacent drawdown areas (see Map 4.1). Because no actions other than those proposed for this project are anticipated in the area, cumulative impacts to groundwater would be of the same type and extent as those described for the No Action and action alternatives.

4.1.8.7 Unavoidable Adverse Impacts

Based on the hydrologic modeling, it is anticipated there will be minimal unavoidable adverse impacts to surface water and soils resulting from cumulative events for the LOP. This expectation results from the increase in surface disturbance in watersheds in the JIDPA. These impacts have the potential to reduce water quality in ephemeral drainages during runoff events. On a watershed scale, little impact would be expected on downstream perennial waters.

Project development would require a maximum of approximately 15,200 acre-ft of fresh water from shallow groundwater 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 for some alternatives 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 feet from the source (see Section 3.1.7). These activities are expected to be the loudest proposed noise-producing operations and would continue 24 hours/day at well sites during development periods (see Appendix B). 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 feet from the source and would attenuate at a rate of approximately 6 dBA with each doubling of distance from the source (Table 4.11). 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 3.16.

Table 4.11. Estimated Noise Attenuation with Distance from Construction Equipment, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Distance from Source (feet)	DBA (Example Noise Source)	
50	70 (busy traffic)	90 (endangers hearing)
100	64 (conversation)	84 (noisy factory)
200	58 (conversation)	78 (noisy factory)
400	52 (quite)	72 (busy traffic)
800	46 (library)	66 (busy traffic, conversation)

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.

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, although no additional significant impacts would occur under the No Action Alternative.

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 oil and gas development 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). No additional significant impacts relating to noise and odor are expected under the No Action Alternative.

Once all approved wells are drilled and developed, noise levels would be reduced by limiting sources 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. Significant impacts from noise and odor are anticipated within the JIDPA and vicinity.

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—approximately 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, or approximately 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. Noise and odor impacts would occur for an estimated 76 years and until all reclamation activities are completed, or approximately 13 years longer than under the No Action Alternative. Significant impacts from noise and odor are anticipated within the JIDPA and vicinity.

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 approximately 105 years plus the time required to complete reclamation activities, or approximately 42 years longer than under the No Action Alternative. Significant impacts from noise and odor are anticipated within the JIDPA and vicinity.

4.1.9.5 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 2.4.5). 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 approximately 76 years plus the time required to complete reclamation work, or approximately 13 years longer than under the No Action Alternative.

4.1.9.6 Cumulative Impacts

The CIAA 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 likely would not 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. Significant cumulative 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.

4.1.9.7 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 (Wyoming State Land Use Commission 1979) and Sublette County (Sublette County Board of Commissioners and Sublette County Planning Commission 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) are considered significant if there is 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 results 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 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. (WUS), and riparian areas would be significant if there were a violation of Section 404 of the Clean Water Act or EOs 11988 or 11990 and/or if a BLM RMP or other land use planning objectives could not be achieved. Because 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, WUS, 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 under all action alternatives, with the exception that the Burma Road would not be improved under Alternative B and the BLM Preferred Alternative.

All vegetation types that potentially could be disturbed by project-related development are common throughout the JIDPA and on surrounding lands. No uncommon or unique vegetation types would be impacted by the project. The estimated disturbance volumes to each of the vegetation types in the JIDPA are provided in Table 4.12.

Table 4.12. Vegetation Type Disturbance Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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						
Existing	3,671	375	112	7	44	4,209
LOP	1,229	126	37	2	15	1,409
Proposed Action and Alternative A						
New beyond No Action	14,129	1,445	431	25	170	16,200
LOP beyond No Action	4,039	413	123	7	49	4,631
Alternative B						
New beyond No Action	2,876	294	88	4	35	3,222
LOP beyond No Action	1,058	108	32	2	13	1,193
Preferred Alternative						
New beyond No Action	8,564–14,061	874–1,435	265–435	20–32	98–161	9,821–16,125
LOP beyond No Action	2,492–4,021	254–410	77–124	6–9	28–46	2,858–4,611
Total Acreage in JIDPA	**26,601**	**2,721**	**811**	**47**	**320**	**30,500**

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 considered successful, at which time grasses and possibly forbs would likely become more dominant than under existing conditions, providing increased forage for some wildlife and livestock (see Section 4.5.2). Shrubs may take 30–100 years or longer to reach predisturbance productivity levels and wildlife habitat complexity (Braun 1998, Slater 2003) (see also Section 4.2.2).

The duration of impacts to vegetation communities would depend essentially on two factors: 1) the rate of development (i.e., 75 wells per year under Alternative B or 250 wells per year under the other action alternatives) and 2) the duration of time needed for reclaimed areas to reach predisturbance conditions.

The following analyses show that all the alternatives are generally compatible with BLM management goals/objectives; however, significant impacts to vegetation are also anticipated in the JIDPA through loss of habitat, forage, and soil protection, and increased potential for invasive, non-native species invasion under any alternative except the No Action 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 existing disturbance of which 1,409 acres would be LOP disturbance, or 13.8% and 4.6% of the JIDPA, respectively. The duration of impacts would be approximately 63 years. According to prior evaluations, it is unlikely that the existing project would significantly impact vegetation resources (BLM 1998b, 2000b) (see also Section 3.2.1).

4.2.1.2 Proposed Action

The Proposed Action would result in an estimated increase of 16,200 acres of new surface disturbance. Therefore, total disturbance under the Proposed Action, including existing disturbance, would be 20,409 acres (see Table 2.3). Of these 20,409 acres, 14,388 acres (70.5%) would be reclaimed and revegetated as soon as possible after disturbance. Not all disturbance would occur at one time, but rather would continue over an approximately 13-year period as development proceeds. The magnitude of surface disturbance at any one time would depend on both the amount of disturbed land present and the rate of ongoing reclamation. Approximately 6,043 acres of vegetation would be removed for the LOP (i.e., 76 years and until adequate reclamation is achieved). The surface disturbance anticipated under the Proposed Action would result in significant impacts to vegetation in the JIDPA.

The Expanded Sand Draw-Alkali Creek watershed could experience the greatest level of impacts to vegetation resources from project-related activities. Potential disturbance to this watershed from the Proposed Action could increase from the existing 4.2% of the watershed to 39.5% (see Table 4.7). 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).

The removal of existing vegetation in the project area would, by disturbing soils and removing native plant cover, render habitats more susceptible to invasion by noxious weeds and other undesirable plant species.

Direct impacts to wetlands and WUS would be temporary, resulting from road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 feet of wetlands or open water or within 100 feet of ephemeral or intermittent channels. Indirect impacts to wetlands, WUS, and/or riparian areas could occur as a result of increased sediment deposition in these areas.

4.2.1.3 Alternative A

It is anticipated that implementation of Alternative A would 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 WUS particularly in the Sand Draw area, would likely be greater than under the Proposed Action. The duration of vegetation impacts under Alternative A would be approximately 76 years. The surface disturbance anticipated under Alternative A would result in significant impacts to vegetation in the JIDPA.

4.2.1.4 Alternative B

Implementation of Alternative B would result in an increase of 3,222 acres of new surface disturbance from that of the No Action Alternative, thereby increasing potential impacts to vegetation. There would be 7,431 acres of total disturbance under Alternative B. Approximately 65% (4,848 acres) of this disturbance would be reclaimed and reseeded as soon as practical after disturbance. An estimated 2,602 acres of total LOP disturbance is anticipated for Alternative B. Compared with the No Action Alternative, LOP disturbance to vegetation from this Alternative would increase from 4.6% to 8.5 % of the JIDPA. Disturbance acreages and percentages within affected watersheds are provided in Tables 4.6 and 4.7, respectively. The duration of vegetation impacts under Alternative B is estimated at 105 years. The surface disturbance anticipated under Alternative B would result in significant impacts to vegetation in the JIDPA.

The removal of existing vegetation in the project area would, by disturbing soils and removing native plant cover, render habitats more susceptible to invasion by noxious weeds and other undesirable plant species.

Direct impacts to wetlands and WUS would be temporary, resulting from road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 feet of wetlands or open water or within 100 feet of ephemeral or intermittent channels. Indirect impacts to wetlands and WUS would occur as a result of increased sediment deposition in these areas.

4.2.1.5 BLM Preferred Alternative

Implementation of the Preferred Alternative would limit total surface disturbance in the Jonah Field at any one time to 14,030 acres (see Section 2.4.5). Contingent upon successful reclamation to BLM standards, Operators may receive credit on an acre-for-acre basis for additional surface disturbance up to 6,379 acres, or a maximum total disturbance through the LOP (new plus existing) of 20,334 acres. Total LOP disturbance (i.e., subsequent to interim reclamation) is expected to range from 4,267 to 6,020 acres, depending on how much acreage is successfully reclaimed, credited, and authorized for additional disturbance. Compared to the No Action Alternative, disturbance to vegetation would increase under this alternative to between 32.2% and

46.0% of the JIDPA, or to a total (new plus existing) of between 46.0% and 66.7% of the 30,500-acre project area. LOP disturbance to vegetation would increase to at least 13.9% and not more than 19.7% of the JIDPA. The surface disturbance anticipated under the Preferred Alternative would result in significant impacts to vegetation in the JIDPA.

The removal of existing vegetation in the project area would, by disturbing soils and removing native plant cover, render habitats more susceptible to invasion by noxious weeds and other undesirable plant species.

Direct impacts to wetlands and WUS would be temporary, resulting from road and pipeline crossings. Other proposed facilities (e.g., well pads, water disposal sites) would not be located within 500 feet of wetlands or open water or within 100 feet of ephemeral or intermittent channels. Indirect impacts to wetlands and WUS could 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 2.4.5).

4.2.1.6 Cumulative Impacts

The CIAA for vegetation, including wetlands and WUS, are the 10 watersheds that drain the JIDPA, which together encompass approximately 210,300 acres. Areas east 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 and associated vegetation disturbance for the portion of the CIAA outside the JIDPA is estimated at 594 acres (see Table 4.6), and results 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 is estimated at 168 acres for the North Alkali Draw Watershed; 126 acres for the Southeast New Fork River; 54 acres for the Big Sandy River-Bull Draw; and 18 acres for the Upper Eighteenmile Canyon.

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, Alternative A, and the BLM Preferred Alternative (i.e., the combined existing, proposed, and RFD disturbance) could be on the order of 22,900 acres (10.9%) in the combined watersheds (see Table 4.6). Under Alternative B, maximum cumulative disturbance would be increased from the No Action Alternative to 9,975 acres, 4.8% of the combined watersheds.

Maximum cumulative disturbance would be greatest in the watersheds that drain into the Green River, and disturbance would be greatest in the Expanded Sand Draw-Alkali Creek Watershed (see Tables 4.6 and 4.7).

The Wyoming sagebrush vegetation type, the primary vegetation type in the JIDPA and CIAA (see Tables 3.17 and 3.18 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 be greatest in the Expanded Sand Draw-Alkali Creek watershed, where gas development would continue to be the primary source of the disturbance. Maximum cumulative disturbance to vegetation in the Expanded Sand Draw-Alkali Creek Watershed is estimated at 2,355 acres (10.3% of the watershed) under the No Action Alternative, 9,612 acres (41.9% of the watershed) under the Proposed Action and Alternative A, 6,775 to 9,612 acres (29.5% to 41.9% of the watershed) under the Preferred Alternative, and 3,805 acres (16.6%) under Alternative B. The Long Draw Watershed, which drains 16% of the JIDPA, would experience the next greatest amount of cumulative disturbance to vegetation. The closed basin watersheds—Jonah Gulch and 140401040603—would likely only experience a small amount of cumulative disturbance to vegetation resources.

Within the CIAA, riparian and wetland habitats are primarily found along drainages and at ponds and reservoirs. Existing adverse impacts within these habitats include roads, livestock grazing, and recreational use. Wetlands, WUS, and riparian areas would be avoided where possible during implementation of this and other proposed projects in the area, so no significant direct impacts to these resources are anticipated. 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 because all future development activities would comply with Section 404 of the Clean Water Act and EO 11990.

4.2.1.7 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 in the JIDPA and would thereby render habitats more susceptible to invasion by noxious weeds and invasive species.

Because 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 (Wyoming State Land Use Commission 1979) and Sublette County (Sublette County Board of Commissioners and Sublette County Planning Commission 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 compromised the above management objectives, and significant impacts to most wildlife species on the JIDPA are anticipated under all project alternatives. Specific impacts that 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, and 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, impacts to wildlife on and adjacent to the JIDPA would not affect BLM's ability to manage these resources pursuant to RMP objectives.

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 permanent surface waters, the absence of activities that contribute to 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 new and LOP disturbance or loss of habitat function. When sagebrush habitats are degraded, vegetation reestablishment may take many years. Wyoming big sagebrush habitats may require 30–100 years or more to recover to approximate predisturbance habitat characteristics (Braun 1998, Slater 2003). Therefore, habitat functionality, particularly for nesting species, on disturbed areas may not be achieved for more than 100 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 timeframe.

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 by using GIS technology to draw buffers of various widths around roads, pipeline ROWs, well pads, and other project-related disturbances.

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 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 buffer distances (i.e., 0.5 mile, 0.25 mile, 0.125 mile, and 0.063 mile) from existing and/or possible project disturbance at various well densities (16, 32, and 64 wells per 640-acre section), an estimate of total acreage and numbers and average sizes of core areas within the JIDPA under a variety of development scenarios has been analyzed. The modeling results are provided in Tables 4.13 and 4.14 and Maps 4.2 through 4.5. Although it is suspected that some species in the area (e.g., greater sage-grouse and 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.

Table 4.13. Percent of the JIDPA Contained within Core Areas for Existing Conditions and Selected Possible Development Scenarios, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

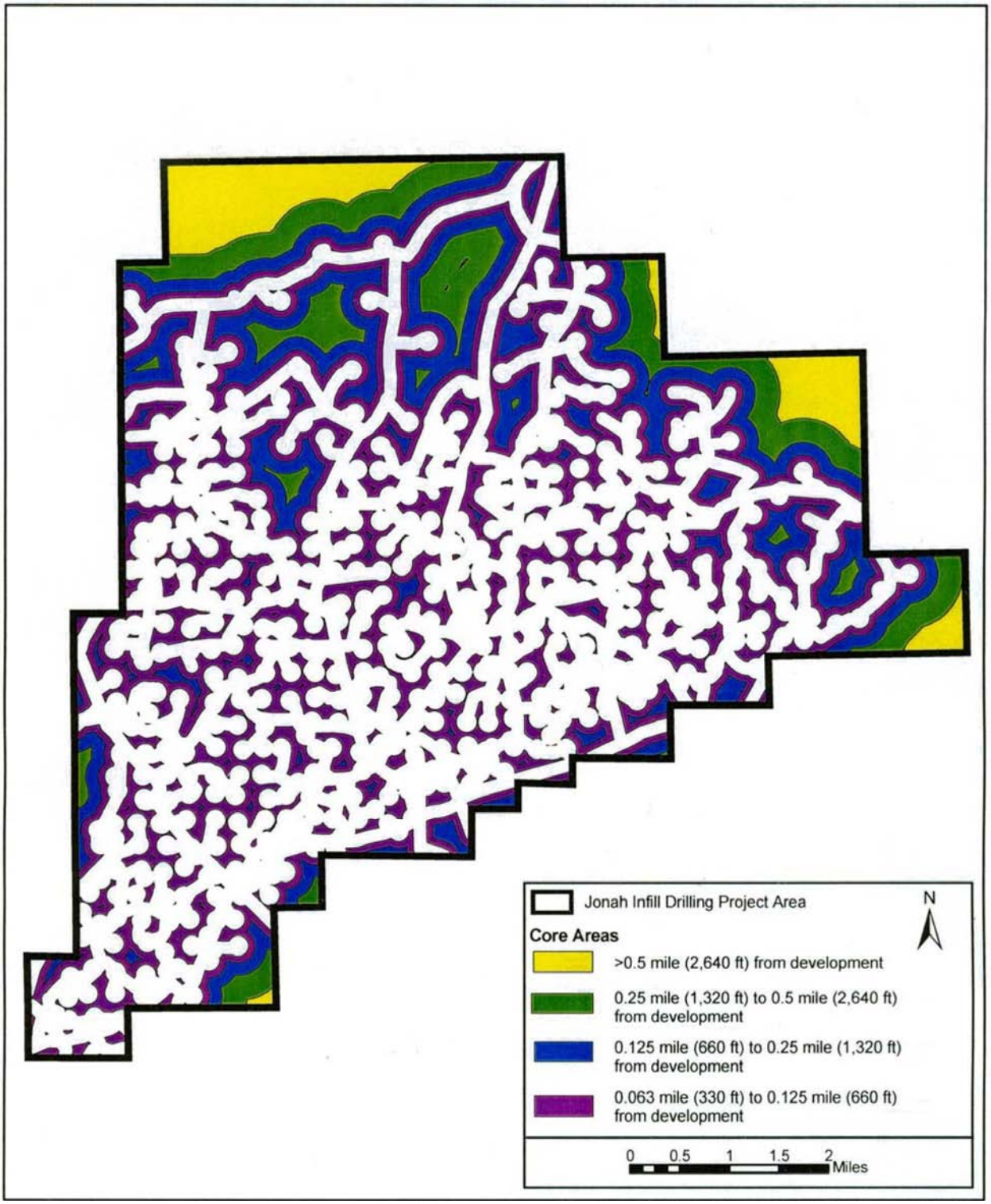
Disturbance Buffer	Percent of JIDPA in Core Areas (%)			
	Existing Conditions	16 Wells/Section	32 Wells/Section	64 Wells/Section
0.063 mile	45.3	28.6	10.10	2.10
0.125 mile	24.3	2.7	1.00	0.80
0.25 mile	12.6	0.2	0.04	0.02
0.5 mile	5.2	0	0	0

[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).

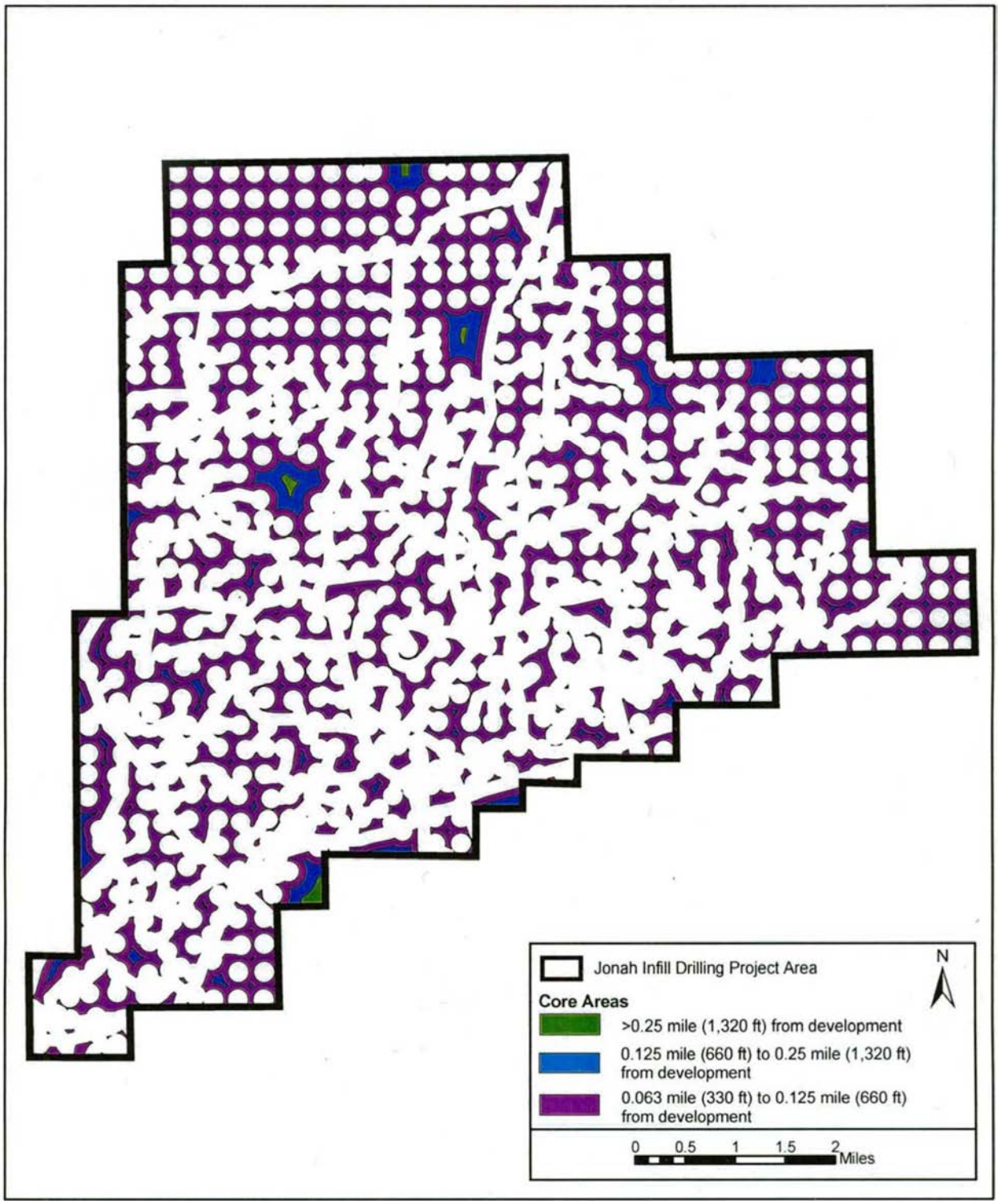
Table 4.14. Number and Mean Size of Core Areas in the JIDPA for Existing Conditions and Possible Development Scenarios, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Disturbance Buffer	Number/Mean Size of Core Areas (acres)			
	Existing Conditions	16 Wells/Section	32 Wells/Section	64 Wells/Section
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

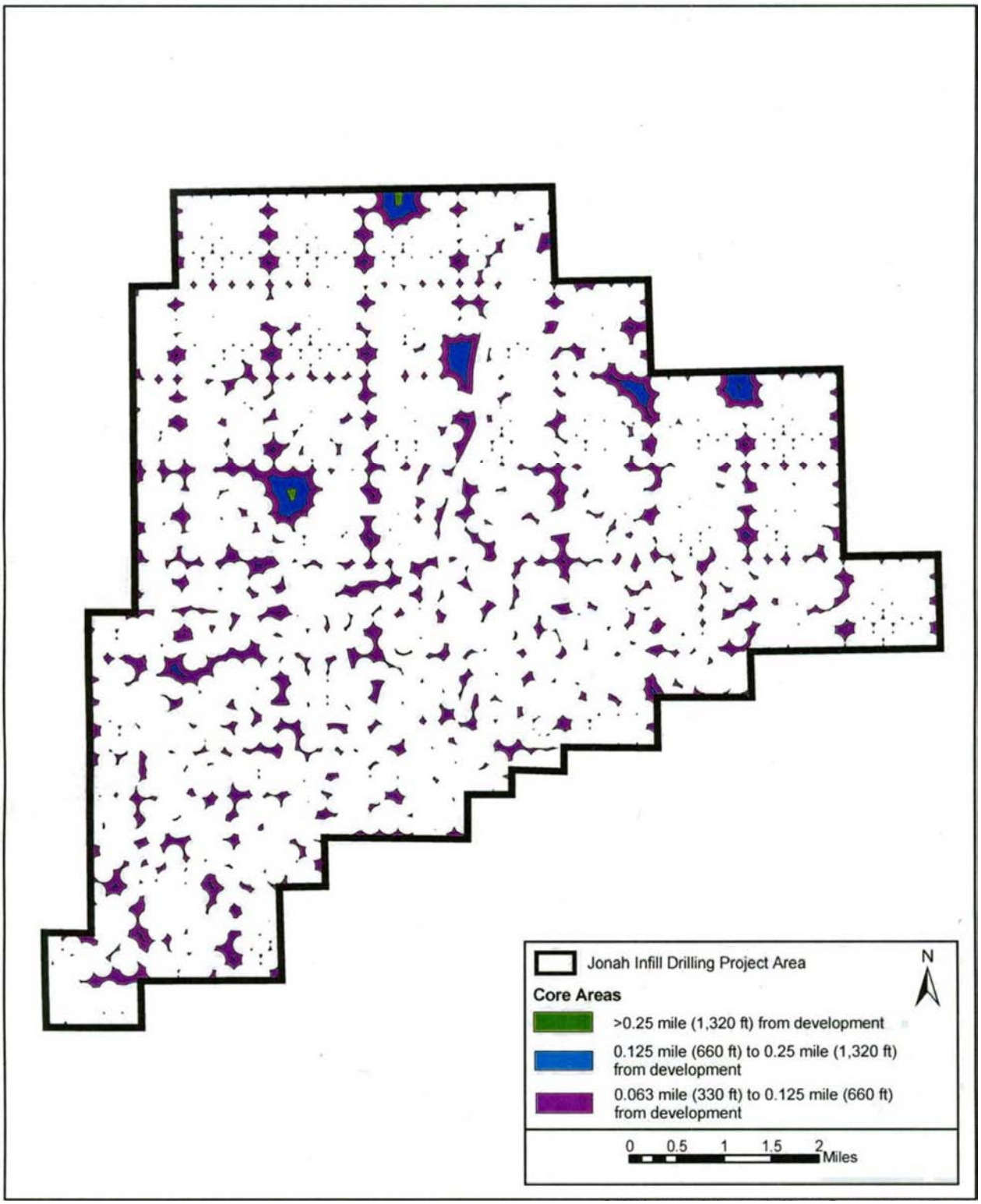
Impacts specific to species or groups of species are described in the following sections. Significant impacts are anticipated under all alternatives (including the No Action Alternative), but would vary in degree as discussed in Sections 4.2.2.1 through 4.2.2.6. Existing and BLM-proposed mitigation for many wildlife species may be inadequate to reduce impacts to less than significant levels in the JIDPA.



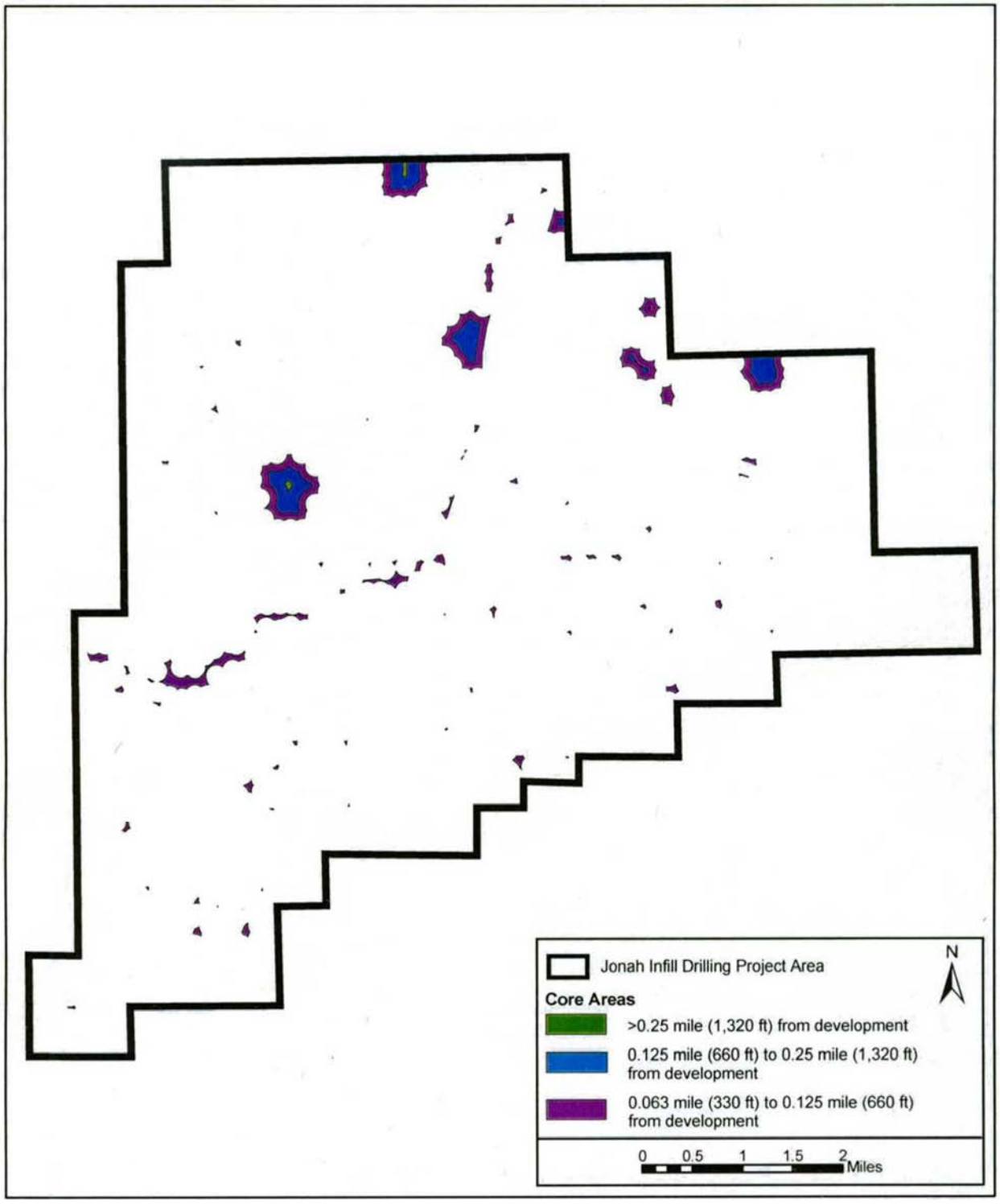
Map 4.2. Existing Wildlife Habitat Fragmentation (No Action), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.



Map 4.3. Wildlife Habitat Fragmentation Expected Under Development at 16 Wells per Section (Alternative E), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.



Map 4.4. Wildlife Habitat Fragmentation Expected Under Development at 32 Wells per Section (Alternative F), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.



Map 4.5. Wildlife Habitat Fragmentation Expected Under Development at 64 Wells per Section (Alternative G), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Pronghorn Antelope

Surface disturbance (both short-term and LOP) would result in the direct loss of spring/summer/fall pronghorn habitat within the Sublette Herd Unit. This would include 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 7,938 square miles of occupied habitat (spring/summer/fall/winter combined), depending on the alternative. No crucial pronghorn habitats would be disturbed in the JIDPA as a result of the proposed project. Upgrading the Burma Road in the Proposed Action and Alternative A would have negligible effects on crucial winter pronghorn habitat. Approximately 65–71% (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 29–35% of the disturbance acreage 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 more than 100 years to reach predisturbance productivity and structure levels (Braun 1998, Slater 2003). 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 indirectly affect utilization of habitats adjacent to development areas. Depending on the severity of these indirect impacts, pronghorn displacement distance could be about 0.5 mile (Gusey 1986, Guenzel 1987, Easterly et al. 1991). However, as noise and human presence are reduced (e.g., during production operations), pronghorn likely would increase their use of otherwise suitable habitats, 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 and 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 noise 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. However, no peer-reviewed scientific literature exists to assess possible energy-related effects on migration of the Sublette Herd Unit (Berger 2003). 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-foot or 1,000-foot 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

Disturbance of breeding, nesting, brood-rearing, and wintering greater sage-grouse and their habitats would increase from that currently occurring in the JIDPA as a result of increased habitat removal and noise and traffic associated with increased 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 habitat), 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, even though lek availability is not considered to be a limiting factor for sage-grouse (USFWS 2005d). 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.

Although greater sage-grouse still use the JIDPA, the direct and indirect impacts of previous developments in the JIDPA may have already rendered the area unsuitable for long-term 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 (Braun 1998, Slater 2003). 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, restoring up to 20% of degraded nesting and early brood-rearing habitats and 30% of the winter habitat may improve habitat conditions. Restoration treatments may consist of providing 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 ineffective to mitigate habitat loss by restoring vegetation because the temporary loss of nesting and roosting habitat and decreased food availability during treatment and mitigation creates an unacceptable level of impacts to greater sage-grouse (Connelly et al. 2000). 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). Because 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 in 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. Although information is not available regarding minimum sagebrush patch sizes required by sage-grouse (USFWS 2005d), maintaining large, continuous tracts of suitable habitat protected from disturbance is likely 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 identification 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 development 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). Secondary impacts would include temporary displacement from potentially suitable habitat resulting from human disturbance. Approximately 65-71% of new 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 more than 100 years to achieve desirable habitat characteristics (e.g., canopy height, coverage, and area) (Braun 1998, Slater 2003). 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 habitat disturbed. Total surface disturbance in the JIDPA would be up to 67% (depending on the alternative). However, 65-71% of that disturbance would be short term, and wetlands and WUS 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 habitat lost, both directly (see Section 4.2.1) and indirectly, and the duration of the 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 greater sage-grouse nesting, brood-rearing, and wintering in the area, and inactivity and failure of some raptor nests and/or nesting territories (particularly for ferruginous hawks). These existing impacts to wildlife species and their habitats would be exacerbated with the implementation of the alternatives and the accompanying direct and indirect disturbances.

The degree of current habitat fragmentation within the JIDPA is high, with 87.40% of the lands in the JIDPA being within 0.25 mile (1,320 feet) of project-related disturbance and 75.70% of the lands being within 0.125 mile (660 feet) (see Table 4.13). Depending on the alternative, up to 99.98% of the JIDPA would be within 0.25 mile (1,320 feet) of project-related disturbance, and up to 99.20% would be within 0.125 mile (660 feet). 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 (see Table 4.14). 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 (direct habitat loss, temporary or permanent displacement from existing habitat resulting from human disturbance, and habitat fragmentation) are significant to the majority of wildlife species within the JIDPA and on adjacent lands under all alternatives.

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 quality, 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. The project would not result in any changes to existing migration bottlenecks outside the JIDPA.

4.2.2.1 No Action Alternative

Direct wildlife habitat loss resulting from 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 direct or indirect impacts to wildlife species from natural gas development would occur in the JIDPA because no additional habitat disturbance would be approved beyond levels listed above. No further habitat fragmentation or displacement would occur beyond current levels (see Map 4.2 and Tables 4.13 and 4.14); however, considerable habitat fragmentation already exists in the JIDPA, and the area may no longer be suitable for the long-term sustainability of some wildlife species. Impact duration would be approximately 63 years plus the time needed for successful reclamation. Impacts to most wildlife species on the JIDPA would be significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated.

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 disturbance, which when combined with existing disturbance, would result in a total of 20,409 acres of project-related surface disturbance. All of the new 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 7,938 square miles of all potential habitat (spring/summer/fall/winter combined). Approximately 70.4% of the total impact area (14,388 acres) would be short-term disturbance. The remaining 29.6% (6,043 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 indirectly affect utilization of habitats adjacent to development areas. However, selected Operator-committed and BLM-required practices for the avoidance of sensitive areas would be implemented. Impact duration would be approximately 76 years plus the time needed for successful reclamation, or approximately 13 years longer than the No Action Alternative. Impacts to most wildlife species on the JIDPA would be significant.

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., 16,200 acres of new disturbance and 4,631 acres of LOP 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-foot 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 feet of project disturbance. Impact duration would be approximately 76 years plus the time needed for successful reclamation, or approximately 13 years longer than the No Action Alternative. Impacts to most wildlife species on the JIDPA would be significant.

4.2.2.4 Alternative B

Alternative B would result in an estimated increase (over the No Action Alternative) of 3,222 acres of new disturbance, for a total of 7,431 acres of project-related surface disturbance in the area. Approximately 65% (4,848 acres) of the total disturbance would be short term, and the remaining 35% (2,602 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, roads, or gathering pipelines. Habitat fragmentation would not increase significantly relative to the No Action Alternative (see Map 4.2). Impact duration would be approximately 105 years plus the time needed for successful reclamation, or approximately 42 years longer than the No Action Alternative. Impacts to most wildlife species on the JIDPA would be significant.

4.2.2.5 BLM Preferred Alternative

The Preferred Alternative would result in an increase (over the No Action Alternative) of a minimum of 9,821 and a maximum of 16,125 acres of new surface disturbance. Approximately 71% (6,971 to 11,577 acres) of the total disturbance would be short term, and the remaining 29% (2,858 to 4,611 acres) would remain disturbed for the LOP (see Table 2.5). Because the specific locations of future well pads are unknown, habitat fragmentation cannot yet be evaluated. Impact duration would be approximately 76 years plus the time needed for successful reclamation, or approximately 13 years longer than the No Action Alternative (see Table 2.1). Impacts to most wildlife species on the JIDPA would be significant.

Total disturbance would be comparable to that of the Proposed Action if the Operators maximize ongoing reclamation as described in Section 2.4.5 (i.e., 20,234 acres vs. 20,409 acres). However, 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 2.4.5). These measures would moderate, to some extent, anticipated impacts to wildlife species.

4.2.2.6 Cumulative Impacts

CIAAs for wildlife and fisheries vary by resource. While the principal 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 to CIAAs under the five alternatives discussed herein can be ranked based on new and LOP disturbance acreages, with the following caveats.

- Although new 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.

The Proposed Action and Alternative A would result in the most surface disturbance within the JIDPA (i.e., 20,409 acres new and 6,043 acres LOP disturbance). If the Operators maximize ongoing reclamation as described in Section 2.4.5, total acres affected under the Preferred Alternative would be almost as high (20,334 acres). However, under the Preferred Alternative total surface disturbance at any given time would be limited to a maximum of 14,030 acres, whereas the maximum disturbance at one time would be unregulated under the other alternatives. Alternative B has the lowest anticipated disturbance acreage of any of the action alternatives, with 7,431 acres of new disturbance and 2,602 acres of LOP disturbance. Under the No Action Alternative, disturbance would be limited to that already approved—4,209 acres total and 1,409 acres LOP disturbance.

Pronghorn Antelope

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 and will continue to redistribute spatially, and that 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 keeping them open is 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 construction may further restrict pronghorn movement and further fragment habitat. None of the alternatives would adversely affect known pronghorn crucial winter range or bottlenecks beyond a negligible degree; therefore, they would not contribute to cumulative impacts to these habitat features.

Under the Preferred Alternative, between 1.6% and 1.7% 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. The Proposed Action and Alternative A would be similar to the maximum allowable impact under the Preferred Alternative; these alternatives would result in approximately 1.7% disturbance to spring/summer/fall range in the Sublette Herd Unit. Based on these relatively low levels of disturbance, it is not anticipated that any of these alternatives would 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 4.15). Indirect habitat loss (loss of habitat function resulting from human disturbance) would occur on an additional but unknown amount of land. The magnitude of these indirect impacts on the Sublette Herd Unit is unknown and cannot be predicted (WGFD 2001); however, these impacts are not anticipated to be cumulatively significant.

Furbearers, Small Game, and Other Mammals

The CIAA for furbearers, small game, and other mammals 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 4.15). 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 associated with 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 predator species (e.g., raptors, foxes, coyotes, badgers, etc.) that depend on small mammal populations for prey. Cumulative disturbance within the Jonah Wildlife Study Area CIAA would range from 4.2% to 12.8% of the area, with up to 12.7% disturbance under the Preferred Alternative (see Table 4.15). Impacts generally would be in proportion to the amount of direct habitat loss and are anticipated to be less than significant.

Raptors

The CIAA for raptors is depicted in Map 3.16.

RFD disturbance in the CIAA includes 2,862 acres (see Table 4.15) and is primarily associated with natural gas development described for the Pinedale Anticline Project. Between 10.1% and 11.5% of the CIAA would be disturbed depending on the alternative—up to 11.5% would be disturbed under the Preferred Alternative (see Table 4.15).

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 it is likely that mitigation opportunities will continue to identified in the future.

Raptors using the JIDPA and CIAA for nesting and foraging would likely experience continued adverse effects, which could lead to reductions in the regional reproductive success of raptors in the CIAA. These adverse effects are anticipated to be cumulatively significant.

Table 4.15. Potentially Disturbed Acreage in Each Wildlife CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Cumulative Impact Analysis Area (CIAA)	Total Acreage of CIAA	Existing Disturbance in CIAA, outside JIDPA	RFD	Disturbance											
				No Action			Proposed Action and Alternative A			Alternative B			Preferred Alternative		
				JIDPA total	LOP	Cumulative[1]	JIDPA total	LOP	Cumulative[1]	JIDPA total	LOP	Cumulative[1]	JIDPA total	LOP	Cumulative[1]
Sublette Antelope Herd Unit	6,727,270	80,791	12,000	4,209	1,409	97,000	20,409	6,043	113,200	7,431	2,602	100,222	14,030–20,334	4,267–6,020	106,821–113,125
Percent of Entire CIAA		0.01				1.4			1.7			1.5			1.6–1.7
Jonah Wildlife Study Area	188,888	2,729	1,014	4,209	1,409	7,952	20,409	6,043	24,152	7,431	2,602	11,174	14,030–20,334	4,267–6,020	17,773–24,077
Percent of Entire CIAA		1.4				4.2			12.8			5.9			9.4–12.7
Raptors	1,184,443	113,092	2,862	4,209	1,409	120,163	20,409	6,043	136,363	7,431	2,602	123,385	14,030–20,334	4,267–6,020	129,984–136,288
Percent of Entire CIAA		9.5				10.1			11.5			10.4			10.9–11.5
Greater Sage-grouse	1,061,805	28,767	1,716	4,209	1,409	34,692	20,409	6,043	50,892	7,431	2,602	37,914	14,030–20,334	4,267–6,020	44,513–50,817
Percent of Entire CIAA		2.71				3.2			4.8			3.6			4.2–4.8

[1] Cumulative disturbance = outside JIDPA + RFD + JIDPA total

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 4.15). Depending on the alternative, disturbance within the CIAA would range from 3.2 to 4.8% of the area; disturbance under the Preferred Alternative would be up to 4.8%.

The proposed project and RFD likely would result in some disturbance to nesting, brood-rearing, and wintering greater sage-grouse. Although the magnitude of the impact resulting from that disturbance is unknown, it is anticipated that the impact would contribute to the decline in regional greater sage-grouse populations and therefore be cumulatively 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 the 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 to amphibians and reptiles 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 to fisheries would not be significant. See Section 4.1.8.6 and Table 4.6 for further information regarding cumulative disturbance within these watersheds.

4.2.2.7 Unavoidable Adverse Impacts

Unavoidable impacts to wildlife would include habitat loss, due to both direct surface disturbance/vegetation removal, and reduction in habitat quality due to project-related activities such as increased traffic, noise, and human presence. Some direct 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 (Wyoming State Land Use Commission 1979) and Sublette County (Sublette County Board of Commissioners and Sublette County Planning Commission 2003) identify the following management goals/objectives associated with wildlife and fisheries, including BLM Wyoming Sensitive Species (BWS). These goals/objectives are also relevant for TEP&C 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 federal TEP&C species would be considered significant if any project action adversely affected or jeopardized these species or their critical habitat and/or any recovery program. Impacts to BWS species would be significant if project activities contributed to the federal listing of any BWS species. BLM prepared a Biological Assessment of potential impacts of the JIDP on federally listed species and submitted it to the USFWS on October 25, 2005, with a request for formal consultation on the Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker. In a letter dated December 16, 2005, the USFWS agreed to initiate formal consultation on the potential effects of the JIDP (see Appendix H). The USFWS expects to issue a Biological Opinion in January 2006.

4.2.3.1 Threatened, Endangered, Proposed, and Candidate Species

None of the alternatives are likely to adversely impact black-footed ferret, bald eagle, or Ute ladies'-tresses given their current absence from the JIDPA (see below) and the implementation of appropriate mitigation measures (see Chapter 2 and Appendices A and B). However, project-related groundwater depletions may adversely affect the four endangered fishes (Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker).

Black-footed Ferret

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, formal consultation would be initiated with the USFWS to ensure their protection and management.

Bald Eagle

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.

Fish

The four species of endangered fish present in the Green and Colorado Rivers below Flaming Gorge Dam would not be affected by sedimentation from any alternative because sediment traps and catchments are proposed for the Jonah Field, and the Fontenelle and Flaming Gorge Reservoirs would serve as macro-scale traps/catchments for any turbidity or sedimentation that may reach the Green River. However, 1,225 acre-ft of groundwater a year would be pumped under three alternatives (the Proposed Action, Alternative A, and the Preferred Alternative), and 367.5 acre-ft a year would be pumped under Alternative B. According to the Biological Assessment prepared for the JIDP, "no data collected … prove that [these] water depletions are not connected to the Colorado River system"; therefore, the groundwater depletions my result in depletions of surface waters occupied by Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker and may indirectly and adversely affect these species. Mitigation would be in the form of paying a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

Ute Ladies'-tresses

Ute ladies'-tresses habitat is not known to occur nor is the species likely to occur within the JIDPA.

4.2.3.2 BLM Wyoming Sensitive Species

Significant impacts to several BWS species, most notably to sagebrush-obligate species, are anticipated within the JIDPA under all alternatives. However, these impacts are not expected to contribute to the federal listing of any BWS species.

Impacts to BWS animal species generally would be similar to those described for wildlife (see Section 4.2.2), whereas impacts to 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.

Mammals

The best habitat areas for the 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, prairie dogs may to some degree adapt to the human presence/disturbance associated with the proposed project. Nevertheless, populations of these mammals in the JIDPA would likely decline in the long term due to continued habitat loss, habitat fragmentation, and direct mortality.

Birds

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 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 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.

Sagebrush obligate species (i.e., sage thrasher, Brewer's sparrow, and sage sparrow) likely would be adversely affected due to habitat loss/disturbance. This impact is anticipated to be significant under all alternatives. Ingelfinger (2001) reported a 50–60% reduction in sagebrush obligates within 100 meters 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 that 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.

4.2.3.3 No Action Alternative

Currently, a total of 4,209 acres of existing 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.

4.2.3.4 The Proposed Action

The Proposed Action would result in an estimated increase (over the No Action Alternative) of 16,200 acres of new surface 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 (14,388 acres) would be reclaimed and reseeded as soon as practical after disturbance (i.e., short-term disturbance). The remaining 29.6% (6,043 acres) would remain disturbed for the LOP. Impact duration would be approximately 76 years plus the time needed for successful reclamation, or approximately 13 years longer than the No Action Alternative.

Potential indirect impacts to Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker of pumping 1,225 acre-ft of groundwater a year would be offset by payment of a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

4.2.3.5 Alternative A

Implementation of Alternative A would result in the same types and acreages of impacts to BWS species as the Proposed Action (i.e., an increase of 16,200 acres [11,577 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. Impact duration would be approximately 76 plus the time needed for adequate reclamation, or approximately 13 years longer than the No Action Alternative.

Potential indirect impacts to Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker of pumping 1,225 acre-ft of groundwater a year would be offset by payment of a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

4.2.3.6 Alternative B

Alternative B would result in an estimated increase over the No Action Alternative of 3,222 acres of new disturbance, for a total of 7,431 acres of project-related surface disturbance in the area. All disturbance would occur in habitats used by BWS species. Approximately 65% (4,848 acres) of the total disturbance would be short term, and the remaining 35% (2,602 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, roads, or gathering pipelines. Impact duration would be approximately 105 years plus the time needed for adequate reclamation, or approximately 42 years longer than the No Action Alternative.

Potential indirect impacts to Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker of pumping 367.5 acre-ft of groundwater a year would be offset by payment of a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

4.2.3.7 BLM Preferred Alternative

The Preferred Alternative would result in an estimated increase over the No Action Alternative of at least 9,821 and not more than 16,125 acres of new surface disturbance. All disturbance would occur in habitats used by BWS species. Approximately 71% (6,971 to 11,577 acres) of the new

disturbance would be short term, and the remaining 29% (2,858 to 4,611 acres) would remain disturbed for the LOP (see Table 2.5). Total surface disturbance at any given time would be limited to a maximum of 14,030 acres. Impact duration would be approximately 76 years plus the time needed for adequate reclamation, or approximately 13 years longer than the No Action Alternative.

The additional Preferred Alternative-specific mitigation and monitoring measures listed for vegetation and wildlife (see Section 2.4.5) would moderate, to some extent, any impacts to BWS species. Impacts still would occur at potentially significant levels for most, if not all BWS species identified as occurring in the JIDPA. Potential indirect impacts to Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker of pumping 1,225 acre-ft of groundwater a year would be offset by payment of a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

4.2.3.8 Cumulative Impacts

The CIAA for TEP&C and BWS species includes the entire range of each species in the BLM PFO area. With regard to federally listed TEP&C species, it is unlikely that any of the alternatives would contribute to cumulative impacts to black-footed ferrets, Ute ladies' tresses, or bald eagles. Neither black-footed ferrets nor Ute ladies' tresses are 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 action alternatives may add to cumulative impacts for the four Colorado River endangered fish species as a result of water reductions in the Green and Colorado Rivers; any potential for indirect affect from groundwater pumping for the JIDP would be offset by payment of a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program.

Project-related impacts to BWS species would add to existing impacts from other disturbances in the CIAA, including existing roads and traffic, oil and gas development, grazing, and other activities resulting in direct mortality, habitat fragmentation, or loss of habitat quality. However, there is no evidence that any of the species would be proposed for listing as threatened or endangered as a result of any cumulative impacts under any of the project alternatives. Site-specific projects requiring surface disturbance on BLM lands require additional permitting which, in turn, may include mitigation measures for BWS similar to those for this project (see Appendices A and B).

4.2.3.9 Unavoidable Adverse Impacts

Habitat loss (direct and indirect) would occur due to construction, and human presence would further reduce habitat quality 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 (Wyoming State Land Use Commission 1979), and Sublette County (Sublette County Board of Commissioners and Sublette County Planning Commission 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 were a reduction in AUMs of a magnitude that required modification to the management of wild horses in the Little Colorado Herd Management Area (LCHMA) (see Map 3.20), if an action prevented the realization of herd objectives, or if project disturbance resulted in a violation of RMP wild horse objectives.

Although there would be potential impacts to wild horses, it is unlikely that any of the alternatives would result in impacts that would be considered significant in terms of jeopardizing the aforementioned management goals/objectives. There would likely be an increase in wild horse displacement, including movement of wild horses off the RSFO LCHMA onto the PFO portion of the JIDPA (through damaged fences or open gates), resulting in the potential for more injuries as a result of encounters with project facilities (e.g., cattle guards, traffic). Direct impacts would result primarily from vegetation loss. Impacts to wild horse viewing are also anticipated under all alternatives because the quality of views (i.e., views set within an oil and gas development background) would be reduced. The reclamation measures proposed to ensure successful revegetation (see Appendix B) and other practices identified in Appendices A and C would help ensure that none of these impacts are significant.

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 based on the proposed rate of development and the time period until affected areas are effectively reclaimed.

4.2.4.2 The Proposed Action

The Proposed Action would result in 2,415 acres of new disturbance (715 acres of LOP disturbance) within the LCHMA, decreasing forage for wild horses in the short term. The extent of forage loss depends on the results of reclamation efforts (see the discussion of effects on livestock grazing in Section 4.5.2). Wild horses would be displaced due to human presence, and the probability of potential vehicle/animal collisions would increase. Impact duration is anticipated to be approximately 76 years (approximately 13 years over the No Action Alternative) plus the time required for effective reclamation.

4.2.4.3 Alternative A

Implementation of Alternative A would result in the same types of impacts as all other action alternatives; however, impacts would be increased in areas that would otherwise have been avoided (e.g., steep slopes, drainage buffers). Impact duration would be the same as for the Proposed Action.

4.2.4.4 Alternative B

Compared to the Proposed Action, loss of forage for wild horses would be lower under Alternative B because this alternative would result in less new disturbance (867 acres) and LOP disturbance (305 acres) within the LCHMA. Wild horses would be displaced due to human presence, and the probability of potential vehicle/animal collisions would increase compared to the No Action Alternative. Impact duration would be approximately 105 years plus the time required for effective reclamation.

4.2.4.5 BLM Preferred Alternative

Impacts under the Preferred Alternative would be similar to those under the Proposed Action, except additional mitigation and monitoring measures would be implemented to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.4.5).

4.2.4.6 Cumulative Impacts

The CIAA for wild horses is the entire LCHMA (see Map 3.20). Existing developments in the LCHMA area are generally limited to secondary roads and natural gas infrastructure. Existing, proposed, and RFD 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 because 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 under all alternatives where horses are observed in areas of development.

4.2.4.7 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; and

- 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 further cultural heritage by protecting most cultural properties from significant damage, increasing cultural resource site databases, and furthering the understanding of history and prehistory. Impacts to historic and cultural resources would be considered significant if they resulted in non-mitigated impacts to National Register-eligible properties, diminishment of the aspects of site integrity, 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. Application of various mitigation protocol (see Appendices A and C) 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.

The greatest identifiable threats to cultural resources result from increased ground disturbance. Overall impacts to cultural resources would primarily occur in direct proportion to the volume of new surface disturbance. More acres of disturbance would generally make cultural property avoidance more difficult, would increase the need for cultural site mitigation, and 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, such as the Shoshone People. Vandalism and illegal collection impacts would occur in relative proportion to the amount of human use on the area.

Because of the requirement for cultural resource inventories in new disturbance areas, a large number of cultural properties would also 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 the understanding of the culture history of the region. However, this would not be true for cultural resources on State of Wyoming lands. 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 cooperative State of Wyoming land development protocol for addressing cultural resources, such as might be established through a Programmatic Agreement, could the avoidance of significant adverse impacts to cultural resources on state lands be assured.

While avoidance of NRHP eligible sites would likely remain the primary tool to minimize potential adverse effects to cultural resources, a high degree of new development is proposed for the JIDPA, with much of this development likely to occur in geomorphologically sensitive areas with high archaeological site discovery potential, and project-by-project avoidance would prove to be increasingly difficult and time-consuming. Because 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 numbers of unanticipated archaeological discoveries would also increase. Such unexpected discoveries are currently being handled on a case-by-case

basis under the general direction of 36 CFR 800.13. Consultation involves the Operators, BLM, Wyoming SHPO, and other interested parties. Under all project development alternatives, a greater number of construction projects would be delayed due to cultural resource 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 resource discovered, 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, timeframes 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 shutdown 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.

Overall, impacts to cultural resources not identified during surveys for cultural resources, such as arising from an archaeological discovery situation (cultural materials found during and not prior to surface-disturbing activities), could be greater and more significant than impacts to resources that were previously identified. This is because damage to discovery sites would occur prior to the site being either recorded or evaluated, thereby complicating cultural resource mitigation procedures. The most significant and time-consuming mitigation of archaeological discoveries would likely be when subsurface components containing extensive or abundant artifact assemblages are located during large disturbances and for sites with structural or human remains in San Arcacio soil contexts, as occur along Sand Draw. Mitigation of impacts to archaeological discovery sites 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 not appropriately mitigated).

Subsurface prehistoric site discoveries resulting from construction are common in portions of the JIDPA, and more of these discoveries are likely to occur with continued development. Archaeological discoveries most often 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 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 moving further proposed surface disturbances or through appropriate mitigation. Any cultural resources discovered during project construction would be treated in accordance with 36 CFR 800 and the statewide protocol.

Adverse impacts to other NRHP-eligible properties, especially properties considered important to Native American groups, would be significant under all alternatives if they cannot be satisfactorily mitigated as determined through consultation with SHPO and other interested parties. Previous 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, such as the Shoshone People in particular.

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.

Overall, vandalism to cultural properties and illegal artifact collection would continue to be an issue in the JIDPA under all alternatives. 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 directly 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. For the JIDPA overall, vandalism may be minimized through law enforcement, site monitoring activities, and educational programs.

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 expiration of the Programmatic Agreement ratified in 1998, significant impacts have occurred and, while most cultural resource impacts have already occurred and been largely mitigated, 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 20,126 acres (66% 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, compressor stations). This equates to a total disturbance of 20,409 acres and 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 (approximately 13 years), but would continue for approximately 76 years and until project personnel are no longer required for the LOP.

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 (approximately 13 years), but the duration of these impacts would continue for the LOP (approximately 76 years).

4.3.4 Alternative B

Under Alternative B, approximately 7,223 acres of the JIDPA would be directly impacted by surface-disturbing activities, and an additional 208 acres of disturbance would occur at locations outside the JIDPA (e.g., , compressor stations). 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) because pad locations are fixed. Vandalism and artifact collection would likely be greatest during development (approximately 42 years), but duration of these impacts would continue for the LOP (approximately 105 years).

4.3.5 BLM Preferred Alternative

Under the Preferred Alternative, approximately 13,822–20,126 acres of the JIDPA (45.3–66.0%) would be directly impacted by surface-disturbing activities, and an additional 208 acres of disturbance would occur outside the JIDPA. An average disturbance of 290–423 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 (5,612–11,916 acres more than No Action). Vandalism and illegal artifact collection would likely be greatest during the development period (approximately 13 years) but would continue for the LOP (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 2.4.5). Any measure that reduces the volume of surface disturbance or the level of human presence has the potential to reduce impacts to cultural resources.

4.3.6 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. With the implementation of the cultural resource mitigation actions identified in Appendices A and C, cumulative impacts to cultural resources in the JIDPA would be minimized or offset.

The great increase in the human presence in the JIDPA and surrounding areas since 1997 has tremendously increased vandalism and artifact collection (Vlcek pers. comm.). 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 resultant alteration of site context and setting.

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. In 2004 alone, several major new archaeological discoveries were 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 tremendously expand knowledge of 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.

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 (illegal artifact collecting or digging), 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.

4.3.7 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 (1999) criteria stipulate that impacts to socioeconomic resources would be considered potentially significant if any of the following were to occur:

- increased demand for housing resulting from project activities that exceeds supply;

- short- or long-term increases in demand for local government facilities or services that exceed existing capacity and are not offset by adequate revenues from continued exploration and development; or

- a 10% change in county government or in countywide employment.

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 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 Environmental Impact Statement* (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 10% 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; therefore, this alternative would not be in accord with BLM, state, and local land use plans. Cumulative impacts are likely to have some economic and social consequences in the CIAA.

In the long term, all alternatives would likely result in economic impacts. Population figures are not likely to be substantially affected over the LOP, with the possible exception that 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 developed per year, project construction, drilling, completion, and production, from approximately 63 to 105 years would be required to complete the project. The fewer the number of wells and/or the faster the pace of development, the shorter the LOP. 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 economic impact of the Proposed Action, alternatives, and cumulative actions on the study-area economy were analyzed in two phases using the methods developed for the SWREE (UWAED 1997) and JMHCAP (UWAED 2003, BLM 2003a). Phase I was the development phase, which considered the economic impacts associated with drilling and completion of infill wells. Due to the large price fluctuations in natural gas, 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.

Assumptions and Methods

Assumptions and methods are detailed in the socioeconomic technical support document (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 authorized, 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 and the number of pads they are placed on. The fewer the number of wells and the faster the pace of development, the shorter the LOP. Some combinations of conventional/directional drilling may make full recovery uneconomical. An estimated 12,800 BCF of natural gas and 99.8 million barrels of Jonah Field condensate (oil) are present beneath the JIDPA. 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 4.16.

Table 4.16. Annual Cost of Natural Gas Production, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Annual Production Operating Costs	Annual Cost per Well
Annual Production (thousand 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
Nonlabor Annual Costs	$212,717
Total Annual Costs	$229,548
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.

Labor

An estimated 16,863 worker-years of direct employment would be provided by the Proposed Action during the LOP (see Appendix B). 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, and 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.

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 4.17. AJEs represent secondary jobs and do not include project-related jobs listed in Table 2.2 of Appendix B. 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.

Table 4.17. Economic Activity from Gas Drilling Per Well, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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 B.
[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.

The value of natural gas production is based on revenues less cost of operation. Table 4.18 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 the socioeconomic technical support document (BLM 2005: Appendix A).

Table 4.18. Economic Activity Gas Production from One BCF of Natural Gas and One MBO, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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

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 the socioeconomic technical support document (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 the socio-economic technical support document (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.

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 for this analysis; 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 also likely that most of this loss has already occurred due to existing development effects.)

Direct impacts from displaced non-consumptive recreationists (per visitor day) could result in a loss of $29.62 (including $6.80 of labor income) and 0.000518 AJEs each (Table 4.19). If all 3,396 RVDs (see Section 3.4.10) 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).

Table 4.19. Economic Activity per RVD from Nonconsumptive Recreation, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

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

It is likely that most recreationists who would avoid the JIDPA as a result of natural gas development would relocate their activities to other places in the vicinity that provide similar recreational opportunities. Individuals may experience impacts in terms of lessened enjoyment and satisfaction from relocated recreational activities.

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 principal 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 existing development. Lands adjacent to the JIDPA may absorb displaced hunting pressure because 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 pronghorn antelope, cottontail, and greater sage-grouse 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 4.20). 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).

Table 4.20. Economic Activity per Hunter Day, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Item	Economic Activity per Hunter Day			
	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

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.

Social Impacts

Social impacts are discussed in more detail in the socioeconomic technical support document (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. With an estimated 1,713 available workers 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. However, some 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.

The project would directly provide up to 9,899 worker years and up to 52,930 AJEs during development and up to 6,964 new worker years and 32,823 new AJEs during production. The duration of these impacts, and therefore the number of jobs, would depend on the rate of development. 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 projects would result in beneficial impacts to local employment—both to the workforce directly involved in oil and gas development and to the general service economy—especially during construction and drilling.

The average wage in the study area ranged from $25,050 to $33,478 in 2000 (see Table 3.34). The estimated annual starting wage per job for jobs created indirectly from development on the JIDPA would range from $31,881 to $32,025. The estimated annual starting wage per job from JIDP production would be $47,173. These estimated annual starting wages are higher than the average wages reported in 2000. Thus, there would likely be beneficial impacts on income and poverty reduction as a result of the Proposed Action and action alternatives. These benefits would not be realized under the No Action Alternative.

Quality of life could cumulatively be impacted by oil and gas development and production in the area. Potential beneficial effects include increased local economic activity and reduced poverty, more health care providers, and improved schools and other tax-supported services and amenities (e.g., libraries, streets, parks). Increased economic activity could enhance the availability of goods, services, and cultural, educational, and certain recreational opportunities. However, some individuals would likely perceive a reduction in the quality of life in the area. The increasing conversion of large tracts of land to gas development is seen by some as industrialization and a diminishment of the characteristics they most value in the region: its natural beauty and quiet, vast reaches of unpopulated and undeveloped open space, fresh air, and wildlife. Moreover, as previously mentioned, the population in the study area is not anticipated to substantially increase in the long term as a result of this project. Because of the demographics of the laborers attracted to oil and gas development and production coupled with a record of increasing criminal activity already affecting the CIAA, the project will likely exacerbate an already worsening crime rate (see Jeffrey Jacquets December 2005 report entitled “Index Crimes, Arrests, and Incidents in Sublette County 1995 to 2004 Trends and Forecasts”).

Depending on how many oil and gas employees relocated to the area, there is a possibility of higher per capita income in the study area. This could attract additional healthcare providers to the area or encourage existing healthcare providers to remain in the area. However, impacts already being experienced by the healthcare community may be incrementally increased as a result of potential increases in population from oil and gas employees attracted by jobs and the secondary employment expected to be generated by the project.

Population in the study area may increase as a result of increased employment opportunities generated both directly and indirectly by the JIDP, affecting the availability of housing. To illustrate the point, both Sublette and Sweetwater Counties are facing a housing shortage and any additional pressure would exacerbate an already tight housing market (Saxton 2005, Gearino 2005). Housing in LaBarge, Lincoln County, is considered available but limited (Woodward

2005). Moreover, if population were to increase, the increased demand for housing would likely put even more upward pressure on already high housing prices (rental costs and home sales prices). Additionally, increased affluence in the study area is likely to cause an increase in the demand for higher-quality housing, which could result in increased housing construction projects. This could make it more difficult for some individuals to obtain satisfactory housing within affordable price ranges.

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 a beneficial impact to the school systems, thereby allowing for a higher quality teaching environment and potentially increasing the wages of teachers, which could attract teachers with better credentials than would otherwise seek 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 performance test scores, thus increasing the overall education level and improving the overall quality of the workforce 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.

4.4.1 No Action Alternative

Under the No Action Alternative, no additional well field development would occur; thus, no economic activity from development would occur (Table 4.21). 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 $11,029.4 million present value, including $1,753.7 million present value in taxes/royalties. Nominal taxes and royalties to Sublette County would be $741.92 million. Based on a population of 6,654 (Year 2004), this would be equivalent to the county receiving $111,484 (approximately $2,787 annually) for each person in the county.

The No Action Alternative would create the least number of AJEs (13,947) (see Table 4.21) and no changes in population.

No effect would be expected to occur on the economic value of recreation or hunting.

In summary, 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. No additional secondary labor earnings or jobs would be created, and no additional taxes or revenues from development would be realized. This would reduce the number of drilling rigs, crews, and associated services currently operating in the area. Between 1996 and 2002, approximately 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.

Table 4.21. Summary of Total Economic Activity Resulting from Natural Gas Development and Production over the Life of Field, Jonah Infill Drilling Project, Sublette County, 2006

Economic Effect	Economic Activity Resulting from Development (LOP)				
	No Action	Proposed Action	Alternative A (Maximum Development)	Alternative B (Minimum Recovery)	Preferred Alternative
Total Anticipated Natural Gas Recovery over the LOP (BCF)	3,366	7,947	8,191	6,124	7,947
Total Anticipated Condensate Recovery over the LOP (million bbls)	31.98	75.50	77.81	58.18	75.50
Potential Change in Employment					
Secondary Development Employment (AJEs)	--	52,930	52,187.5	61,110	52,930
Average Earnings Per Job	--	$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	32,928
Average Earnings Per Job	$47,173	$47,173	$47,173	$47,173	$47,173
Recreation AJEs	--	-92.4	-92.4	-144.2	-92.4
Hunting AJEs	--	-49.9	-49.9	-77.9	-49.9
Potential Change in Employment (AJEs)	13,947	85,715.7	85,984.2	86,261.9	85,715.7
NOMINAL VALUE OF ECONOMIC ACTIVITY					
75 Wells Per Year Development Rate					
Value of Development[1] (millions of $)	0.0	--	--	9,612.5	--
Value of Production[1,2] (millions of $)	12,922.5	--	--	23,510.8	--
Taxes/royalties from proposed project (millions of $)	2,334.9	--	--	4,881.4	--
Recreation (millions of $)	0.0	--	--	-8.2	--
Hunting (millions of $)	0.0	--	--	-3.5	--
Total Nominal Economic Activity (millions of $)	15,257.4	--	--	37,993.0	--
250 Wells Per Year Development Rate					
Value of Development[1] (millions of $)	0.0	8,588.6	8,497.2	--	8,588.6
Value of Production[1,2] (millions of $)	12,922.5	30,509.5	31,446.1	--	30,509.5
Taxes/royalties (millions of $)	2,334.9	6,072.1	6,234.7	--	6,072.1
Recreation (millions of $)	0.0	-5.3	-5.3	--	-5.3
Hunting (millions of $)	0.0	-2.2	-2.2	--	-2.2
Total Nominal Economic Activity (millions of $)	15,257.4	45,162.7	46,170.5	--	45,162.7
PRESENT VALUE OF ECONOMIC ACTIVITY[3]					
75 Wells Per Year Development Rate					
Value of Development[2] (millions of $)	0.0	--	--	4,997.3	--
Value of Production[2] (millions of $)	9,275.7	--	--	9,325.1	--
Taxes/royalties (millions of $)	1,753.7	--	--	2,108.2	--
Recreation (millions of $)	0.0	--	--	-2.7	--
Hunting (millions of $)	0.0	--	--	-1.1	--
Total Present Value of Economic Activity (millions of $)	11,029.4	--	--	16,426.8	--
250 Wells Per Year Development Rate					
Value of Development[2] (millions of $)	0.0	6,631.8	6,561.2	--	6,631.8
Value of Production[2] (millions of $)	9,275.7	17,963.8	18,511.2	--	17,963.8
Taxes/royalties (millions of $)	1,753.7	3,474.7	3,574.9	--	3,474.7
Recreation (millions of $)	0.0	-2.4	-2.4	--	-2.4
Hunting (millions of $)	0.0	-1.0	-1.0	--	-1.0
Total Present Value of Economic Activity (millions of $)	11,029.4	28,066.9	28,643.9	--	28,066.9

[1] Includes non-project 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 the other action alternatives wells currently in production (i.e., No Action Alternative wells); natural gas price is assumed at $3.50/mcf and condensate price is assumed at $21/bbl.
[3] Number of years to develop is approximately 42 years for Alternative B and13 years for all other action alternatives; well life is assumed to be 40 years; see Section 4.4 for a discussion of discounting. The discount rate used for this analysis was 3.5%. Conservatively assumes revenues are received as a lump.

4.4.2 Proposed Action

Because up to 3,100 new wells (assumed at 2,825 conventional, 275 directional) would be drilled under the Proposed Action, economic activity from development would be greater than under the No Action Alternative (see Table 4.21). Up to 7,947 BCF of gas and 75.5 MBO would be recovered under this alternative.

Over the LOP, economic activity would be $28,066.9 million present value, including $3,474.7 million present value in taxes/royalties (see Table 4.21). Nominal taxes and royalties to Sublette County would be $1,839.08 million. Based on a population of 6,654 (Year 2004), this would be equivalent to the county receiving funds of $276,387 (approximately $5,264 annually) for each person in the county. Under the Proposed Action, local area government operating budgets would likely expand, increasing the level of services and infrastructure provided to community residents. These impacts would be higher under the Proposed Action than under the No Action Alternative.

The number of AJEs that would be created in the study area is estimated at 85,715.7 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 (BLM 2005).

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 92.4 AJEs. 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 49.9 AJEs. Impacts to recreation and hunting under the Proposed Action would be greater than under the No Action Alternative due to increased disturbance and longer project duration.

In summary, this alternative would have more nominal economic activity related to development and production than the No Action Alternative because of the higher level of resource recovery.

4.4.3 Alternative A

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 4.21).

Over the LOP, economic activity would be $28,643.9 million present value, including $3,574.9 million present value in taxes/royalties (see Table 4.21). Nominal taxes and royalties to Sublette County would be $1,892.00 million. Based on a population of 6,654 (Year 2004), this would be equivalent to Sublette County receiving $284,340 (approximately $5,416 annually) for each person in the county. Property tax revenues would likely be higher under this alternative than under the No Action Alternative or the Proposed Action due to the greater amount of construction involved with development, which would result in an increased tax base. Because Alternative A maximizes resource recovery, at least conceptually, changes in production for this field could impact pricing of natural gas for consumers. But given the size of the market, it is not likely that a measurable change in market price would be associated with this alternative. Moreover, local area government operating budgets would likely increase more 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 is estimated at 85,984.2, 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).

This alternative could result in a loss of present value economic activity from recreation of $2.4 million and hunting of $1.0 million. The loss of economic activity from recreation and hunting would be greater under Alternative A than under the No Action Alternative.

In summary, this alternative would have more nominal economic activity in terms of production than the Proposed Action because of the higher level of resource recovery.

4.4.4 Alternative B

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 4.21). Economic activity would be $16,426.8 million present value, including $2,108.2 million present value in taxes/royalties (see Table 4.21). Nominal taxes and royalties to Sublette County would be $1,446.56 million. Based on a population of 6,654 (year 2004), this would be nominally equivalent to Sublette County receiving funds of $217,398 (approximately $2,651annually) 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 level 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 would be 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 is estimated at 86,261.9 with an average wage ranging from $31,881 to $47,173. Population changes from secondary employment would likely be similar to those of the Proposed Action.

This alternative could result in a present value loss of economic activity from recreation of $2.7 million and from hunting of $1.1 million. The loss of economic activity from recreation and hunting would be increased under Alternative B as compared to the No Action Alternative.

In summary, 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.

4.4.5 BLM Preferred Alternative

Under the Preferred Alternative, up to 3,100 new wells would be developed. Economic activity from the Preferred Alternative would be similar to that described for the Proposed Action.

4.4.6 Cumulative Impacts

The cumulative impacts assessment area 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 3.4.7.4). The JIDP, along with other oil and gas developments, would increase employment opportunities, expand the tax base, and improve the ability of the counties to maintain and increase services and infrastructure for residents. Increased oil and gas development results in impacts related to employment, tax base/revenues, and general economic health. Wells developed as part of this project would add proportionately to the economic benefits realized from 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 authorized.

Increases in regional oil and gas development activity over a short period can cause notable changes in employment and income. These variables can also cause changes in population trends, which could have impacts on community services, social structures, and lifestyles. Under all action alternatives, increased oil and gas development is expected to cause an increase in taxes and revenues to all governments in the study area. 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 governments. 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 project 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 typical for the private mineral owner to share in the profits from the recovery of the mineral resource.

A portion of the resident population, as well as many nonresidents, place great value on preserving the character of the area 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 project.

4.4.7 Unavoidable Adverse Impacts

There would be unavoidable short-term or long-term adverse impacts to socioeconomics as a result of the proposed project. Impacts could be reduced by implementation of suggested mitigation measures.

4.4.8 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 3.4.11), 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 short-term 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 4.1.4), 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 2,811 acres in the short term and 1,409 acres over the 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, but natural gas development and production operations would increase compared to the No Action Alternative, resulting in approximately 16,200 acres of new surface disturbance. Short-term (14,388 acres) and LOP (6,043 acres) disturbance would total 20,409 acres. The duration of impact 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. Duration of impact would be approximately 76 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 3,222 acres of new surface disturbance from that of the No Action Alternative. Short-term (4,848 acres) and LOP 2,602 acres) disturbance would total 7,431 acres. Impact duration would be approximately 105 years.

4.5.1.5 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 9,821–16,125 acres of new surface disturbance from that of the No Action Alternative. Short-term (9,782–14,388 acres) and LOP (4,267–6,020 acres) disturbance would total 14,030–20,334 acres. Project duration is anticipated to be approximately 76 years.

If the Operators maximize ongoing reclamation as described in Section 2.4.5, total acres affected would be comparable to that of the Proposed Action (20,334 acres vs. 20,409 acres). However, 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 2.4.5). 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.

4.5.1.6 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.

4.5.1.7 Unavoidable Adverse Impacts

There would be no unavoidable adverse impacts to land status/ownership.

4.5.2 Livestock/Grazing Management

The major premise in analyzing each alternative's impacts to the livestock forage resource is the linear rationale that for every 10 acres of vegetation removed in construction of the Jonah gas field there will be approximately one AUM of livestock forage lost. This would indeed be true, and impacts would be significant, if the selected alternative resulted in an unvegetated landscape that failed to meet the forage demands of the permitted livestock.

Section 3.5.2 describes how livestock forage demands are currently being met in the wake of several years of natural gas drilling in the area of analysis. Consequently, it is unrealistic to assume that forage (AUMs) will be lost proportionately to the degree of development in any particular alternative. Therefore, it is premature to assume that grazing permits will be reduced as a result of alternative implementation. This could occur if reclamation were unsuccessful, but any reduction in grazing permits can only be determined after an interpretation of rangeland monitoring data indicate a need to do so.

If and when results of monitoring indicate that forage to satisfy permitted use is lacking, or that livestock use is preventing the accomplishment of other resource objectives, then the process outlined in 43 CFR 4110.3 will be used to make necessary adjustments in grazing management.

Other potential impacts that may occur relative to the industrial development include loss of livestock to hazards such as increased traffic. 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 reclaimed areas, thus increasing the chances of vehicle/livestock collisions. Construction activities could result in shifts in livestock distribution patterns, causing them to concentrate on and around reclamation areas. Open pits and trenches, if not properly fenced, can result in death or injury to livestock. Also, 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, as well as decreasing forage palatability. These development associated impacts may occur regardless of the alternative selected, and would be proportionate to the amount of allowable activity.

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 disturbance in the JIDPA, including 1,348 acres of disturbance over the LOP (BLM 1998b, 2000b).

Blue Rim Desert Common Allotment

Because the Burma Road would not be upgraded under the No Action Alternative, no impacts would occur to the Blue Rim Desert Common Allotment.

Stud Horse Common Allotment

Livestock grazing would continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Sand Draw Common Allotment

Livestock grazing would continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Boundary Allotment

Livestock grazing would continue at the permitted levels in conjunction with adaptive management strategies, including rangeland and reclamation monitoring. Watershed condition and forage availability could be reevaluated in the future based upon monitoring data and reclamation success. The allotment would be expected to, at a minimum, meet the Wyoming Standards for Healthy Rangelands.

4.5.2.2 The Proposed Action

The Proposed Action assumes 20,126 acres of disturbance in the JIDPA, including 5,962 acres of disturbance over the LOP.

Blue Rim Desert Common Allotment

The Burma Road upgrade will require reclamation along the roadsides and will attract cattle to the planted areas. Increased traffic and increased speed will increase the potential for vehicular collisions with cattle.

Stud Horse Common Allotment

There would be significant potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Sand Draw Common Allotment

There would be significant potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Boundary Allotment

There would be significant potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies, including rangeland and reclamation monitoring. Watershed condition and forage availability could be reevaluated in the future based upon monitoring data and reclamation success. The allotment would be expected to, at a minimum, meet the Wyoming Standards for Healthy Rangelands.

4.5.2.3 Alternative A

As with the Proposed Action, this alternative assumes 20,126 acres of total disturbance in the JIDPA, including 5,962 acres of disturbance over the LOP.

Blue Rim Desert Common Allotment

The Burma Road upgrade will require reclamation along the roadsides and will attract cattle to the planted areas. Increased traffic and increased speed will increase the potential for vehicular collisions with cattle.

Stud Horse Common Allotment

There would be significant potential for a decrease in livestock forage under this alternative as in the Proposed Action for a decrease in livestock forage, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Sand Draw Common Allotment

There would be significant potential for a decrease in livestock forage under this alternative as in the Proposed Action, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Boundary Allotment

As in the Proposed Action, there would be significant potential for a decrease in livestock forage under this alternative depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies, including rangeland and reclamation monitoring. Watershed condition and forage availability could be reevaluated in the future based upon monitoring data and reclamation success. The allotment would be expected to, at a minimum, meet the Wyoming Standards for Healthy Rangelands.

4.5.2.4 Alternative B

This alternative assumes 7,223 acres of total disturbance in the JIDPA, including 2,541 acres of disturbance over the LOP.

Blue Rim Desert Common Allotment

Because the Burma Road would not be upgraded under Alternative B, no impacts would occur to the Blue Rim Desert Common Allotment.

Stud Horse Common Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Sand Draw Common Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Boundary Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies, including rangeland and reclamation monitoring. Watershed condition and forage availability could be reevaluated in the future based upon monitoring data and reclamation success. The allotment would be expected to, at a minimum, meet the Wyoming Standards for Healthy Rangelands.

4.5.2.5 BLM Preferred Alternative

This alternative assumes 13,822–20,126 acres of total disturbance in the JIDPA, including 4,090–5,962 acres of disturbance over the LOP.

Under the Preferred Alternative, additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives (i.e., maintain permitted livestock AUMs) and to minimize impacts to resources (see Section 2.4.5).

Blue Rim Desert Common Allotment

Because the Burma Road would not be upgraded under the Preferred Alternative, no impacts would occur to the Blue Rim Desert Common Allotment.

Stud Horse Common Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted

levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Sand Draw Common Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies including rangeland and reclamation monitoring.

Boundary Allotment

There would be considerable potential for a decrease in livestock forage under this alternative, depending on the results of reclamation efforts. Livestock grazing will continue at the permitted levels in conjunction with adaptive management strategies, including rangeland and reclamation monitoring. Watershed condition and forage availability could be reevaluated in the future based upon monitoring data and reclamation success. The allotment would be expected to, at a minimum, meet the Wyoming Standards for Healthy Rangelands.

4.5.2.6 Cumulative Impacts

The CIAA for livestock/grazing includes all of the four grazing allotments (Blue Rim Desert Common, Stud Horse Common, Sand Draw Common, and Boundary) that may be affected by the proposed project. These four allotments cover 120,597 acres and contain a total of 9,876 AUMs. RFD surface disturbance in these allotments is estimated to be approximately 396 acres 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) could potentially result in significant forage loss if reclamation strategies were not applied on a timely schedule and/or were unsuccessful. Maximum long-term cumulative AUM loss within all allotments is estimated to be insignificant, as current observation of reclamation results appears to be keeping up with AUM demand by livestock. Cumulative impacts to livestock/grazing across alternatives would be proportional to the extent of surface disturbance and development features/human activity. There is also a potential for well-field facilities to reach a density such that it is impractical to move cattle into the area.

4.5.2.7 Unavoidable Adverse Impacts

The project would result in the temporary and potentially long-term loss of available livestock forage, depending on reclamation results. Decreases in livestock forage would be determined through rangeland monitoring.

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 reduction in the quality of the recreational experience, especially for hunting, camping, wildlife watching, and OHV activities.

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 because 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, photography), 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 that 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) as detailed in past NEPA documents (BLM 1998b, 2000b). Under all alternatives, including the No Action Alternative, the Recreation Opportunity Spectrum (ROS) classification for the JIDPA is expected to change from semi-primitive motorized to rural or urban as a result of approved and existing development. Impacts on dispersed recreation opportunities may be significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated.

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. ROS classification changes would be as noted in the No Action Alternative. Impacts on dispersed recreation opportunities under the Proposed Action may be significant.

Upgraded conditions on the Luman and Burma Roads would likely be retained after project completion, allowing for increased recreational use of the area. This improvement of non-paved road for oil and gas projects opens new areas for recreational use outside of the project area. New access and increased awareness of opportunities could encourage existing and new recreational use of previously primitive or semi-primitive areas. This could displace traditional recreational users with more new users and different uses (e.g., OHV).

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 pronghorn antelope, 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 (approximately 76 years). ROS classification changes would be as noted in the No Action Alternative. Impacts on dispersed recreation opportunities under Alternative A may be significant. Impacts resulting from upgraded road conditions would be the same as those of the Proposed Action.

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 period (approximately 42 years). 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 (approximately 105 years). ROS classification changes would be as noted in the No Action Alternative. Impacts on dispersed recreation opportunities under Alternative B may be significant. Impacts resulting from upgraded road conditions would be similar to those of the Proposed Action except that the Burma Road would not be upgraded.

4.5.3.5 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 comparable, if all acres potentially available for development credit following successful interim reclamation are utilized, to impacts under the Proposed Action. Duration of impacts would be for the LOP and until areas are adequately reclaimed (approximately 76 years). ROS classification changes would be as noted in the No Action Alternative. Impacts on dispersed recreation opportunities under the Preferred Alternative may be significant. Impacts resulting from upgraded road conditions would be similar to those of the Proposed Action except that the Burma Road would not be upgraded.

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 Sections 2.3 and 2.4.5).

4.5.3.6 Cumulative Impacts

The CIAA for recreation, totaling 1,557,558 acres, is shown on Map 3.23. Existing surface disturbance impacting recreation opportunities throughout the CIAA is 138,740 acres (216 square miles) or 6.6% of the CIAA, which is primarily a result of agriculture (83%), road and pipeline ROWs (12%), and existing natural gas development in the Jonah, Pinedale Anticline, Fontenelle, Moxa, Stagecoach Draw, LaBarge Platform, Riley Ridge, and Mesa Verde project areas (5%) as well as the Tip-Top and Hogsback Units. The extent of development throughout the CIAA has and will continue to result in displaced recreational use from these areas and added pressure on existing recreational opportunities and facilities elsewhere within the CIAA.

Maximum cumulative disturbance (i.e., the combined alternative-specific and RFD disturbance) in the recreation CIAA for all alternatives is presented in Table 4.22. Cumulative impacts to recreation are anticipated to be similar under all development alternatives. ROS classifications may be altered as human activities increase in areas adjacent to the JIDPA.

Table 4.22. Cumulative Acreage of Disturbance in the Recreation CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Cumulative Impact Analysis Area (CIAA)	Total Acreage of CIAA	Existing Disturbance in CIAA, outside JIDPA	RFD	Disturbance					
				No Action			**Proposed Action and Alternative A**		
				JIDP Total	LOP	Cumulative[1]	JIDP Total	LOP	Cumulative[1]
Recreation	1,557,558	84,352	7,014	4,209	1,409	95,575	20,409	6,043	111,775
Percent of Entire CIAA		5.4				6.1			7.2
				Alternative B			**Preferred Alternative**		
				JIDP Total	LOP	Cumulative[1]	JIDP Total	LOP	Cumulative[1]
Recreation				7,431	2,602	98,797	14,030–20,334	4,267–6,020	105,396–111,700
Percent of Entire CIAA						6.3			6.7–7.2

[1] Cumulative disturbance = outside JIDPA + RFD + JIDPA total.

A large proportion of workers employed for this project would likely be hired from the local workforce. However, regional and local 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 most traditional users. Some individuals may no longer recreate in the area at all. Current users of recipient areas may be adversely affected by increased use, overcrowding, and a feeling that the quality of the recreation experience of solitude has diminished.

4.5.3.7 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. Because the design of new and upgraded roads in the JIDPA would be in compliance with the BLM road standard guidelines (BLM 1985, 1991a), the Transportation Plan for this project (Appendix B, subappendix DP-A), 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 C. Further detail on transportation planning and effects is provided in the project Transportation Plan (Appendix B, subappendix DP-A).

Up to 465 miles of new resource roads and 8 miles of new collector roads would be required for this project (Table 4.23). 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.

Table 4.23. Miles of New Roads, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Alternative	Miles of New Resource Roads[1]	Miles of New In-Field Collector Roads	Miles of Burma Road Upgrade
No Action Alternative	0	0	0
Proposed Action	465	8	12
Alternative A	465	8	12
Alternative B	0	0	0
Preferred Alternative	465	8	0

[1] Based on 0.4 mile per well pad.

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 approved roads in the JIDPA is approximately 199 miles (see Table 4.23). Under the No Action Alternative, transportation impacts would continue at existing approved levels (no new roads), 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 B). Prior decisions found that the existing approved 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 465 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 4.23). 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 B). This is an increase of 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; however, some of the new roads would be built in areas that would be avoided under other project alternatives.

4.5.4.4 Alternative B

Under Alternative B, impacts would be similar to those of 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 because traffic would occur only to the existing pads. The Burma Road would not 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 B). This is an increase of 7,138,400 round trips when compared to the No Action Alternative. Duration of impacts would be an estimated 105 years.

4.5.4.5 BLM Preferred Alternative

Under the Preferred Alternative, impacts would be similar to those for the Proposed Action, except the Burma Road would not be upgraded and additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.4.5). 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 Jonah Interagency Office (JIO) also could reduce impacts to transportation through appropriate planning.

4.5.4.6 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 or 250 new wells developed per year). Existing major highways and county roads are adequate to handle anticipated increased traffic (Appendix B). 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, although to different degrees depending on whether the Burma Road is upgraded.

4.5.4.7 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 on federal lands and minerals are also defined as an apparent visual change, to the casual observer, from a natural landscape to an "industrialized appearing" landscape. 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, visual resource impacts are anticipated under all alternatives for the LOP and until areas are adequately reclaimed. Significant visual resource impacts would not occur within the JIDPA specifically because the entire JIDPA is considered a Class IV VRM area. The project under all alternatives is generally consistent with Class IV objectives, but impacts may be significant when viewed from locations where the JIDPA and/or project effects (e.g., light sources, haze, smoke plumes) are visible. Non-JIDPA areas where project effects may be visible include VRM Class I and II areas, including wilderness and wilderness study areas. Project-related effects and features visible from U.S. Highway 191 would be consistent with VRM Class III objectives.

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. No additional significant impacts beyond those of previously authorized actions are anticipated under the No Action Alternative.

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 LOP. 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. Impacts may be significant in some non-JIDPA areas, including VRM Class I and II areas.

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 approximately 76 years). Impacts may be significant in some non-JIDPA areas, including VRM Class I and II areas.

4.6.4 Alternative B

Implementation of Alternative B would result in the same types of impacts as the No Action Alternative but would be increased due to expanded development. Impacts would be reduced from the other project alternatives because no new well pads or roads would be built. Duration of impacts would be approximately 105 years. Impacts may be significant in some non-JIDPA areas, including VRM Class I and II areas.

4.6.5 BLM Preferred Alternative

Under this alternative, visual resource impacts are anticipated to be similar to those of the Proposed Action, but slightly less as the Operators would implement unique development procedures (see Section 2.4.5). Because the BLM Preferred Alternative would limit total surface disturbance at any given time to a maximum of 14,030 acres and the Proposed Action has no such limits, it is possible that at any given time visual impacts from surface disturbance may be less under this alternative. Duration of impacts would be approximately 76 years. Impacts may be significant in some non-JIDPA areas, including VRM Class I and II areas.

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 2.4.5). 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 on vegetation or facilitate enhanced reclamation have the potential to reduce impacts to visual resources.

4.6.6 Cumulative Impacts

The CIAA for visual resources, totaling 2,089,363 acres, is shown on Map 3.24. The surface disturbance resulting from each of three of the alternatives (the Proposed Action, Alternative A, and the BLM Preferred Alternative) would likely exceed 20,000 acres. All of this disturbance would occur on areas designated as VRM Class IV. Maximum cumulative disturbance for the visual resources CIAA (i.e., the combined existing, proposed, and RFD disturbance) for each of these alternatives is 8.0% of the CIAA (Table 4.24). The RFD includes 7,302 acres of new disturbance primarily from natural gas developments in other project areas in the CIAA.

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 contributing developments and visual attributes (including haze, smoke plumes

Table 4.24. Cumulative Acreage of Disturbance in the Visual Resources CIAA, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Cumulative Impact Analysis Area (CIAA)	Total Acreage of CIAA	Existing Disturbance In CIAA, Outside JIDPA	RFD	Disturbance					
				No Action			**Proposed Action and Alternative A**		
				JIDP Total	LOP	Cumulative[1]	JIDP Total	LOP	Cumulative[1]
Visual Resources	2,089,363	138,740	7,302	4,209	1,409	150,252	20,409	6,043	166,452
Percent of Entire CIAA		6.6				7.2			8.0
				Alternative B			**Preferred Alternative**		
				JIDP Total	LOP	Cumulative[1]	JIDP Total	LOP	Cumulative[1]
Visual Resources				7,431	2,602	153,474	14,030–20,334	4,267–6,020	160,072–166,376
Percent of Entire CIAA						7.3			7.7–8.0

[1] Cumulative disturbance = outside JIDPA + RFD + JIDPA total.

and night lighting), along with other regional developments, are visible and may be noticeable to the casual observer from areas outside the project area, including VRM Class II and I areas within the CIAA such as a BLM wilderness study area and the Bridger Wilderness. Therefore, significant cumulative impacts to regional visual resources may occur at these sites.

4.6.7 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.

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;
- 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 water and groundwater 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 B). 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 water and groundwater 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 B) and existing SPCCPs.

With the implementation of the aforementioned procedures plus the additional mitigations and practices identified in Appendices A, B, and C, 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. However, potential impacts to wildlife and surface waters would be increased in some areas because selected wildlife and drainage buffers would not be avoided. The duration for potential impacts would be for the LOP, which would be approximately 76 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. Compared to the Proposed Action, however, the potential for accidental hazardous materials spills, pipeline ruptures, and/or exposure to hazardous materials would be reduced because development and production activities would be limited to the existing well pads and roads because no new pads or roads would be constructed.

The duration for potential impacts would be approximately 105 years and until all potentially contaminated sites are remediated.

4.7.5 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.

Impacts under the Preferred Alternative would be similar to those of the Proposed Action, except additional mitigation and monitoring measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources (see Section 2.4.5). 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.

4.7.6 Cumulative Impacts

All existing, proposed, and future development projects would use mitigation measures similar to those described for this project (Appendix B) to prevent soil contamination, surface water and groundwater 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.

4.7.7 Unavoidable Adverse Impacts

With strict adherence to identified hazardous material management requirements (Appendix B), no unavoidable adverse impacts are anticipated.

4.8 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 B).

4.9 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.