
CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

The purpose of this chapter is to determine the potential for significant impact of the “federal action” on the “human environment.” The CEQ regulations for implementing the NEPA state that the “human environment” shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment [40 CFR §1508.14]. The “federal action” is the BLM’s selection of an alternative plan on which future land use actions would be based.

4.1.1. Impact Analysis

Analysis of the alternatives focuses on identifying types of impacts and estimating their potential significance. Throughout this chapter the terms “impact” and “effect” are synonymous. An overview of the types of impacts is presented below. Cumulative impacts are defined and discussed separately in Chapter 5.

Direct Impacts: These are effects that are caused by the action and occur at the same time and place. Examples include the elimination of original land use due to the building of a structure. Direct impacts may cause indirect impacts, such as ground disturbance resulting in resuspension of dust.

Indirect Impacts: These are effects that are caused by the action but occur later in time or are farther removed in distance; they are still reasonably foreseeable and related to the action by a chain of cause and effect. Indirect impacts may reach beyond the natural and physical environment (e.g., environmental impact) to include growth-inducing effects and other effects related to induced changes to resources users (e.g., non-environmental impact).

Significant Impacts: Both direct and indirect impacts may be significant. “Significant” requires consideration of both the context and intensity of the impact. This means that an action must be analyzed in several contexts – such as the immediate vicinity, affected interests, and the locality. Both short-term and long-term effects are relevant. Intensity refers to the severity of impact. Thus, significant impacts are of greater intensity than negligible, minor, or substantial impacts.

Residual Impacts: These are foreseeable impacts after the LOP and after proposed mitigation measures are applied.

The BLM manages public lands for multiple uses in accordance with the FLPMA. Land use decisions are made to protect the resources while allowing for multiple-use of those resources, such as livestock grazing, energy development, and recreation. Where conflicts exist between resources uses, or where a land use activity may result in irreversible or irretrievable impacts to the environment, the BLM may restrict or prohibit some land uses in specific areas. To ensure that the BLM meets its multiple-use mandate in land management actions, the impacts of the alternatives on resource users are identified and assessed as part of the planning process. The projected impacts on land use activities and the associated environmental impacts of land uses are characterized and evaluated for each of the alternatives.

4.1.2. Significance Criteria

Significance criteria are developed to gauge the magnitude of impact that an action would have on the human environment. An adverse impact on resources as a result of human activities would be

considered potentially significant if its magnitude required special mitigation or if the impact persisted indefinitely.

The concept of significance encompasses several factors, including the degree of change from existing conditions and the likelihood of the change to occur. The context and intensity of the impact are also considered. Context refers to the environmental circumstances at the location of the impact. Intensity refers to the severity or extent of an impact, including the potential for violation of laws or regulations and the recovery or resilience of the resource.

Determining significance is complex, in that impacts are dynamic and may change during the planning period. Significance can be real and supportable by fact, or perceived and perhaps not fully supportable even with rigorous study. For this analysis, the approach to establishing significance criteria was based on legal issues (i.e., government regulatory standards), public input, available scientific and environmental documentation, and professional judgment of resource specialists.

4.1.3. Best Management Practices/Mitigation Measures

BMPs and mitigation measures are developed based on BLM requirements and on compensation for potential impacts to the natural and physical or the relationship between people and that environment. All proposed BMPs and mitigation measures for resources are presented in Appendix A of the EIS. All alternatives will comply with the Kemmerer RMP.

4.2. Air Quality

Because of the highly technical nature of air quality modeling and impacts assessment and the quantity of tables and figures required to make informed decisions regarding the impacts of each of the project alternatives, the following sections related to air quality only summarize the results of the modeling efforts. A detailed technical support document containing all of the model assumptions, results, tables, and figures is located in Appendix C in Volume 2 of this DEIS.

4.2.1. Introduction

The Project's location in southwest-central Wyoming required the examination of Project and cumulative source impacts in Wyoming, northwestern Colorado, northeastern Utah, and southeastern Idaho within a defined air quality modeling domain (Map 3-1). The methodologies utilized in the analysis were originally defined in an air quality impact assessment protocol (Protocol) prepared with input from the BLM and project stakeholders, including the EPA, NPS, USDA Forest Service, and Wyoming Department of Environmental Quality Air Quality Division (WDEQ-AQD). The analysis area includes the area surrounding MAA and all or a portion of the Bridger, Fitzpatrick, Popo Agie, Teton, Flattops, Rawah, Mount Zirkle, and Washakie Wilderness Areas; Dinosaur National Monument, the Wind River Roadless Area; and Grand Teton and Rocky Mountain National Parks.

Impacts analyzed include those on air quality and air quality related values (AQRVs) resulting from air emissions from: 1) project sources within the MAA, 2) non-project state-permitted and reasonably foreseeable future action (RFFA) sources within the modeling domain, and 3) non-project reasonably foreseeable development (RFD) within the modeling domain. The Project source emissions inventory was performed in accordance with the Protocol and following WDEQ-AQD oil and gas inventory guidance (WDEQ 2001a). Non-project sources were inventoried as part of a cooperative effort between the BLM Wyoming State Office and the Project proponents. Data from Wyoming, Colorado, Idaho and Utah air agencies were also obtained for the non-project sources. The following ten tasks were performed for air quality and AQRVs impact assessment:

- Project Air Emissions Inventory. Development of an air pollutant emissions inventory for the Project.
- Regional Air Emissions Inventory. Development of an air pollutant emissions inventory for other regional sources not represented by background air quality measurements, including state-permitted sources, RFFA, and RFD.
- Project Near-Field Analysis. Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA.
- Regional Near-Field Analysis. Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA in combination with other existing and proposed regional compressor stations.
- In-Field Cumulative Analysis. Assessment of concentration impacts within the MAA resulting from the project and other regional sources inventoried under the second bullet of this list.
- Mid-Field Cumulative Analysis. Assessment of mid-field visibility impacts to regional communities resulting from the Project and other regional sources.
- Far-Field Direct Project Impact Analysis. Assessment of far-field air quality concentration and AQRV impacts resulting from proposed Project activities.
- Far-Field Direct Project Impact Analysis. Assessment of far-field ozone concentration impacts resulting from proposed Project activities.
- Far-Field Cumulative Impact Analysis. Assessment of far-field air quality concentration and AQRV impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under the second bullet of this list.
- Far-Field Cumulative Impact Analysis. Assessment of far-field ozone impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under the second bullet of this list.

The following sections discuss development of the emissions inventory, near-field impacts, far-field impacts and ozone impacts. Appendix C provides a detailed assessment of air quality impacts.

4.2.1.1. Emissions

4.2.1.1.1. *Project Emissions*

All project emission calculations were completed in accordance with WDEQ-AQD oil and gas guidance (WDEQ 2001a) in effect at the time the inventory was conducted, stack test data, EPA's AP-42, or other accepted engineering methods.

Calculated project emissions included construction, production and total field emissions. Construction emissions were based on well construction, drilling, drilling traffic, completion traffic, and completion flaring. Well construction emissions were based on the number of wells constructed per year and the type of well constructed. Drilling, drilling traffic, completion traffic, and completion flaring were based on the number of wells developed per year. As a conservative assumption, completion flaring operations were assumed to occur at all of the wells under construction and compression was included. Production emissions were calculated based on the total number of producing wells in the field. Total producing wells were equal to the difference in number of wells proposed and the number of wells constructed per year.

4.2.1.1.2. *Cumulative Emissions Inventory*

An emissions inventory of industrial sources within the Project's regional modeling domain was prepared for use in the cumulative air quality analysis. The modeling domain included portions of Wyoming, Colorado, Utah, and Idaho (Map 3-1). Industrial sources and oil and gas wells permitted

within a defined time frame (January 1, 2001 through June 30, 2006) through state air quality regulatory agencies and state oil and gas permitting agencies were first researched. The subset of these sources which had begun operation as of the inventory end-date was classified as state-permitted sources, and those not yet in operation were classified as RFFA sources. Also included in the regional inventory were industrial sources proposed under NEPA in the states of Wyoming and Colorado. The developed portions of these projects were assumed to be either included in monitored ambient background or included in the state-permitted source inventory. The underdeveloped portions of projects proposed under NEPA were classified as RFD sources.

RFD information was obtained from final NEPA air quality analysis documents that were submitted to BLM for planned project development. Undeveloped portions of these authorized projects were obtained from BLM records tracking project development to determine total wells or other equipment yet undeveloped. For instance, for an authorized gas field development area for which 2,000 wells were projected but only 250 wells had been developed as of the inventory end-date of this study, 250 wells would be included under permitted source inventory and the remaining 1,750 would be considered RFD. RFD information from not-yet-authorized projects was obtained from contractors working on ongoing air quality analyses for NEPA projects.

Full development of proposed projects inventoried as RFD may or may not coincide with full development of the Project. As a result, the inclusion of RFD in the cumulative analysis may result in overly conservative impact estimates. To ensure "reasonable, but conservative" analysis results for all stages of Project development, the cumulative modeling analysis was performed both with and without RFD sources. A map showing NEPA RFD project areas that were examined in this study, as defined in the paragraph above is presented in Map 5-1. All development areas were reviewed for inclusion, and those projects with significant pollutant emissions during production activities were included as RFD. To ensure a timely, complete modeling analysis, only development authorized through the inventory end-date of June 30, 2006, or quantified as of the beginning of the modeling analysis, was included in the Project analysis.

4.2.1.2. Near-field Impacts

4.2.1.2.1. *Criteria Pollutants*

The EPA's proposed guideline dispersion model, AERMOD, was used to model the near-field concentrations of PM₁₀, PM_{2.5}, CO, NO₂, and SO₂. AERMOD was run using one year of AERMET preprocessed MAA meteorology data following all regulatory default switch settings. Because PM₁₀, PM_{2.5}, NO₂, and SO₂ emissions would be present during both the resource road/well pad construction phase of field development and the production phase, these emissions sources were modeled under both scenarios to determine compliance with the appropriate standards. CO and NO_x emissions primarily from compressor stations would be greatest during well production.

4.2.1.2.2. *Hazardous Air Pollutants*

AERMOD was also used to determine hazardous air pollutant (HAP) impacts in the immediate vicinity of the MAA for short-term (acute, 1 hour) exposure assessment and at Granger, Wyoming for calculation of potential long-term (chronic, 1 year) exposure assessment. Sources of HAPs include well-site fugitive emissions (BTEX and n-hexane), completion flaring and venting (BTEX and n-hexane), and compressor station combustion emissions (formaldehyde). Because maximum field-wide annual emissions of HAPs occur during the production phase, only HAP emissions from production were analyzed for long-term risk assessment.

Short-term exposure assessments were performed for production HAP emissions using various well densities (based on each alternative), and for an individual well construction completion (venting and flaring) event. Reference Exposure Levels (RELs) or chronic Reference Concentrations (RfCs) were

used to assess potential impacts. RELs are defined as concentrations at or below levels from which no adverse health effects are expected. RfCs are defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2002). Because no acute RELs are available for ethylbenzene and n-hexane, Immediately Dangerous to Life or Health (IDLH) values were used for acute exposure. REL and IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database. RfCs are developed by EPA and were also obtained from EPA's Air Toxics Database. Model results are only used for comparison purposes to these standards.

Long-term exposures to emissions of suspected carcinogens (benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants for comparison purposes only, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URFs) for carcinogenic constituents

Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1993), where a cancer risk range of 1×10^{-6} to 1×10^{-4} is generally acceptable. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home. For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

4.2.1.3. Far-Field Impacts

Far-field impact analyses were performed using the CALMET/CALPUFF modeling system (Version 6.0, dated April 14, 2006) to predict air quality impacts from the Project and cumulative sources at far-field PSD Class I and sensitive Class II areas within the far-field modeling domain (Map 3-1). The modeling system was used to generate meteorological fields and calculate ambient concentrations and AQRV impacts for 3 years: 2001, 2002 and 2003. CALMET was used to develop wind fields and other meteorological data for the study area within the modeling domain.

A separate analysis was performed to assess the effects of the Project's and cumulative sources' NO_x, VOC, and CO emissions on ozone concentrations.

The Class I and sensitive Class II receptor areas analyzed in the far-field modeling are:

- Bridger Wilderness Area (Class I);
- Fitzpatrick Wilderness Area (Class I);
- Grand Teton National Park (Class I);
- Mount Zirkel Wilderness Area (Class I);
- Teton Wilderness Area (Class I);
- Washakie Wilderness Area (Class I);
- Bridger Antelope Trap (Class II);
- Bridger Butte (Class II);
- Dinosaur National Monument (Federal Class II, Colorado Class I);
- Flaming Gorge National Recreation Area (Class II);
- Fontenelle Reservoir (Class II);

- Gros Ventre Wilderness (Class II);
- Popo Agie Wilderness Area (Class II);
- Seedskaadee National Wildlife Refuge (Class II); and
- Wind River Roadless Area (Class II).

Predicted pollutant concentrations at these areas were compared to applicable national and state ambient air quality standards and PSD Class I and Class II increments and were used to assess potential impacts to AQRVs, which include visibility (regional haze) and acid (sulfur [S] and nitrogen [N]) deposition. In addition, analyses were performed for seven lakes designated as acid sensitive located within Class I and Class II areas to assess potential lake acidification from acid deposition impacts. These lakes are:

- Deep Lake in the Bridger Wilderness Area;
- Black Joe Lake in the Bridger Wilderness Area;
- Hobbs Lake in the Bridger Wilderness Area;
- Upper Frozen Lake in the Bridger Wilderness Area;
- Lazy Boy Lake in the Bridger Wilderness Area;
- Ross Lake in the Fitzpatrick Wilderness Area; and
- Lower Saddlebag Lake in the Popo Agie Wilderness Area.

4.2.1.3.1. *Dispersion Model Input and Options*

The CALPUFF model was used to model Project-specific and cumulative emissions of NO_x, SO₂, fine particulate matter (PMF), and coarse particulate matter (PMC). CALPUFF was run using the EPA-recommended default control file switch settings (Atkinson and Fox 2006) for almost all parameters. Deviations from EPA-recommended defaults are discussed in Appendix C. Chemical transformations were modeled using the MESOPUFF II chemistry mechanism for conversion of SO₂ to sulfate (SO₄) and NO_x to nitric acid (HNO₃) and nitrate (NO₃). Each of these pollutant species was included in the CALPUFF model runs. NO_x, HNO₃, and SO₂ were modeled with gaseous deposition, and SO₄, NO₃, PMF (PM_{2.5}), and PMC (PM_{2.5-10}) were modeled using particle deposition. Total PM₁₀ impacts were determined in the post-processing of modeled impacts.

4.2.1.3.2. *Post-Processing Procedures and Background Air Quality Data*

For criteria pollutants, ambient air concentration data collected at monitoring sites in the region provide a measure of background conditions in existence during the most recent available time period. Regional monitoring-based background values for criteria pollutants (PM₁₀, PM_{2.5}, CO, NO_x, and SO₂) were collected at monitoring sites in Wyoming and northwestern Colorado. Ambient air background concentrations were added to modeled pollutant concentrations to arrive at total ambient air quality impacts for comparison to National Ambient Air Quality Standards (NAAQS), Wyoming Ambient Air Quality Standards (WAAQS), Colorado Ambient Air Quality Standards (CAAQS), and Utah Ambient Air Quality Standards (UAAQS). These background values are based on an e-mail from Darla Potter of WDEQ to Michele Easley of BLM dated August 8, 2006.

The visibility analysis differed from previous Wyoming NEPA cumulative air quality impact studies in its update of visibility background to include the most current data available. It also used representative monitoring data collected from the Interagency Modeling of Protected Visual Environment (IMPROVE) network for the time period (2000 to 2004) that coincides with the time period that will be used to establish “baseline conditions” under the EPA Regional Haze Rule (EPA, 2003a). Monitored visibility background data that have undergone QA/QC are currently available through December 31, 2004.

The most recent lake chemistry background acid neutralizing capacity (ANC) data were obtained from the Federal Land Managers (FLMs) for each sensitive lake in the study area. The 10th percentile lowest ANC values were calculated for each lake following procedures provided from the USDA Forest Service.

4.2.1.3.3. *Class I Area Far-Field Air Quality and AQRV Impact Assessment*

CALPUFF modeling was performed to compute direct Project impacts and for estimating cumulative impacts from the Project and other regional emission sources. The analyzed alternatives represent maximum emissions scenarios that included the last year of field development, at the maximum annual construction activity rate, combined with nearly full-field production. Regional emission inventories for existing state-permitted RFFA and RFD sources were modeled in combination with each Project alternative to estimate cumulative impacts. Also, because the RFD sources are highly speculative, a scenario that consists of the Project alternatives plus all cumulative emissions less the RFD sources is also analyzed.

For each far-field sensitive area, CALPUFF-modeled concentration impacts were post-processed with POSTUTIL and CALPOST to derive: 1) concentrations for comparison to ambient standards (WAAQS, CAAQS, UAAQS, and NAAQS) and PSD Class I and II Increments; 2) deposition rates for comparison to S and N deposition thresholds and to calculate changes to acid neutralizing capacity (ANC) at sensitive lakes; and 3) light extinction changes for comparison to visibility impact thresholds.

4.2.1.3.4. *Sulfur and Nitrogen Deposition*

Maximum predicted S and N deposition impacts were estimated for each Project alternative and cumulative source scenarios. The POSTUTIL utility was used to estimate total S and N fluxes from CALPUFF predicted wet and dry fluxes of SO₂, SO₄, NO_x, NO₃, and HNO₃. Predicted direct Project impacts were compared to the NPS Deposition Analysis Thresholds (DATs) for total N and S deposition in the western U.S., which are defined as 0.005 kg/ha-yr for both N and S. Total deposition impacts from Project alternative and regional sources and background values were also compared to USDA Forest Service levels of concern, defined as 5 kg/ha-yr for S and 3 kg/ha-yr for N (Fox et al. 1989). It is understood that the USDA Forest Service no longer considers these levels to be protective; however, in the absence of alternative FLM-approved values, comparisons with these values were made.

4.2.1.3.5. *Acid Neutralizing Capacity Calculations for Sensitive Lakes*

The CALPUFF-estimated annual deposition fluxes of S and N at sensitive lake receptors were used to estimate the change in ANC. The change in ANC was calculated following the January 2000, USDA Forest Service Rocky Mountain Region's Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide (USDA Forest Service 2000). The predicted changes in ANC are compared with the USDA Forest Service's Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 microequivalents per liter (µeq/l) and 1 µeq/l for lakes with background ANC values of 25 µeq/l or less. Of the lakes in the study area identified by the USDA Forest Service as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive as they have ANC values of less than 25 µeq/l (6 and 10.8 µeq/l, respectively) (Appendix C, Table 4-9).

4.2.1.3.6. *Visibility*

The CALPUFF model-predicted concentration impacts at far-field PSD Class I receptors were post-processed with CALPOST to estimate potential impacts to visibility (regional haze) for each analyzed alternative and cumulative sources for comparison to visibility impact thresholds. CALPOST estimated visibility impacts from predicted concentrations of PMC, PMF, SO₄, and NO₃ using the

original IMPROVE reconstructed mass extinction equation (Malm, et al. 2000) as recommended by FLAG (2000) and EPA (2003a, b).

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in FLAG (2000) report results as a percent change in light extinction over Natural Background Conditions. The thresholds of concern are defined as 5% and 10% changes over the reference background visibility for project sources alone and cumulative source impacts, respectively. Visibility impacts have also been expressed as a change in deciview (dv) over Natural Background where a 1.0 and 0.5 change in dv is essentially numerically equivalent to a 10% and 5% change in extinction over Natural Background. The BLM considers a 1.0 dv change as a significant adverse impact; however, there are no applicable local, state, tribal, or federal regulatory visibility standards. Note that a 10% change in extinction and a 1.0 change in dv over natural conditions are almost equivalent metrics.

Five visibility assessment methods (1, 2, 3a, 3b, and 4) were used to analyze the potential visibility impacts due to the Project alone for its various alternatives and the Project plus the cumulative emissions, as discussed in Appendix C. These methods differ on which background Natural Conditions are used (FLAG, IMPROVE or EPA Default) and whether hourly (MVISBK=2) or monthly (MVISBK=6) relative humidity adjustment factors [f(RH)] are used.

4.2.1.3.7. Ozone

The ozone issue in southwestern Wyoming is complicated by the fact that elevated ozone levels have been recorded in the winter, which is in contrast to most areas whose highest ozone events occur during the summer. Consequently, the concept of an “ozone season” is difficult to define for the region. Thus, an entire year was simulated in order to capture all potential high ozone conditions in the region. A photochemical grid model was used to model 8-hour ozone concentrations resulting from the Proposed Action and alternatives and for cumulative sources.

There are two main photochemical grid models that are currently being used to address 8-hour ozone issues:

- The Community Multi-scale Air Quality (CMAQ) modeling system (Byun and Ching, 1999) developed by EPA that is publicly available with no fee from the CMAS Center (<http://www.cmascenter.org/>); and
- The Comprehensive Air-quality Model with extensions (CAMx) that was developed by ENVIRON (2006) that can also be downloaded for free (www.camx.com).

Both CMAQ and CAMx are current state-of-science models capable of simulating ozone formation due to new sources, such as those being considered in this application. For this study, the CAMx model was selected for the following reasons:

- CAMx includes algorithms for enhancing photolysis rates due to the presence of snow on the ground, which is important because some of the highest ozone measurements recorded in southwestern Wyoming have occurred in the winter when snow is present;
- CALMET meteorological data can be processed for input to CAMx, whereas CMAQ is designed to run solely off meteorological data from MM5 or WRF – the MM5 and WRF prognostic models have difficulty in simulating stagnant conditions because they try to “organize” the simulated flows, and therefore overestimate wind speeds during periods of light winds. On the other hand, if stagnant observations are input into CALMET they will be reflected in the CALMET wind fields;
- CAMx incorporates two-way grid nesting that allows concentrations to feed back and forth between coarse and fine grids, whereas CMAQ only supports one-way grid nesting that just

- allows concentrations to flow from the coarser to the finer grids, but not vice versa. Thus, CAMx will be able to estimate ozone impacts over a larger area more cost-effectively;
- CAMx includes a flexi-nesting feature that allows for the run time interpolation of coarse grid data to finer grids that is not available in CMAQ; and
 - CAMx is easier to use and more flexible.

A detailed description of the model development, the emissions used, and the modeled results are contained in Appendix C, Section 5. The impact of the Proposed Action and alternatives and other new sources in the region (cumulative emissions) on ozone concentrations were analyzed using the following methods. Detailed descriptions of these methods are contained in Section 5.4 of Appendix C.

- The first approach follows EPA's guidance for projecting future year ozone concentrations for determining attainment of the ozone NAAQS.
- The second approach uses the modeled absolute model predictions and compares the modeled fourth highest 8-hour ozone concentration estimates with the 8-hour ozone NAAQS.

4.2.2. Significance Criteria

4.2.2.1. Near-Field Pollutants

4.2.2.1.1. Criteria Pollutants

Potential impacts to air quality would be significant in the near-field if potential concentrations of criteria pollutants (PM₁₀, PM_{2.5}, CO, NO₂, and SO₂) exceed the applicable WAAQS or NAAQS standards.

4.2.2.1.2. Hazardous Air Pollutants

Potential impacts to air quality would be significant if potential HAP concentrations exceeded applicable RELs or RfCs.

4.2.2.2. Far Field Pollutants

4.2.2.2.1. Criteria Pollutants

Potential impacts to air quality would be significant in the far-field if potential concentrations of criteria pollutants (PM₁₀, PM_{2.5}, CO, NO₂, and SO₂) exceed the applicable PSD increment.

4.2.2.2.2. Sulfur and Nitrogen Deposition

Potential impacts would be significant if deposition exceeded the USFS levels of concern (LOC) for total N and S deposition.

4.2.2.2.3. Acid Neutralizing Capacity for Sensitive Lakes

Potential impacts would be significant if potential decreases in ANC values exceeded the USFS Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 µeq/l and 1 µeq/l for lakes with background ANC values of 25 µeq/l or less.

4.2.2.2.4. Visibility

Potential impacts would be significant if the visibility impacts at any Class I area exceeds the applicable LOC, as estimated by the BLM method.

4.2.2.3. Ozone

Potential impacts would be significant if modeled concentrations exceed threshold set for any of the analysis methods described in section 4.2.1.3.7.

4.2.3. Direct and Indirect Impacts

4.2.3.1. Near-field Impacts

4.2.3.1.1. Criteria Pollutants

Construction Emissions

When the maximum modeled concentrations of criteria pollutants for construction emissions were added to representative background concentrations, it was demonstrated that all criteria pollutant concentrations for all alternatives comply with the WAAQS and NAAQS.

The total 24-hour PM_{2.5} value of 32 µg/m³ was closest to the NAAQS standard of 35 µg/m³, with half of the total value representing the background concentration. All other total criteria pollutant values were well below standards.

Project Emissions

Maximum predicted pollutant concentrations from project sources were also shown to be below the PSD Class II Increment for all pollutants. In addition, when these impacts are combined with representative background concentrations, they are below the applicable WAAQS and NAAQS.

The total 24-hour PM_{2.5} value for all alternatives was 34 µg/m³, only slightly below the NAAQS standard of 35 µg/m³, with background contributing approximately one-half of the total value. The total 24-hour PM₁₀ value for all alternatives was 149 µg/m³, only slightly below the WAAQS/NAAQS standard of 150 µg/m³, with background contributing approximately one-third of the total value. All other PM values for all alternatives were well below standards.

NO₂ and CO total values were all well below standards for all alternatives. Annual NO₂ values for the Alternative C (60 µg/m³) were approximately twice those of the Proposed Action (34 µg/m³), with all values being less than the WAAQS/NAAQS annual standard of 100 µg/m³. CO values were all an order of magnitude lower than the standards for both 1 hour and 8 hour averaging times for all alternatives, with Alternative C being approximately 20% higher than the Proposed Action. Alternative A values were less than the Proposed Action while Alternative B would be expected to have potential levels between those estimated for the No Action and Alternative C.

Hazardous Air Pollutants

Modeling indicated that from all operations short-term HAP concentration would be one to two orders of magnitude below the REL or IDLH values for all scenarios and that the maximum predicted long-term (annual) HAP impacts at the nearest residence locations in Granger would be one to four orders of magnitude below the RfC for all scenarios. In addition, formaldehyde impacts at Granger are shown to be below the RfC thresholds when Project source impacts are combined with regional source impacts.

Under the MLE scenario, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is below 1×10^{-6} for all alternatives. For formaldehyde, the risk is 3.5×10^{-7} for all alternatives. For benzene, the risk ranges from 5.2×10^{-8} for Alternative C to 3.7×10^{-8} for the Proposed Action, to 2.2×10^{-8} for Alternative A/No Action. It is likely that Alternative B would have benzene values between those predicted for the Proposed Action and Alternative C.

Under the MEI analyses, for each modeling scenario, the risk for formaldehyde is 3.1×10^{-6} . For benzene, the risk ranges from 4.7×10^{-7} for Alternative C to 3.4×10^{-7} for the Proposed Action, to 2.0×10^{-7} for Alternative A/No Action. Alternative B would have values no greater than those predicted for Alternative C.

4.2.3.2. Far-field Impacts

4.2.3.2.1. Criteria Pollutants

The maximum predicted concentrations of NO₂, SO₂, PM₁₀, and PM_{2.5} at any receptor within the PSD Class I areas for each modeled Project alternative are shown in Appendix C, Table 4-11. The highest estimated concentration impacts at any Class I area and any Project alternative occurs for Alternative C at the Bridger Wilderness Area (Bridger). Most of these impacts are 1% or less than the PSD Class I area increments. The largest impact is for 24-hour PM₁₀ where Alternative C values are estimates at approximately 6% of the PSD Class I area increment at Bridger. The far-field results demonstrate that the maximum air quality impacts for the Proposed Action and alternatives would not be expected to exceed any PSD Class I increment at any Class I area.

Appendix C, Table 4-12 also displays the maximum estimated PSD pollutant concentrations at Class I areas due to the various alternatives plus the cumulative emissions inventory and compares them to the PSD Class I increments. The highest modeled impacts would occur in the Bridger Wilderness Area as a result of the cumulative emissions plus the project emissions for Alternative C. These impacts include:

- Less than 1% of the PSD Class I increments for annual, 24-hour and 3-hour SO₂ concentrations;
- Less than 3% and 20% of the PSD Class I area increments for annual and 24-hour PM₁₀, respectively; and
- Less than 8% of the PSD Class I area increment for annual NO₂.

The estimated air quality impacts due to any of the alternatives plus the cumulative emissions would not exceed any PSD Class I area increment at any Class I area.

The CALPUFF-estimated maximum concentration of any alternative and the cumulative emissions at any Class I area were combined with the existing maximum background concentrations (Appendix C, Table 4-5) in the region to obtain a total estimated concentration that is compared against the NAAQS, WAAQS, UAAQS, and CAAQS (Appendix C, Table 4-13). The maximum CALPUFF-estimate impact due to any alternative plus the cumulative sources always occurs at the Bridger Class I Area and always occurs for Alternative C. When the Project plus the cumulative potential impacts at any Class I area are added to the maximum background concentrations to obtain a total concentration, no federal or state ambient air quality standards are exceeded.

In summary, the modeling results indicate that, for the Proposed Action and alternatives, neither direct impacts nor cumulative source impacts would exceed any air quality standards (WAAQS, UAAQS, CAAQS, and NAAQS) or PSD Class I area increments. The PSD demonstrations are for informational purposes only and do not constitute a regulatory PSD increment consumption analysis.

4.2.3.2.2. Sulfur and Nitrogen Deposition

Modeling results for the Project and the Proposed Action and No Action alternatives indicate that there is no direct Project total N or S deposition impacts above the NPS western DAT (0.005 kg/ha/yr) at any Class I area (Appendix C, Table 4-14). For Alternative C, the maximum nitrogen deposition at the Bridger Class I area just barely exceeds (0.006-0.007 kg/ha/yr) the NPS DAT (0.005 kg/ha/yr) for

the three years of modeling (Appendix C, Table 4-14b), but at the other Class I areas they are below the DATs.

For the Project alternatives plus the cumulative emissions, the estimated S deposition is well below the NPS DAT for all three years of modeling and all Class I areas (Appendix C, Table 4-15). The total N deposition at several of the Class I areas caused by the combination of the alternatives and cumulative emissions exceeds the NPS DAT. The maximum estimated annual N at any Class I area for the Project plus cumulative emissions occurs at the Bridger Class I area for 2001 with values of 0.031, 0.034 and 0.029 kg/ha/yr are estimated for the Proposed Action, Alternative C, and Alternative A/No Action, respectively. Values for Alternative B would likely fall in the range of conditions between the Proposed Action and Alternative C. Although these maximum N deposition impacts are above the NPS DAT, they are approximately a factor of 100 lower than the Forest Service 3.0 kg/ha/yr level of concern.

4.2.3.2.3. Acid Neutralizing Capacity Calculations for Sensitive Lakes

ANC calculations were performed for each of the alternatives plus cumulative emission (Appendix C, Table 4-16). The maximum changes in ANC are estimated to range from 0.4% to 1.4% so the deposition impacts from direct project and cumulative emissions would not contribute significantly to an increase in acidification at any of the five sensitive lakes with background 10% ANC values > 25 µeq/l. The Upper Frozen Lake in the Bridger Wilderness Area is the only lake starting with 10% ANC < 25 µeq/l for which we have ANC calculations, and a change in ANC greater than 1% may be a cause for concern. For the Upper Frozen Lake, where a change in ANC greater than 1% is of concern, the change in ANC due to the cumulative emissions plus project emissions are 13.4% for the Proposed Action, 15.2% for Alternative C, and 12.0% for Alternative A/No Action. Alternative B would not have ANC values greater than those predicted for Alternative C. Thus, the project emissions plus the cumulative emissions may impact ANC at the Upper Frozen Lake for all alternatives.

4.2.3.2.4. Visibility

The BLM considers a 1.0 change in d_v (10% change in extinction) to be a significant impact. Due to the Project alone, only Alternative A/No Action has no days exceeding this threshold. Estimates for the Proposed Action indicate that between 1 and 3 days across 3 years at Bridger (0.09% to 0.3% of the time) exceed this threshold using the 4 methods. Similar results for Alternative C range from 2 to 23 days (0.2% to 2.0% of the time). Impacts for Alternative B would be no greater than those predicted for Alternative C.

4.2.3.3. Ozone

Table 4-1 summarizes the potential ozone concentrations. Using these projection techniques the potential maximum 8-hour ozone concentrations for the Proposed Action would be below the 8-hour ozone NAAQS.

Table 4-1. Maximum projected 8-hour ozone concentrations near the Project and in the 4 km grid domain due to Base Case emissions plus the Cumulative Emissions and comparisons with the NAAQS.

Domain	8-Hour Ozone NAAQS (ppb)	Projected Maximum 8-Hour Ozone (ppb)	
		EPA Guidance Approach	Absolute Model Predictions
Near the Project	85	76.6	77.8
4 km Domain	85	77.6	83.8

Alternative A/No Action has emissions that are much lower than the Proposed Action with NO_x and VOC emissions that are 26% and 7% of the Proposed Action, respectively. Thus the No Action alternative would have lower ozone than the Proposed Action alternative so would also not jeopardize compliance with the 8-hour ozone NAAQS.

Alternatives B and C have NO_x and VOC emissions that are, respectively, 1.96 and 2.30 times the Proposed Action alternative emissions. The maximum ozone increment near the Project due to the Proposed Action alternative was 2.5 ppb. Assuming the larger of the NO_x/VOC emissions increase for Alternatives B and C (2.30) gives an estimate of the ozone increment of 5.75 ppb (2.3 x 2.5). When added to the 75 ppb maximum background we get a conservative estimate of a maximum 8-hour ozone concentrations of 80.8 ppb, which is still below the 8-hour ozone NAAQS. Although ozone formation is non-linear so the 2.30 factor is uncertain, it is likely a conservative estimate of the effects of emissions from Alternatives B and C on ozone concentrations in the area and still leads to ozone that is well below the 8-hour ozone NAAQS.

4.2.4. Residual Impacts

Because emissions will cease after the LOP, no residual air quality impacts are expected. However, in areas where deposition occurs there would be some residual impacts.

4.2.5. Mitigation

ANC values for Upper Frozen Lake exceed the significance threshold. Mitigation would likely do little to immediately reduce the potential ANC issues in Upper Frozen Lake. All alternatives, including the No Action are well above the significance threshold and implementation of mitigation in the MAA would do little to reverse this. However, operators should phase in cleaner drilling rigs and equipment to reduce the emissions from oil and gas development activities.

4.3. Geology and Mineral Resources

4.3.1. Surface Geology and Topography

4.3.1.1. Introduction

Impacts to topography and surface geology would be caused by surface disturbance resulting from well pad, access road, pipeline, and associated facilities construction. Impacts would be similar across all alternatives, differing in the amounts of disturbed acreage. The low relief over much of the MAA, avoidance of streams and riparian areas, and BLM guidelines discouraging construction in slopes exceeding 25% (BLM 1990) would reduce the levels of cut-and-fill construction required and the resultant impacts on topography.

4.3.1.2. Significance Criteria

Impacts to topography would be considered significant if surface-disturbing activities caused permanent alterations to local drainages that resulted in major changes to runoff patterns. In particular, drainage alterations with the potential for negative impacts to wetland or riparian communities in or downstream of the MAA would be considered significant.

4.3.1.3. Direct and Indirect Impacts

Impacts to topography are assumed to be proportional to the degree of surface disturbance of each alternative.

4.3.1.3.1. *Proposed Action*

Implementation of the Proposed Action would result in short-term disturbance to surface geology of 18,650 acres (3.92% of the MAA, Table 2-2). Approximately 12,300 acres of short-term disturbance would occur within the core area (2.59% of the MAA, 5.78% of the core), and 6,350 acres of short-term disturbance would occur within the flank (1.33% of the MAA, 2.41% of the flank). Approximately 6,990 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 5,997 acres (1.26% of the MAA), of which approximately 2,265 acres would occur on federally administered lands. When combined with existing disturbance related to oil and gas development in the MAA, a total of 14,070 acres would be disturbed over the life of the project (LOP).

4.3.1.3.2. *Alternative A*

Implementation of Alternative A/No Action would limit surface-disturbing activities within the MAA to those previously approved and would result in short-term surface disturbance of 10,921 acres (2.30% of the MAA, Table 2-3). Approximately 5,971 acres of short-term disturbance would occur within the core area (1.25% of the MAA, 2.80% of the core), and 4,287 acres of short-term disturbance would occur within the flank (0.90% of the MAA, 1.63% of the flank). Approximately 5,129 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 2,848 acres (0.60% of the MAA), of which approximately 1,424 acres would occur on federally administered lands. When combined with existing disturbance in the MAA, a total of 10,921 acres would be disturbed over the LOP.

4.3.1.3.3. *Alternative B*

Long-term impacts to topography and surface geology resulting from Alternative B would be similar to Alternative A/No Action. Although the total number of wells that could be drilled and overall surface disturbance over the LOP would be the same as Alternative C, the long-term surface disturbance after successful interim reclamation would remain below the 10,921 acres predicted for the No Action. Short-term disturbance prior to successful interim reclamation could be as high as Alternative C over the life of the project (approximately 33,235 acres within the core area and 12,338 acres within the flank) with no more than 10,921 acres disturbed at any given time.

To achieve a reduction in surface disturbance the operators could employ a variety of development and reclamation techniques including drilling multiple wells from a single well pad; centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors.

Directionally drilling new wells from existing pads on federal lands would reduce some of the surface disturbance associated with drilling up to 5,165 new wells. However, these impacts would only be reduced on federally administered lands and/or minerals and overall reductions in surface disturbance for the project would be expected to be minimal. However, if operators used directional drilling technology on private and state lands, the reduction in surface disturbance would be much greater. Table 4-2 describes the expected reduction in surface disturbance that would occur if wells in the federal mineral estate were drilled directionally. If 100% of all new wells on federally administered lands/minerals were drilled directionally from existing well pads, overall surface disturbance could be reduced by as much as 14,564 acres.

Centralizing production facilities could be utilized in some portions of the Moxa Arch; especially in areas with higher drilling densities (i.e., downhole and pad spacing of less than 80 acres). Centralizing facilities could also potentially reduce disturbance associated with roads if they were reclaimed back to two-tracks and used only to access the wellhead when necessary for maintenance activities.

Table 4-2. Estimated reduction in oil and gas related surface disturbances that would result from directionally drilling specified percentages of 1,995 federally administered wells in the core from currently existing well pads. Estimates for 0% are the same as for Alternative C.

% Of Wells Drilled Directionally from Existing Pads	Total Short-term Disturbance on Federal Lands	Reduction of Disturbance
0	24,637	0
10	23,180	1,456
25	20,996	3,641
50	17,355	7,282
75	13,714	10,923
90	11,530	13,107
100	10,073	14,564

Co-location of roads and pipelines in common rights-of-way would also reduce disturbance across the entire MAA. Reduction in long-term disturbances that might be associated with gathering pipelines as a result of using common rights-of-way with roads would reduce surface disturbance approximately 350 acres in the MAA when compared with the Proposed Action.

4.3.1.3.4. *Alternative C*

Implementation of Alternative C would result in short-term surface disturbance of 45,573 acres (9.58% of the MAA, Table 2-4). Approximately 33,235 acres of short-term disturbance would occur within the core area (6.98% of the MAA, 15.61% of the core), and 12,338 acres of short-term disturbance would occur within the flank (2.59% of the MAA, 4.69% of the flank). Approximately 24,637 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 15,357 acres (3.23% of the MAA), of which approximately 8,339 acres would occur on federally administered lands. When combined with existing disturbance in the MAA, a total of 23,430 acres would be disturbed over the LOP.

4.3.1.4. Residual Impacts

The final reclamation recontouring requirement indicates that there would be no significant residual impacts to topography from any alternative. Appendix E contains information related to reclamation procedures that would be used.

4.3.2. Geohazards

4.3.2.1. Introduction

Potential geohazards in the vicinity of the MAA include landslide and slump features, seismic activity, and the presence of mined-out areas. As discussed in Chapter 3, the MAA is considered to have a generally low risk for geologic hazards.

Impacts to project facilities and personnel from geohazards could conceivably result from landslides or slumps or from earthquake activity. Implementation of the Proposed Action or any alternative is not anticipated to trigger any geologic hazard.

4.3.2.2. Significance Criteria

Geohazards associated with implementation of the Proposed Action or an alternative action would be considered significant if there were a high potential for damage to project facilities or for risk of

serious injury or death to workers. Geohazard impacts would also be considered significant if they could be triggered by implementation of oil and gas development activities.

4.3.2.3. Direct and Indirect Impacts

Regardless of alternative, landslide risks would generally be restricted to steep slopes and bluffs adjacent to perennial streams and along the sides of residual mesas. The risk of such effects is considered to be low, based on avoidance of construction on slopes exceeding 25%, avoidance of perennial water bodies, and the absence of major mapped landslides in the MAA.

The MAA is situated within a low-risk seismic zone. The three earthquakes historically mapped within the MAA have all been of very low intensity, and the MAA does not overlie known or suspected faults capable of generating large seismic events. No impacts to geohazards have been identified for any project alternative.

4.3.2.4. Residual Impacts

No residual geohazard impacts have been identified.

4.3.3. Paleontological Resources

4.3.3.1. Introduction

The BLM uses the PFYC system to rate the potential for recovery of scientifically important fossils. In the MAA, both the Bridger Formation and Laney Member of the Green River Formation are rated 5, which is the highest possible ranking. Impacts to paleontological resources would result from construction-associated excavations into MAA bedrock formations.

4.3.3.2. Significance Criteria

Impacts that would have the potential to damage or destroy fossils of scientific importance would be considered significant. Scientifically important fossils generally include most well-preserved and complete vertebrate skeletons, but they could also include invertebrate fossils that provide important taxonomic, stratigraphic, or paleoecologic information.

4.3.3.3. Direct and Indirect Impacts

Excavations that affect only Quaternary-age deposits would not result in potential loss or recovery of scientifically important fossils. Direct impacts could be either negative, involving the destruction of important fossils, or beneficial, involving the discovery of important fossils that would otherwise have gone undetected. Increased human presence during the excavation process could lead to illegal collection of fossils. Indirect impacts would include long-term academic access to scientifically important fossils that may be uncovered during construction.

Because the entire MAA bedrock surface carries a PFYC ranking of 5 (highest), impacts are considered to be proportional to the level of surface disturbance for each alternative and are not separately analyzed.

4.3.3.4. Residual Impacts

Residual impacts to paleontological resources have not been identified.

4.3.4. Mineral Resources

4.3.4.1. Introduction

The Moxa Arch is a prolific producer of natural gas and is situated immediately adjacent to the world's largest trona reserve. The eastern portion of the MAA is located within areas considered potentially exploitable for trona. A portion of the MAA overlies the MMTA; therefore, the potential for conflict between natural gas and trona development exists. Oil and gas leasing and development are in conformance with the Kemmerer RMP.

Projected and existing production data were obtained from the Proponents for the analyses presented for mineral resource sections. These data were limited to estimates for the Proposed Action. Following development of a production schedule for the Proposed Action alternative, modifications were made to generate production schedules for the other alternatives. The alternative production schedules were based on a field-wide type decline curve provided by the operators (EOG Resources 2006). These alternative production schedules are considered to be reasonable and have been approved by the BLM's Wyoming State Reservoir Management Group (Chase 2006).

Impacts to mineral resources would include extraction and depletion of as much of the remaining gas reserve within the MAA as is economically feasible during the LOP. Impacts to other mineral resources under current and foreseeable economic conditions are limited to conflicts between oil and gas development and underground trona mining.

A portion of the MAA comprising approximately 33,200 acres overlies the MMTA. In proportion to the area of surface ownership in the entire MAA (which closely approximates mineral ownership), slightly more non-federal wells (54% of MMTA acreage) and slightly fewer federal wells (43% of MMTA acreage) would be affected by the MMTA drilling restriction. The MMTA restriction would apply to approximately 0.7% of the MAA core and to approximately 12% of the MAA flank.

4.3.4.2. Significance Criteria

Impacts to mineral resources would be considered significant in the event that:

- Conflicts with other resources or values result in the inability to extract the vast majority of the maximum technically-recoverable portion of the natural gas resource or trona resource,
- Conflicts with other resources or values, or mitigation measures imposed for the protection of other resources or values, resulted in production costs exceeding the economic viability of producing the resource, or
- Access to economically recoverable resources were restricted or prohibited.

4.3.4.3. Direct and Indirect Impacts

Implementation of any of the alternatives would result in varying levels of depletion of the non-renewable natural gas resource. The restrictions on gas development over portions of the MAA resulting from conflicts with trona mining would be considered a significant negative impact to resource recovery.

Impacts to other mineral resources and indirect impacts to mineral resources have not been identified. Summaries of oil and gas development by surface ownership for each alternative are indicated in Tables 2-3, 2-4, and 2-5.

4.3.4.3.1. Proposed Action

Implementation of the Proposed Action would result in the drilling of 1,861 new wells. Of this total, 1,226 are expected to be drilled in the MAA core (310 federal wells and 916 non-federal wells), and the remaining 635 will be drilled in the flank (385 federal and 250 non-federal wells). The Proposed Action is expected to recover at least 1,800 BCF of natural gas (710 BCF from federal wells and 1,090 BCF from non-federal wells) and 12.5 million barrels of condensate. The Proposed Action would recover approximately 60% of the estimated technically recoverable resource for the MAA. Figure 4-1 illustrates the anticipated decline in production over the life of the project for each alternative.

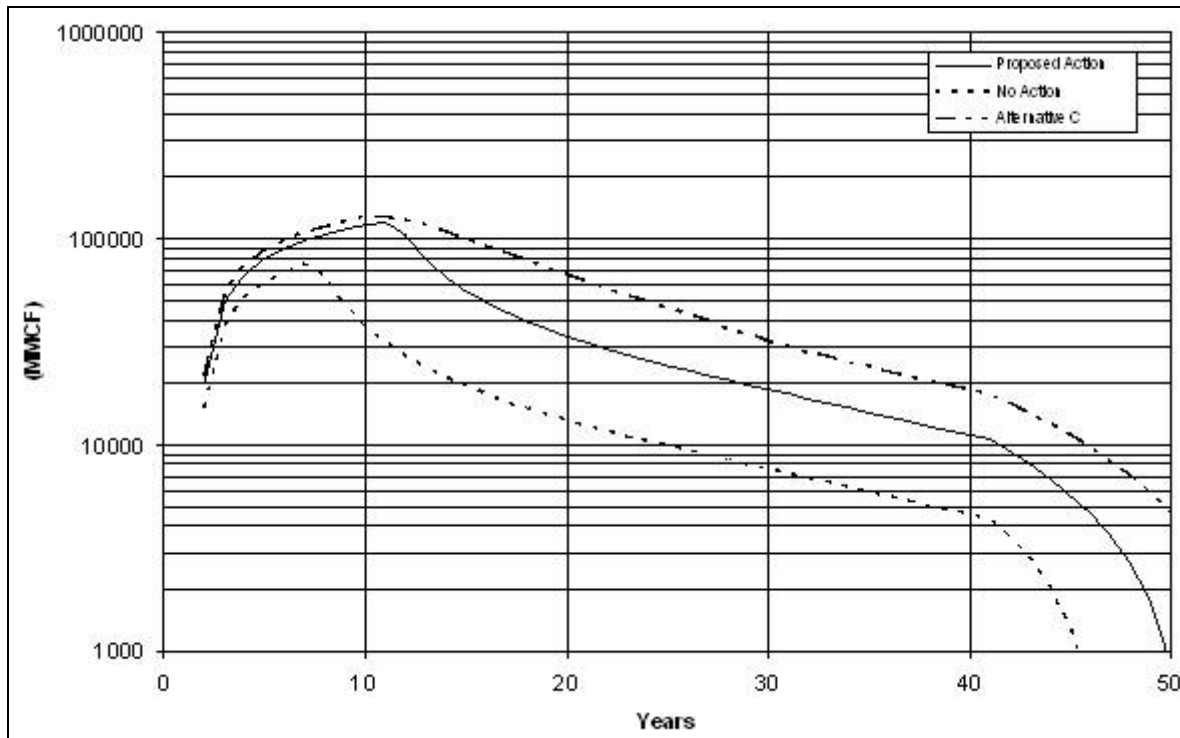


Figure 4-1. Estimated Recoverable Gas Resources in the MAA under Each Alternative. Recoverable Gas for Alternative B would be Identical to Alternative C.

4.3.4.3.2. Alternative A

Under Alternative A/No Action, 670 new wells would be drilled, as authorized under the 1997 Moxa Arch EIS ROD. Although the increased well density would result in additional gas recovery, a reduction in per well recoveries would occur as smaller volumes per well are drained. Per well recoveries would also be greater than those calculated for the Proposed Action (0.967 BCF). For this analysis, an average per well recovery of 1.1 BCF has been estimated. Alternative A is projected to recover approximately 737 BCF of natural gas and 5.1 millions barrels of condensate over a time period similar to that of the Proposed Action. Alternative A would involve recovery of approximately 24.5% of the estimated technically recoverable resource for the MAA. No impacts to trona recovery would occur due to the current MMTA restrictions.

4.3.4.3.3. Alternative B

Implementation of Alternative B would recover the same amount of the natural gas resource as Alternative C even if directional drilling technologies were applied to minimize surface disturbance. In the Moxa Arch, directionally drilled wells recover the same amount of the gas resource as vertically drilled wells (personal communication, Matthew Warren, BLM Petroleum Engineer). Continued enforcement of the MMTA drilling restriction would remove approximately 246 wells from the total

of 5,165. However, if MMTA restrictions are lifted or relaxed over the 25-year drilling phase, those wells could become available for drilling. If this were to occur, trona recovery could be impacted.

4.3.4.3.4. *Alternative C*

Under Alternative C, 5,165 wells would be drilled, including 3,763 in the core and 1,402 in the flank. Well density would increase to approximately one well per 44 acres in the core and one well per 173 acres in the flank. Total gas recovery would increase, while per well recoveries would be less than those calculated for the Proposed Action. Based on rig availability estimates, the 5,165 wells will be drilled over an approximate 25-year period. Continued enforcement of the MMTA drilling restriction would remove approximately 246 wells and well pads from the total of 5,165. However, if MMTA restrictions are lifted or relaxed over the 25-year drilling phase, those wells could become available for drilling. If this were to occur, trona recovery could be impacted.

The recoverable natural gas under Alternative C would be approximately 2,560 BCF and approximately 18 million barrels of condensate. Average per well recoveries would drop to approximately 0.5 BCF. For the production schedule, a lower initial production rate and steeper decline rate was assumed for wells drilled later (after year 10) in the estimated 25-year drilling period. Alternative C would recover approximately 85% of the estimated technically recoverable resource for the MAA.

4.3.4.4. Mitigation

Restriction on oil and gas development within the MMTA is the principal negative impact to oil and gas resources. No mitigation measures that would allow concurrent gas recovery from within the MMTA have been identified.

On a case-by-case basis, technologies such as directional drilling, horizontal drilling, mat drilling, and others would be evaluated to reduce surface disturbance impacts.

4.3.4.5. Residual Impacts

Residual impacts associated with mineral resource development would be the result of leaving technically recoverable mineral resources in the ground. Economics drives the recoverable reserves and other alternatives may become economical when technologies change.

4.3.5. **Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts**

Impacts to geologic, mineral, and paleontologic resources are principally limited to direct impacts. No residual impacts have been identified. Impacts to topography and paleontology would be proportional to the levels of surface disturbance for each alternative and would be less than significant for all alternatives. Provided that required mitigation occurs, the potential for impacts from geohazards associated with implementation of any alternative is considered to be very low and less than significant. Information on specific proposed mitigation measures is provided in Appendix A. Impacts to mineral resources, which would be limited to the depletion of natural gas resources, are dependent on the number of wells allowed under each alternative. Continued enforcement of the ban on oil and gas development within the MMTA, which applies to all alternatives, would have effects on gas recovery proportional to the number of wells proposed in the MMTA for each alternative. Because Alternatives B and C are the only alternatives with potential wells that could occur in the MMTA, they are the only alternatives that could have significant impacts to minerals.

4.4. Soils

4.4.1. Introduction

Potential impacts to MAA soils from access road, well pad, pipeline, and ancillary facilities construction and operation would result from the exposure and disturbance of in-place soils and both short-term and long-term loss of soil productivity. Anticipated soil exposure to the elements and disturbance is based on construction and operational requirements to blade/level, excavate/move, or loosen and/or compact soil materials, as well as to disturb existing steep slopes and create steep slopes of disturbed surfaces.

Adverse impacts could limit potential reclamation success for any post-construction, affected soil due to instability (soil movement and loss by erosion), long term soils compaction, loss of soil materials (erosion), loss of sub-surface biological components, undesirable mixing of soil horizons, and suitability of growth media represented by replaced or disturbed-in-place soil materials. However, these impacts, when coupled with additional inherent limitations to successful reclamation that characterize those problematic/sensitive soils that are present within the MAA, would pose even greater challenges to successful reclamation. Appendix E contains information related to reclamation procedures that would be used.

Field development in the MAA would result in disturbance of both sensitive and non-sensitive soil types. The estimated area of disturbance for each of the sensitive/problematic soil types in the MAA for three of the four alternatives is provided in Table 4-3. Surface disturbance estimates for Alternative B are not included in Table 4-3 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Acres of impact for the alternatives are in addition to existing disturbance in the MAA. The poor quality and limited quantity of topsoil and the high erodibility and potential for accelerated erosion of the materials comprising the sensitive soil types pose the greatest challenges to successful soil stabilization, reclamation, and restoration of protective and productive vegetative cover following construction, for both interim and final reclamation efforts (BLM 1995b).

In addition to natural limiting factors inherent to the sensitive soil types, additional limitations on post-construction and reclamation success may result from accidental releases of contaminants, including hydrocarbons and other hazardous chemicals, which may limit revegetation establishment and success and may indirectly contribute to surface water contamination via runoff from contaminated soil surfaces.

4.4.2. Significance Criteria

Impacts to soils would be significant if one or more of the following occurred:

- Non-compliance with the Kemmerer RMP.
- Non-compliance with Wyoming BLM Standards for Healthy Rangeland, Standard 1.
- Location and construction of project facilities on Sensitive Soils without the commitment to apply appropriate and adequate design and control measures to stabilize affected soils and to revegetate those portions of disturbed areas caused by construction that are no longer needed for operations.
- Accelerated soil erosion of disturbed areas.
- Failure to re-establish a native vegetative cover equal to 80% cover of comparable, adjacent undisturbed lands within the timeframes specified in Appendix E and in the appropriate Onshore Oil and Gas Order.

Table 4-3. Anticipated Disturbance Acreages for Sensitive and Non-sensitive Soils Types.

Disturbance Type	Core/ Flank	Sand Dune Soils*	Steep Slopes >25% >200 ft	Badland Soils	Saline/ Sodic Bottomland Soils*	Wetland Soils	Floodplain Soils	Non-sensitive Soils
Alternative A								
Construction and Field Development	Core	981	7	402	710	34	145	3,691
	Flank	515	19	188	602	41	87	2,833
Post Interim Reclamation	Core	272	2	112	197	9	40	1,024
	Flank	143	5	52	167	11	24	786
Proposed Action								
Construction and Field Development	Core	1,827	43	798	1,339	158	541	7,662
	Flank	681	28	571	244	66	136	4,551
After Interim Reclamation	Core	589	14	257	431	51	173	2,470
	Flank	218	9	183	78	21	44	1,456
Alternative C								
Construction and Field Development	Core	5,079	108	1,959	3,378	306	998	21,394
	Flank	1,490	52	960	646	121	270	8,802
After Interim Reclamation	Core	1,716	36	655	1,141	103	335	7,225
	Flank	500	17	322	217	41	90	2,951

* Impacts for sand dune soils might be overestimated because they are generally avoided due to significant cultural resource issues. When this occurs, development will occur in other soil types and could potentially raise impacts to those soil types.

4.4.3. Direct and Indirect Impacts

Implementation of any of the four alternatives would result in disturbance of both sensitive and non-sensitive soil types. The estimated area of disturbance for each of the sensitive/problematic soil types in the MAA for each of the four alternatives is provided in Table 4-3. Construction and field development impacts are quantified as acres disturbed from construction of well pads, roads, pipelines, and related facilities. Post interim reclamation or residual impacts are quantified as acres of disturbance that remain after interim reclamation of pipelines and those portions of roads, well pads, and other related facilities that would not be used during operations. Locations of roads, wells, pipelines, and other facilities have not yet been identified; therefore, site-specific impacts on soils are not assessed in this analysis. The poor quality and limited quantity of topsoil and the high erodibility and potential for accelerated erosion of the materials comprising the sensitive soil types pose the greatest challenges to successful soil stabilization, reclamation, and restoration of protective and productive vegetative cover following construction for both interim and final reclamation efforts (BLM 1995).

4.4.3.1. Proposed Action

The Proposed Action would result the direct impact of 18,645 acres of soil resources during construction and field development. Of this area approximately 12,213 acres of disturbance would occur in non-sensitive soils (Table 4-3), and approximately 6,432 acres of new disturbance would occur in sensitive soils that pose unique limitations to successful implementation of reclamation measures and long-term maintenance of protective and productive vegetative cover (Table 4-3). Implementation of an interim reclamation program, would attempt to reduce disturbance to approximately 3,926 acres in non-sensitive soils (Table 4-3), and 2,068 acres in sensitive soils.

4.4.3.2. Alternative A

Alternative A/No Action will result in the direct impact of 10,255 acres of additional soil resources during the construction and field development. Of this area approximately 6,524 acres would occur in non-sensitive soils, and 3,731 acres of the new disturbance would occur in sensitive soils (Table 4-3) during construction and field development. After interim reclamation, disturbance would be reduced to approximately 1,810 acres in non-sensitive soils (Table 4-3), and 1,034 acres in sensitive soils. Operator committed mitigation identified in the 1997 ROD (BLM 1997a) could reduce these disturbance estimates to approximately 1,500 acres in non-sensitive soils and 800 acres in sensitive soils. Although impacts to soils within the MAA are anticipated, the continued application of BLM-required mitigation measures outlined in Sections II, III, and IV of the 1997 ROD (BLM 1997a) would minimize impacts.

4.4.3.3. Alternative B

In order to remain under the 10,921 acre surface disturbance cap, there will be an emphasis on successful reclamation under Alternative B. This would reduce impacts to sensitive soils that pose unique limitations to successful reclamation and long-term maintenance of protective and productive vegetative cover. However, this would likely increase short-term and long-term disturbance in non-sensitive soil types across the MAA. Short-term impacts in non-sensitive soils would likely be greater for Alternative B than for Alternative C because of the increased emphasis on reclamation.

To achieve a reduction in surface disturbance the operators could employ a variety of development and reclamation techniques including drilling multiple wells from a single well pad; centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors. Minimizing topsoil removal would keep soil microbial and faunal communities relatively intact and increase potential success of reclamation activities.

Technologies to reduce topsoil removal (i.e., mat drilling) could be investigated for use in the MAA per the operators Proposed Action. This technique could also be used during final reclamation and abandonment. If operators could minimize or eliminate topsoil removal during final reclamation activities, the long-term impacts to soils in the MAA would be greatly reduced. Directionally drilling new wells from existing pads on federal lands would reduce some of the surface disturbance associated with drilling up to 5,165 new wells (Table 4-2).

Burying gathering pipelines in or adjacent to access roads and use of common ROWs and utility corridors would reduce surface disturbance to sensitive and non-sensitive soils in the project area. Overall, 350 acres of surface disturbance, most in non-sensitive soils, would be expected from implementation of this alternative on federally-administered lands and minerals.

4.4.3.4. Alternative C

Of the anticipated 45,563 acres of disturbance in the MAA during construction and field development, approximately 30,196 acres would occur in non-sensitive soils, and 15,367 acres of the new disturbance would occur in sensitive soils that pose unique limitations to successful implementation of reclamation measures and long-term maintenance of protective and productive vegetative cover (Table 4-3). After interim reclamation, disturbance would be reduced to approximately 10,176 acres in non-sensitive soils (Table 4-3), and 5,173 acres in sensitive soils.

4.4.4. Mitigation

Additional mitigation information is provided in Appendix A. Sensitive soils should be avoided where possible, due to high potentials for post-disturbance, accelerated erosion, and poor reclamation

potential. Appendix E contains information related to reclamation procedures that would be used in addition to the Operators' proposed reclamation strategy. The limited quantities and quality of topsoil and the high potential for accelerated erosion on surfaces of these soil types would pose limiting conditions to successful reclamation. To preclude significant impacts in these soil types, roads, well sites, and pipelines should not be located in areas with slopes greater than 25%, in badland soils, or in sand dune soils. Where avoidance is not feasible, site-specific construction should incorporate special soil stabilization and erosion control measures as part of the application of mandated BMPs (BLM 1997a). Operators need to work to limiting the amount of time well pads and soils are disturbed. This would include evaporation pit drying time reductions methods, use of larger topsoil stockpiles (increases the initial disturbance area), seed topsoil piles, use of micro inoculants, use of irrigation methods during drought conditions, use of mat drilling technology to reduce impacts to soils, utilize smallest area necessary to drill wells etc.

Avoiding stripping of topsoils during final reclamation would minimize impacts to soils in the MAA. This could be accomplished if operators recontoured and reclaimed the portions of the well pads that would not be used during operations and maintenance activities.

Floodplain and wetlands soil types should also be avoided where possible to prevent significant impacts to these soil types and to minimize potential future impacts to any facilities constructed in these areas.

Other sensitive soil types should also be avoided, but the application of site-specific engineering design and features could be used to minimize impacts below significance criteria.

4.4.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

During project construction, implementation of the Alternative A/No Action Alternative and its approved, ongoing development would initially affect 10,255 acres of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 2,844 acres.

Implementation of either the Proposed Action would initially affect 18,645 acres (3.9%) of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 5,994 acres.

Implementation of Alternative B could initially affect up to 45,563 acres (9.6%) of the MAA depending on the reclamation success rate. Interim reclamation efforts during well production would reduce disturbance acreage to a residual of 2,844 acres.

Implementation of Alternative C would initially affect 45,563 acres (9.6%) of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 15,349 acres. The application of additional BMPs, mandated as part of Alternative A, would effectively reduce the residual acreage and support successful final reclamation efforts and avoidance of significant impacts.

4.5. Water Resources

4.5.1. Surface Water

4.5.1.1. Introduction

The majority of surface disturbance would occur within the Blacks Fork Watershed, particularly the Sevenmile Gulch, Lower Hams Fork, Dry Muddy Creek, Lower Blacks Fork, and Middle Blacks Fork hydrologic units. Proportionally, the Shute Creek, Sevenmile Gulch, and Middle Blacks Fork hydrologic units have the greatest percentage of their total surface areas within the MAA (72%, 95%, and 81%, respectively); therefore, these units would be most impacted by actions in the MAA.

4.5.1.2. Significance Criteria

Project impacts would be considered significant if they resulted in a violation of RMP objectives, downstream water rights, and/or water quality standards for salinity. Changes to water quality would be significant if WDEQ water quality class or WGFD class objectives were not met; the project did not comply with the federal CWA or state water quality standards; and/or increased salinity loading resulted in non-compliance of the Salinity Control Act. Currently, waters in the Wyoming portion of the Colorado Basin are rated good to very good for salinity, and no waters are listed for salinity-related impacts. Impacts to surface water resources would be considered significant if:

- Water quality is degraded beyond the designated use of the receiving water body or other violations of federal or state water quality standards occur, or a water body listed on the State 303d list of Impaired or Threatened Waterbodies is negatively impacted.
- Salt loading to the Colorado River System increases above background conditions.
- There is a net loss of wetlands or wetland function (EO 11990).
- Project-related activities degrade wetland/riparian areas such that, as a minimum physical state, PFC is not being maintained.
- Stream flow characteristics are altered such that established users are affected.
- Erosion and runoff alters the physical characteristics of streams or drainages, beyond what would be expected with natural processes.

4.5.1.3. Direct and Indirect Impacts

Impacts to surface waters could occur as a result of usage and changes to quality. Potential impacts could include increased levels of water flow and runoff, increased sediment yields and corresponding changes to salinity and turbidity, accidental spills, and increased water consumption and resulting water depletions.

The magnitude of impacts to surface waters would depend on the proximity of the disturbance to drainage channels (minimum 500 feet, per Kemmerer RMP directives); slope, aspect, and gradient; degree and area of soil disturbance and vegetation density; soil character; duration of activities; and length of time between impacts and implementation of mitigation measures. Impacts would likely be greatest shortly after the start of construction and would decrease in time due to natural stabilization, reclamation, and revegetation efforts. Removal of vegetation and soil disturbance would potentially increase erosion and sedimentation of surface waters in the MAA and downstream.

The degree of potential impact to individual watersheds depends on the total acreage of the watershed and the percentage of that watershed that falls within the MAA (Table 3-12). Impacts were calculated by determining the acreage of well pads, pipelines, and roads that fall within a watershed. Table 4-4

shows the acres of surface disturbance in the four major watersheds that overlap the MAA and the percentage of the overall watershed area affected before and after interim reclamation. Surface disturbance estimates for Alternative B are not included in Table 4-4 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Drilling and completion disturbances could be similar to those reported for Alternative C while the disturbance after interim reclamation will likely be more similar to Alternative A/No Action.

Table 4-4. Acres of Surface Disturbance Within the Four Major Watersheds that Overlap the MAA and Percent of the Watershed Affected.

Development Phase	Acres/ %	Upper Green	Upper Green-Slate Creek	Blacks Fork	Muddy Creek
Alternative A					
Drilling and Completion	Acres	0	4,495	5,762	0
	%	0	0.47	0.33	0
After Interim Reclamation	Acres	0	1,248	1,600	0
	%	0	0.13	0.09	0
Proposed Action					
Drilling and Completion	Acres	160	4109	14332	48
	%	0.01	0.4	0.8	0.01
After Interim Reclamation	Acres	51	1325	4603	15
	%	< 0.01	0.1	0.3	< 0.01
Alternative C					
Drilling and Completion	Acres	251	11767	33470	85
	%	0.01	1.2	1.9	0.01
After Interim Reclamation	Acres	84	3929	11194	28
	%	0.01	0.4	0.6	0.01

4.5.1.3.1. Proposed Action

The Proposed Action would impact approximately 2.9% of Shute Creek, 3.0% of Sevenmile Gulch, and 4.0% of the Middle Blacks Fork hydrologic units (Table 4-5). Surface impacts to all other hydrologic units would be less than 2.0%. Reclamation efforts would reduce surface impacts to approximately 1.3% or less in all affected watersheds. Appendix E contains information related to reclamation procedures that would be used.

Surface Water Use

Assuming a maximum of 2.0 acre-feet of surface water per well would be required for drilling, completion, hydrostatic testing, and dust control activities, approximately 3,722 acre-feet of water would be required over the life of the Proposed Action. No more than approximately 374 acre-feet would be required in any year under the Proposed Action. Water used for drilling purposes (for all alternatives) will be obtained from the Blacks Fork, Hams Fork, and Green Rivers as a result of water appropriation permits obtained from the State of Wyoming (State Engineer's Office) and from commercial or privately owned water source wells. This level of water removal from the three river systems is not likely to have a noticeable or measurable impact to stream flows.

Table 4-5. Acres of Surface Disturbance within 15 Watersheds (5th Order) that Overlap the MAA. Disturbances for Alternative B cannot be calculated but would likely have long-term impacts after interim reclamation similar to those estimated for Alternative A.

		Upper Green		Upper Green-Slate Creek			Blacks Fork							Muddy Creek		
		Fontenelle Creek	Green River - Delaney Canyon	Slate Creek	Shute Creek	Green River	Sevenmile Gulch	Lower Hams Fork	Dry Muddy Creek	Lower Blacks Fork	Middle Blacks Fork	Upper Blacks Fork	Smiths Fork	Cottonwood Creek	Big Dry Creek	Muddy Creek
Alternative A																
Drilling and Completion	Core	0.00	0.00	83.13	2165.42	69.35	759.35	349.74	102.18	724.79	1314.44	0.00	40.33	54.92	307.38	0.00
	Flank	0.00	0.00	311.73	1820.93	44.69	597.27	428.70	180.18	189.64	238.01	0.00	140.36	283.10	52.18	0.00
After Interim Reclamation	Core	0.00	0.00	23.08	601.11	19.25	210.79	97.09	28.36	201.20	364.88	0.00	11.19	15.24	85.33	0.00
	Flank	0.00	0.00	86.53	505.48	12.41	165.80	119.00	50.02	52.64	66.07	0.00	38.96	78.59	14.48	0.00
Proposed Action																
Drilling and Completion	Core	0.00	0.00	81.69	2518.00	148.41	1673.95	1783.34	439.21	1499.76	3700.00	0.00	53.15	60.28	412.34	0.00
	Flank	3.56	156.85	261.22	894.04	206.07	517.26	864.00	357.30	232.17	1540.86	21.15	284.05	494.72	398.42	48.38
After Interim Reclamation	Core	0.00	0.00	27.63	813.97	48.09	540.78	572.90	141.47	482.06	1189.91	0.00	17.02	19.35	132.49	0.00
	Flank	1.14	50.19	83.59	286.09	65.94	165.52	276.48	114.34	74.30	493.08	6.77	90.90	158.31	127.49	15.48
Alternative C*																
Drilling and Completion	Core	0.00	0.00	781.06	7302.25	1138.28	5375.06	4100.33	1212.41	3179.34*	9186.17*	0.00	75.09	99.08	776.70	0.00
	Flank	3.27	248.02	537.91	1693.69	313.44	1704.03*	1368.31	596.41	1520.29*	2332.62*	31.62	432.10	788.24	691.95	84.59
After Interim Reclamation	Core	0.00	0.00	259.65	2435.87	380.71	1794.36	1371.27	405.08	1062.62*	3070.55*	0.00	25.16	33.13	259.58	0.00
	Flank	1.10	83.14	180.32	567.77	105.08	571.24*	458.70	199.93	509.64*	781.96*	10.60	144.85	264.24	231.96	28.36

* Portion of impacts are within the MMTA

Surface Water Quality

No significant increases in salt loading would be expected due to the small quantities of sedimentation expected with implementation of control measures. Significant degradation of water quality in water bodies listed on the State of Wyoming 303d list of Impaired or Threatened Waterbodies is not anticipated under any alternative. Effective surface runoff, erosion, and sedimentation control measures, as well as compliance with section 404 of the CWA, would provide for adequate water quality protection under all alternatives. Impacts to surface water quality for all alternatives would be identical to the Proposed Action and will not be further discussed for project alternatives.

4.5.1.3.2. Alternative A

Under Alternative A/No Action, no additional activities would affect water resources other than those currently existing or approved for the area. Alternative A would impact approximately 3.6% of Shute Creek, 1.9% of Sevenmile Gulch, and 1.2% of the Middle Blacks Fork hydrologic units. Surface impacts to all other hydrologic units would be less than 1.0%.

Surface Water Use

Approximately 1,340 acre-feet of water would be required over the life of the project for Alternative A. No more than approximately 223 acre-feet would be required in any year under Alternative A.

4.5.1.3.3. Alternative B

Short-term impacts to surface water use and quality could be as high as for Alternative C, assuming the maximum numbers of wells are drilled from individual well pads. However, through the use of various technologies, including directional drilling, the surface impacts to watersheds throughout the MAA could be reduced as described in section 4.3.1.3.3. To remain under the 10,921 acre surface disturbance cap, there will be an emphasis on successful reclamation. Therefore, long-term impacts would be similar to Alternative A, although the distribution of the wells throughout watersheds would vary.

Surface Water Use

Water use could be as high as described for Alternative C. However, it is likely that less water would be required for drilling and completion activities under Alternative B if technologies designed to minimize surface disturbance (i.e., directional drilling, mat drilling, systems to reuse drilling fluids) are implemented. These technologies would reduce water use by decreasing the amount of dust abatement that would be required and through the use of the same drilling fluids for multiple wells. Increased emphasis on interim reclamation could require more water if operators select to apply water to the soil to improve reclamation success.

4.5.1.3.4. Alternative C

The percentage of impacts to hydrologic units would be higher than for the other alternatives. Alternative C would impact approximately 7.6% of Shute Creek, 9.7% of Sevenmile Gulch, and 8.8% of the Middle Blacks Fork hydrologic unit. Surface area disturbance within all other hydrologic units would be less than 3.5%. Drilling of the additional wells would take place over 25 years, compared to the 10-year drilling duration for the Operators' Proposed Action. Therefore, impacts to surface water under Alternative C would be greater than for the Proposed Action, due to both the increased surface area disturbance and the longer project duration before reclamation.

Surface Water Use

Approximately 10,300 acre-feet of water would be required over the LOP under Alternative C. No more than approximately 414 acre-feet would be required in any year for Alternative C. This alternative would use approximately 6,578 acre-feet more water than the Proposed Action.

4.5.1.4. Mitigation

No additional mitigation is required for impacts to surface water. BLM BMPs, CWA requirements, and Wyoming water quality standards are protective of surface water uses and water quality. Appendix E contains information related to reclamation procedures that would be used in addition to the Operators' proposed reclamation strategy as described in Chapter 2 for the Proposed Action. BMPs that might be implemented to protect surface waters is included in Appendix A.

4.5.1.5. Residual Impacts

Some surface water impacts may continue even after final reclamation at the end of the project because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. Impacts to sensitive soils where reclamation, and stabilization activities would be hindered would also be long lasting and result in residual impacts to the hydrologic regime. Generally, forbs, brush, and trees reduce surface runoff more effectively than do grasses that establish first after reclamation. The Gold Book (2006) identifies that all access roads that are developed for oil and gas will be removed and reclaimed back to original contours etc. However, many of the main access points to the MAA would likely be retained by local communities and to aid with livestock operations in the future. The MAA would also likely retain numerous improved project roads where vegetation would not be re-established to pre-disturbance conditions and/or where a Travel Management plan has identified a road for retainment for other resource uses. Additionally, if disturbed soils are not reclaimed on private and state lands in the same manner as on federal lands, surface waters could continue to be affected.

4.5.2. Groundwater

4.5.2.1. Introduction

Impacts to groundwater supplies could occur as a result of usage and changes to quality. Potential impacts to groundwater include leakage of fluids from reserve pits, mixing water from aquifers of differing qualities, accidental spills in areas with a shallow groundwater table, and withdrawal from groundwater reservoirs for drilling, completion, and production activities.

Groundwater quality may be affected by mixing water from aquifers of differing qualities. However, the magnitude of mixing would be relatively small, due to the short duration of drilling time and the effects of casing and cementing efforts. Casing practices required by the BLM and the WOGCC limit the potential for movement of any materials outside the well casing and across aquifers. Well completion must be accomplished in compliance with Onshore Oil and Gas Order No. 2 guidelines. Any accidental contamination would be mitigated through an EPA groundwater clean-up program.

4.5.2.2. Significance Criteria

Impacts to groundwater would be significant if the quality did not meet WDEQ groundwater standards for domestic, agriculture, or livestock use. Changes in water quantity would be significant if endangered fish or the water rights of downstream water users were affected. Impacts would also be significant if decreases in groundwater levels limited or prevented use of existing permitted water wells in the area.

4.5.2.3. Direct and Indirect Impacts

Groundwater used for construction, drilling, and operations would come from permitted wells only. Some local depletion from these wells and the surrounding groundwater table might occur under all alternatives. Relative use of groundwater is expected to be proportional to the number of wells drilled for each alternative.

Leakage of fluids from reserve pits and related impacts would be minimal from lined pits. Potential for impacts would be greater for unlined pits; however, impacts from leakage from unlined pits would be unlikely given restrictions regarding design and location of such pits. Potential impacts of pit leakage would be minimal and the same for all alternatives.

Water wells used for the project would be deeper than most domestic and livestock wells in the area. Therefore, impacts to domestic and livestock wells would not be likely. Some groundwater contamination might occur during drilling activities as water from different aquifers is mixed. However, under current casing and cementing policies, this impact is expected to be minimal and the same for all alternatives.

4.5.2.4. Mitigation

For all alternatives, oil and gas wells will be cased below freshwater zones (less than 5,000 mg/L of total dissolved solids) and cemented to prevent the contamination of aquifers. Exploration holes will be properly plugged to prevent groundwater contamination.

4.5.2.5. Residual Impacts

With implementation of mitigation measures and casing standards, no significant residual impacts to groundwater resources are expected. If comparable measures and guidelines are not used on both state and private lands, the impacts could be more significant.

4.5.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

It is anticipated that no alternative would have significant impacts to water resources, due to RMP requirements, BMPs, and CWA requirements. Surface water and groundwater would be affected by surface disturbance in the MAA. Water in the MAA is impacted by an increase in surface runoff, sedimentation, and water use. As surface disturbance and the number of wells increase, the impacts to surface waters and groundwater quality and quantity also increase. Therefore, of the four alternatives, Alternative C would have the highest level of impact on water resources, and Alternative A/No Action would have the least impact on water resources. Impacts would be moderate for both the Proposed Action and Alternative B; however, the reduced surface disturbance and increased reclamation efforts implemented with Alternative B would likely reduce overall impacts to surface water as compared to the Proposed Action.

4.6. Noise

4.6.1. Introduction

Noise sensitive receptors in the MAA include residents, visitors participating in recreational activities, and wildlife. Most area residences are sufficiently distant from noise sources, but continuous high noise levels from traffic, construction, and operations may affect wildlife movement, breeding success, and stress levels.

4.6.2. Significance Criteria

To avoid adverse environmental impacts, the EPA standard for noise levels is 55 decibels (dBA). Due to the lack of research documenting the effects of noise levels on wildlife, noise impacts will be considered significant if they exceed the EPA maximum acceptable noise level of 55 dBA except for

raptors. Sage-grouse and raptors have been shown to be sensitive to noise impacts at levels above 49 dBA (WGFD 2004).

4.6.3. Direct and Indirect Impacts

Most noise impacts will be short-term impacts from project construction. The loudest project-related noise source — drilling and flaring operations — would produce temporary noise levels of up to 115 dBA at the source. This would be reduced to 55 dBA at 3,500 feet from the source (BLM 1991, 1995a). All project-related noise is expected to be less than 55 dBA for residents and recreators who are not directly adjacent to the source. Following well-drilling activities, noises would be reduced during normal operations. Some on-going impacts will occur due to traffic on access roads and activity at ancillary facilities and compressor sites. Human, equipment, and vehicular activity and the associated noise impacts would be more frequent and intensive as the well density and project duration increases.

4.6.3.1. Proposed Action

Under the Proposed Action, noise would exceed the 55 dBA threshold at certain locations in the MAA during drilling and completion phases. An increase in well construction, drilling, traffic, and compressor stations in the area would result in higher overall noise impacts. High levels of noise impacts would be temporary during drilling and construction and would decrease during the production phase and reclamation.

Drilling, field development, and field operations workers would be the only groups directly affected by Proposed Action-related noise disturbances for more than a brief period of time. These groups are subject to OSHA regulations regarding industrial noise protection. Grazing operators and area recreators would typically be affected by noise impacts only for brief periods while passing by sites where drilling, field development, and field operations occur.

One additional, natural gas compression facility is anticipated to be developed in coordination with the project area development, which would be a source of long-term noise impacts. These impacts would exceed the 55 dBA maximum standard at the compression site, but noise levels would be attenuated to below acceptable levels less than one mile from the compression site.

Drilling noise would occur during the 10 years following project approval. Production noise would continue for approximately 40 years during the life of the wells after drilling is completed. Noise from traffic would continue until reclamation activities are completed.

4.6.3.2. Alternative A

Under Alternative A/No Action, noise impacts would be those approved for the existing Moxa Arch developments in the 1997 ROD. Once all approved wells have been drilled, noise levels would be limited to production related sources, such as traffic, compressor stations, and reclamation equipment. Drilling noise would be completed over the next 6 years. Production noise would continue for approximately 40 years during the life of the wells after drilling is completed. Noise from traffic would continue until reclamation activities are completed. The 1997 ROD found noise impacts to be less than significant.

4.6.3.3. Alternative B

Under Alternative B, efforts to reduce surface disturbance may decrease sources for noise impacts. Noise from drilling would be limited by the number of wells authorized in a given year. Centralizing production facilities and drilling multiple wells from each pad would reduce the number of areas that would be subjected to high noise levels. However, in areas where directional drilling is used, noise

impacts could occur over a longer period because multiple wells would be drilled from the same pad and drilling time would increase. Additionally, because more wells are authorized for Alternative B, the duration of noise impacts would be longer than for the Proposed Action. The reduction in number of areas subjected to high noise would be most beneficial in big game winter range areas and within 1 mile of sage-grouse leks.

4.6.3.4. Alternative C

Noise levels from Alternative C would be similar to those of the Proposed Action; however, the drilling phase would be 25 years rather than 10 years. Alternative C allows for 3,304 more wells than the Proposed Action. Therefore, more individual sources of noise in the MAA would occur under Alternative C, and those noise impacts would continue for an additional 15 years.

4.6.4. Mitigation

Noise reduction techniques should be evaluated on a site-by-site basis during the APD process to minimize impacts to resources.

A recent study of field automation completed by BP on behalf of other MAA operators showed that remote monitoring of wells could reduce field visits by 50%. Field automation should be applied to decrease traffic in the MAA during operations, resulting in reduced noise impacts over the LOP.

4.6.5. Residual Impacts

Following well drilling activities, noise would be reduced during normal pumping operations. There would be no residual noise impacts after the LOP.

4.6.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Construction and development activities under the Proposed Action would be sufficiently distant from residences that would likely be affected by noise impacts. Noise generated from construction operations during peak activity periods could exceed 55 dBA at certain locations and cause significant impacts; however, these impacts would be temporary and would attenuate as distance from the source increases. It is anticipated that most noise impacts would be temporary during drilling and flaring operations and would likely not cause long-term significant impacts over the LOP for any alternative.

4.7. Vegetation and Wetlands

4.7.1. Plant Communities

4.7.1.1. Introduction

Vegetation removal creates short- and long-term impacts, including the modification of vegetation structure, plant species composition, and aerial extent of cover types; increased soil exposure; loss of wildlife habitat; reduced plant diversity; and loss of livestock forage. Indirect impacts include the increased potential for non-native/noxious plant establishment and introduction, accelerated wind and water erosion, changes in water runoff in habitats due to road/facility construction, soil impacts that affect plant growth (soil erosion or siltation), reduction of wildlife habitat, shifts in species composition and/or changes in vegetative density, and changes in visual aesthetics.

Continued oil and gas development in the MAA would require clearing vegetation during the construction phase. These activities, along with higher traffic volume, increase the potential for noxious/non-native plant introduction and the spread of existing invasive plant species.

4.7.1.2. Significance Criteria

Impacts to vegetation communities would be significant if there were a long-term reduction in vegetation productivity, a permanent change in species composition, a net loss of wetlands, or an increase in noxious weeds and other non-native species that contributes to unsuccessful revegetation. This includes the introduction of noxious or invasive plants into areas that were previously free of weeds or an increase in noxious or invasive species where they already exist.

Impacts to vegetation would also be significant if they violate federal, state, and local agency rules and regulations, or Kemmerer RMP management guidelines, such as:

- A violation of Section 404 of the CWA, EO 11988 (floodplain management), or EO 11990 (protection of wetlands) that would impact riparian vegetation, wetlands, and other waters of the U.S., or a decreased PFC rating of streams within or downstream of the MAA. Because wetland and riparian areas would generally be avoided, significant impacts would not be expected for any of the alternatives.
- Lack of protection for federally listed and BLM sensitive plant species.
- Non-compliance with reclamation activities required under EO 13112 (invasive species).
- Non-compliance with the BLM Standards for Healthy Public Rangelands (Standard 2 for wetland and riparian vegetation, Standard 3 for upland vegetation, and Standard 4 for sensitive species habitat).
- Short-term disturbance of a vegetation cover type that exceeds 10% of its total cover.
- Introduction and establishment of noxious or invasive plants that results in increased populations of noxious plant species.

4.7.1.3. Direct and Indirect Impacts

The estimated area of disturbance for each of the vegetation types in the MAA is provided in Table 4-6. Surface disturbance estimates for Alternative B are not included in Table 4-6 because it cannot be determined how wells would be distributed across the MAA under this alternative. Acres of impact for the alternatives are in addition to existing disturbance in the MAA. The No Action/Low Development Alternative includes additional well development that was evaluated in the 1995 EIS but has not yet been completed.

For all alternatives, disturbance to desert shrub/sagebrush and alkali scrub plant communities throughout the MAA would occur. Due to long recovery rates for the shrub species in these habitats, reclamation would primarily result in herbaceous plant recovery initially, replacing shrublands with grassland-type cover and structure. These impacts would likely occur for up to 30 years beyond the LOP.

Table 4-6. Estimated disturbance to vegetation types across alternatives in the MAA (in acres).

Disturbance Type	Core/ Flank	Wyoming Big Sagebrush	Vegetated Sand Dunes	Alkali Scrub	Barrens	Riparian/ Wetlands	Agriculture Cropland	Juniper Woodland
Alternative A								
Drilling and Completion	Core	3,428	981	899	532	65	67	-
	Flank	2,736	515	659	207	60	104	-
After Interim Reclamation	Core	952	272	250	148	18	19	-
	Flank	759	143	183	58	17	29	-
Proposed Action								
Drilling and Completion	Core	7,398	1,744	1,715	959	253	301	-
	Flank	4,400	632	362	669	148	64	5
After Interim Reclamation	Core	2,385	563	552	308	81	96	-
	Flank	1,408	202	116	214	47	21	2
Alternative C *								
Drilling and Completion	Core	20,629	4,936	4,271	2,402	471	516	-
	Flank	8,536	1,422	891	1,127	250	116	4
After Interim Reclamation	Core	6,967	1,668	1,442	810	158	173	-
	Flank	2,862	477	229	378	84	39	1

* Includes development within the MMTA

Noxious weeds and invasive plants can be introduced and become established in areas disturbed by construction, vehicle traffic, road maintenance, and topsoil removal. Therefore, all alternatives would increase the potential for introduction of noxious/invasive plants. Establishment of noxious weeds leads to displacement of native species and shifts in plant community composition and ecosystem functioning. The resulting changes in the plant community can alter wildlife habitat, wildlife and livestock forage, and the fire regime. Additionally, sites dominated by weeds often have a different visual character that may contrast with the surrounding native vegetation. Potential impacts from noxious weeds would be roughly proportional to the amount of disturbance for each alternative and will not be analyzed further.

4.7.1.3.1. *Proposed Action*

The Proposed Action would result in an estimated 18,650 acres (3.9% of the MAA) of short-term disturbance to vegetation (12,370 acres in the core, and 6,280 acres in the flank). Interim reclamation during the 10-year construction and drilling phase would reduce vegetation disturbance to 5,995 acres. This level of disturbance would be present for approximately 30–40 years prior to final reclamation of these areas. However, interim reclamation would not reduce disturbance to sagebrush or other shrub species because of the time it takes to reestablish those species. Impacts to sagebrush and shrub communities could occur for up to 30 years after the LOP.

The extent of surface disturbance at any particular time depends on the amount of disturbance and the rate of ongoing reclamation. Although most impacts would be short-term, with implementation of reclamation and revegetation plans, some plant species would take several years to re-establish to pre-disturbance conditions. Therefore, the surface disturbance from the Proposed Action would result in significant impacts to vegetation in the MAA.

The most impacted vegetation community during the drilling and completion phase under the Proposed Action would be Wyoming big sagebrush, with a disturbance of 11,798 acres (7,398 acres in the core, and 4,400 acres in the flank). Because of the large area (312,400, acres) covered by desert shrub/sagebrush, only 3.7% of the community would be impacted by new disturbance. The second most impacted vegetation community would be vegetated sand dunes, with 2,376 acres or 3.9% of its total land cover (1,744 acres in the core, and 632 acres in the flank). The third most impacted community would be alkali scrub, with a total disturbance of 2,077 acres or 4.3% of its total availability (1,715 acres in the core, and 362 acres in the flank). Disturbance to the remaining four vegetation communities would account for 2,399 acres (1,513 acres in the core, and 886 acres in the flank).

4.7.1.3.2. *Alternative A*

Under Alternative A/No Action, no additional impacts to vegetation other than those previously approved for the MAA would occur. Under current development, total disturbance to vegetation in the short term would be approximately 10,258, acres (2.16% of the MAA) (5,971 acres in the core, and 4,287 acres in the flank). After interim reclamation, disturbance to vegetation would be reduced to 2,848 acres. However, interim reclamation would not reduce disturbance to sagebrush or other shrub species because of the time it takes to reestablish those species. Impacts to sagebrush and shrub communities could occur for up to 30 years after the LOP.

The most impacted vegetation community under Alternative A would be Wyoming big sagebrush, with disturbance to 6,164 acres or 2.0% of its total land cover (3,428 acres in the core, and 2,736 acres in the flank). Vegetated sand dunes would be the second most impacted vegetation community, with disturbance to 1,496 acres or 2.4% of its total land cover (981 acres in the core, and 515 acres in the flank). Alkali scrub would be the third most impacted community, with disturbance to 1,558 acres or 3.2% of its availability (899 acres in the core, and 659 acres in the flank). Disturbance to the remaining four vegetation communities would account for 1,035 acres of disturbance (664 acres in the core, and 371 acres in the flank).

4.7.1.3.3. *Alternative B*

Under Alternative B, maximum well numbers and short-term disturbance estimates could be as high as those for Alternative C (Table 2-5). However, disturbance to vegetation communities would be reduced in order to remain under the surface disturbance limit of 10,920 acres. However, long-term impacts of Alternative B would be greater than those for Alternative A because of the time it would take to reestablish shrub species on reclaimed well pads and pipeline ROWs. While short-term recovery of grasses and forbs might occur relatively quickly and meet the required reclamation standards, the overall disturbance to shrub species would likely be similar to that predicted for the Proposed Action or Alternative C. Short-term disturbance to vegetation could be reduced through implementation of various technologies and development techniques. Techniques that could be selected by the operators to reduce impacts to vegetation include the following:

- Drilling multiple wells from a single pad to avoid sensitive areas and decrease surface disturbance. This would reduce surface disturbance and associated disturbance to vegetation. As described earlier for surface geology and topography, reduction of up to 14,564 acres of short-term surface disturbance and associated vegetation could be achieved from drilling new wells from existing well pads on federally administered lands in the core of the MAA. The majority of the reduction would be expected in sagebrush and alkali scrub vegetation communities.
- Using common utility or ROW corridors. Total reduction in surface disturbance would be the same as described for surface geology and topography. Most of the reduction would be expected in sagebrush and alkali scrub communities. However, this technique would likely have the greatest utility in sensitive soils where reclamation of the vegetation reliant on those soils is most difficult.
- Centralizing production facilities. This could reduce impacts to vegetation where centralized production is possible. It could also decrease traffic in the MAA and reduce the likelihood that weeds would spread.

An emphasis would be placed on successful reclamation of disturbed vegetation under this alternative in order to remain under the surface disturbance cap. Plant communities existing on sensitive soil types that are difficult to revegetate would likely be avoided more than they would be for other alternatives. However, successful interim reclamation would not reduce the long-term disturbance to sagebrush communities and other shrub-dominated communities because of the time it takes to reestablish those species to pre-disturbance sizes. Therefore, the short-term and long-term impacts to sagebrush communities could be the same as Alternative C over the LOP.

The extent of surface disturbance at any particular time depends on the amount of disturbance and the rate of ongoing reclamation. Although most impacts would be short-term, with implementation of reclamation and revegetation plans, some plant species would take several years to re-establish to pre-disturbance conditions.

4.7.1.3.4. *Alternative C*

Alternative C would result in a total of 45,571 acres (9.6% of the MAA) of short-term disturbance to vegetation (33,225 acres in the core, and 12,346 acres in the flank). Interim reclamation during the drilling and construction phase would reduce disturbance to 15,288 acres (11,218 acres in the core, and 4,070 acres in the flank).

Disturbance to vegetation communities would be the highest under this alternative. The most impacted vegetation community in Alternative C would be Wyoming big sagebrush, with 29,165 disturbed acres or 9.3% of its total land cover (20,629 acres in the core, and 8,536 acres in the flank). Although this does not exceed the 10% significance threshold, the total acreage disturbed is high enough that impacts would be significant. The second most impacted community would be vegetated

sand dunes, with a total of 6,358 acres disturbed or 10.4% of its total land cover (4,936 acres in the core, and 1,422 acres in the flank). The third most impacted community would be alkali scrub, with 5,162 acres disturbed or 10.7% of its total land cover (4,271 acres in the core, and 891 acres in the flank). Disturbance to the remaining four vegetation communities would total approximately 4,886 acres (3,389 acres in the core, and 1,497 acres in the flank).

4.7.1.4. Mitigation

Increasing the amount of field automation used in the MAA would reduce traffic, and would thereby reduce the impacts on vegetation from fugitive dust. Additionally, it would likely reduce the spread of noxious weeds in the MAA. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

Operators should evaluate technologies such as mat drilling or vegetation mowing to minimize disturbance to soils and vegetation.

4.7.1.5. Residual Impacts

The alternatives would potentially leave some residual impacts on the landscape even after final reclamation because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. The timeframe for re-establishment of sagebrush communities could take up to 30 years beyond the date of final well abandonment. The Project Area would also likely retain numerous improved project roads where vegetation would not be re-established to pre-disturbance conditions. If noxious weeds are not controlled on private and state lands, the vegetation on adjacent federal lands may be affected as seeds carry over and establish themselves in revegetation areas.

4.7.2. Cryptobiotic Soil Crusts

4.7.2.1. Introduction

Cryptobiotic crusts are present in limited locations in the MAA. Continued oil and gas development in the MAA requires topsoil clearing during the construction phase, which would result in disturbances to soil crusts if they are present.

Potential impacts to cryptobiotic soil crusts would be caused by surface disturbance resulting from well pad, access road, pipeline, and associated facilities construction. This type of disturbance generally results in loss of species diversity, biomass, and surface cover of cryptobiotic crust components. Impacts include decreased cryptobiotic crust productivity, accelerated invasion of exotic plants, changes in the fire regime, changes in soil structure and function, reduction in water infiltration, and increased soil erosion (Belnap et al. 2001).

4.7.2.2. Significance Criteria

Impacts to cryptobiotic soil crusts would be considered significant if surface-disturbing activities caused long-term reduction in intact crust cover, resulting in major changes to crust species composition and ecological functioning.

4.7.2.3. Direct and Indirect Impacts

All alternatives would cause similar impacts to disturbed cryptobiotic crusts. Due to the very long recovery rates for crusts and the lack of reclamation techniques, any disturbance would result in long-

term or permanent impacts. The level of impact would be proportional to the acres disturbed for each alternative.

4.7.2.4. Mitigation

Impacts to cryptobiotic crusts should be avoided to the extent possible during the APD process. If crusts are observed during on-site visits to proposed well pad locations, measures should be taken to avoid impacting those crusts.

4.7.2.5. Residual Impacts

Recovery of disturbed cryptobiotic crusts may take from 20 to 250 years, assuming the area is not disturbed again (Belnap et al. 2001). Extent, type, and intensity of disturbance are critical factors in determining recovery rates. Limiting the size of the disturbed area increases the rate of recovery.

4.7.3. Riparian and Wetland Areas

4.7.3.1. Introduction

Most of the 8,700 acres of riparian and wetland areas in the MAA are associated with perennial drainages and water bodies, although minor coverage is associated with isolated ponds, seeps, and springs. Wetland types identified in the MAA include lowland alkali scrub, riparian forest/shrub, wet meadow, playas, marsh, aquatic bed/open water, and riverine (Cowardin et al. 1979; PIC Technologies 1996).

In some cases, roads and pipelines may cross drainages, possibly impacting wetland/riparian vegetation. Any impacts from these crossings would require a Section 404 permit and would be analyzed by the USACE permit process. These unavoidable impacts should be minimized and mitigated.

Some impacts to wetlands and riparian habitat could occur as surface runoff and sedimentation increase during construction and drilling.

4.7.3.2. Significance Criteria

Impacts to riparian vegetation, wetlands, and other waters of the U.S. would be significant if a violation of Section 404 of the CWA, EO 11988 (floodplain management), or EO 11990 (protection of wetlands) occurred. Impacts to riparian areas would be significant if they decreased the PFC rating of streams within or downstream of the MAA. Because wetland and riparian areas would generally be avoided, significant impacts would not be expected for any of the alternatives.

4.7.3.3. Direct and Indirect Impacts

For the most part, impacts to wetlands and riparian vegetation would be avoided by complying with the 500-foot buffer required by BLM stipulations. All wells will remain outside the 500-foot buffer. This 500-foot buffer would effectively reduce the disturbance to wetland/riparian areas below the levels presented in Table 4-6. However, road and pipeline crossings could still impact wetland/riparian habitats. The majority of major pipeline crossings within the project area on federal surface are drilled reducing the direct impacts resulting from instream work. Many of the streams systems within the MAA are intermittent or ephemeral and would require the installation of culverts designed to hold 50 year flow events. Most perennial water sources have existing crossings (i.e. bridges) that would continue to be used throughout the development of the project. It is unlikely that additional bridge construction would be required within the MAA. It is anticipated that Alternative C

would have the greatest impact, due to the greater number of wells, but it is not possible to quantify and compare impacts for each alternative.

4.7.3.4. Mitigation

BLM stipulations restrict construction within 500 feet from stream corridors on federal lands. Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through CWA permitting, if necessary. Continued implementation of these stipulations would adequately protect fisheries and aquatic ecosystems.

Any unavoidable impacts to riparian areas or wetlands would be mitigated and would be determined during the Section 404 permitting process. Continued implementation of a 500-foot buffer around all wetland/riparian habitats should reduce impacts that would result from well pad construction.

4.7.3.5. Residual Impacts

No residual impacts to wetlands are likely to occur with successful mitigation.

4.7.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Removal of vegetation results in increased soil exposure, loss of wildlife habitat, reduced plant diversity, and loss of livestock forage. The disturbed surface area increases potential for non-native/noxious plant establishment, accelerates erosion, and changes the visual aesthetics of the area. Mitigation measures will reduce long-term vegetation impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts from vegetation removal are likely to continue after the LOP. Sensitive areas, such as wetlands, will be avoided to the extent practicable. Where impacts to wetlands are unavoidable, mitigation through the Section 404 process would reduce impacts.

Compared to Alternative A/No Action, the Proposed Action would increase disturbance to vegetation communities by 7,061 acres in the short term, and by 2,778 acres after interim reclamation. Alternative C would increase short-term vegetation disturbance by approximately 26,921 acres compared to the Operators' Proposed Action. Drilling of the additional wells would take place over 25 years, compared to the 10-year drilling duration for the Operators' Proposed Action. Therefore, reclamation of disturbed areas would take longer to reach pre-disturbance conditions. A significant overall increase in grassland-type cover and structure while shrub species recover would occur. Impacts to vegetation under Alternative C could be substantial; impacts under all other alternatives are not anticipated to be significant.

4.8. Fisheries and Wildlife

4.8.1. Fisheries and Aquatic Ecosystems

4.8.1.1. Introduction

Sedimentation, localized impacts of road and pipeline crossing, water depletions, and spread of noxious weeds, such as tamarisk, could impact fisheries and aquatic habitat. Additionally, accidental spills or other impacts to water quality could cause direct mortality of aquatic organisms, including fish. Water depletions associated with field development activities could also impact fisheries.

4.8.1.2. Significance Criteria

Impacts to fisheries would be significant if the following occurred:

- Substantial loss of habitat function or disruption of life history requirements for a species or population segment.
- Actions that result in substantial disruption, irreplaceable loss, or abandonment of vital and high value riparian habitats and aquatic resources (Table 4-7), as defined by the WGFD (WGFD 2004).

Table 4-7. WGFD Impact Thresholds for Priority Wildlife Species and Habitat from Oil and Gas Development Activities. Adapted from WGFD 2004, Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats.

Species and Habitat	Value	Impact Threshold	
		Number of Wells per Section	Cumulative Ground Disturbance Per Section (acres)
Mule Deer and Pronghorn Crucial Winter Ranges	Vital	>16 (<i>extreme impact</i>) 5-16 (<i>high impact</i>) 1-4 (<i>moderate impact</i>)	>80 (<i>extreme impact</i>) 20-80 (<i>high impact</i>) <20 (<i>moderate impact</i>)
Elk Crucial Winter Range and Parturition Areas	Vital	>4 (<i>extreme impact</i>) 1-4 (<i>high impact</i>)	>60(<i>extreme impact</i>) up to 60 (<i>high impact</i>)
Big Game Migration Corridors	Priority	>4 wells/section (<i>extreme impact</i>)	Development causing further constriction within narrow corridors (<0.5 mi wide) should be avoided.
Riparian Corridors	High	>16 (<i>extreme impact</i>) 5-16 (<i>high impact</i>) 1-4 (<i>moderate impact</i>)	No net loss of function
Aquatic Resources	Priority*	>16 (<i>extreme impact</i>) 5-16 (<i>high impact</i>) 1-4 (<i>moderate impact</i>)	Avoid to the extent reasonable
Raptor Nesting Areas	Vital	Development activity within buffers and time frames developed with state and federal agencies should be avoided.	
Native Non-game Birds	High	From April 1 through June 30, greater than 49 dBA noise levels within breeding habitat considered an impact, effects greatest for night work.	

*Muddy Creek and Smiths Fork watersheds are categorized as "Priority." Other watersheds vary in value.

4.8.1.3. Direct and Indirect Impacts

The BLM requires 500-foot buffers around all perennial water bodies and wetlands in the MAA. This level of protection would adequately protect fisheries and aquatic communities in and downstream of the Project Area. Some impacts might occur as a result of sedimentation as discussed in the Water Resources section. However, BMPs that would be applied to control sediments would likely be adequate to protect aquatic systems under all alternatives. Any new crossings that are constructed could change channel geomorphology and hydrology and have direct and indirect impacts on aquatic

ecosystems. Potential impacts to aquatic resources and fisheries are expected to be the same for the Proposed Action and the alternatives.

4.8.1.4. Mitigation

Construction should remain outside a 500-foot buffer around all streams and wetlands on federal lands.

For all new or expanded crossings on federal lands operators would provide BLM with an estimate of the wetland and riparian habitats that would be removed or modified as well as a list of BMPs that would be used to avoid impacts to those wetland and riparian habitats. Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through CWA permitting.

4.8.1.5. Residual Impacts

Residual impacts to downstream fish habitat could occur if pipelines or other equipment crossings were placed such that they disturb the flow of water or stream bottoms. Hydrology and geomorphology changes upstream and downstream from crossings may occur under all alternatives and could have residual impacts to aquatic ecosystems after the LOP.

4.8.2. Raptors

4.8.2.1. Introduction

Raptor nesting and foraging habitat is found throughout most of the MAA. Federally listed and BLM sensitive raptors are discussed in Section 4.9. All raptor species and their active nests are protected under the MBTA.

Habitat value and impact thresholds for raptor breeding areas and non-game birds are presented in Table 4-8. In general, birds are more sensitive to indirect impacts, such as unexpected noises, and the WGFD has determined that noise levels greater than 49 dBA within breeding habitat from April 1 through June 30 are a negative impact to non-game birds, especially at night (WGFD 2004).

A 0.5-mile buffer and a 1-mile buffer around the 106 known raptor nests in the MAA were used to assess potential impacts of the project alternatives on breeding raptors and their home ranges. Potential effects to these buffers, without protection measures, are shown in Table 4-8. However, active raptor nests would have disturbance-free buffers placed around them by the BLM AO during breeding activity seasons to prevent any impacts. Surface disturbance estimates for Alternative B are not included in Table 4-8 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. However, the long term disturbance would be identical to Alternative A/No Action while the short term impacts could be as high as Alternative C.

Table 4-8. Potential Impacts to Raptor Breeding and Home Range Areas in the MAA.

Activity	Core/ Flank	Disturbance within 0.5 mi of known nests (acres)	Disturbance within 1.0 mi of known nests (acres)
Proposed Action			
Drilling and Completion	Core	1380	4480
	Flank	600	1930
After Interim Reclamation	Core	444	1434
	Flank	192	618
Alternative A			
Drilling and Completion	Core	670	2036
	Flank	444	1470
After Interim Reclamation	Core	186	565
	Flank	123	408
Alternative C			
Drilling and Completion	Core	3390	11255
	Flank	1108	3564
After Interim Reclamation	Core	1144	3773
	Flank	371	1195

4.8.2.2. Significance Criteria

Impacts to raptor species would be significant if the following occurred:

- Activities contributed to unlawful ‘take’ of any migratory bird, including raptors, as defined by the MBTA.
- Actions resulted in an irreplaceable loss, or abandonment of vital and high value habitats as defined by WGFD (WGFD 2004).
- Surface disturbance from drilling and completion activities of more than 5% of area within 0.5 mile buffer around 106 known raptor nests as a measure of potential forage loss around nesting areas.

4.8.2.3. Direct and Indirect Impacts

4.8.2.3.1. Impacts Common to All Alternatives

All alternatives would have some potential for noise impacts above 49 dBA within breeding habitat (WGFD 2004). Impacts to raptors from noise would be identical to the impacts described in the Noise section earlier in Chapter 4.

In addition, development within specific distances from various species of raptors has been identified to result in the abandonment or failure of nesting raptor species. Within the MAA all species with the exception of Bald Eagle and Ferruginous Hawk have restrictions on the timing of development between February 1 and July 31 which applies to all surface disturbing activities as well as drilling, and completion activities within a ½ mile from active nests. Bald Eagle and Ferruginous Hawks have timing restrictions applied to development within 1 mile of an active nest.

4.8.2.3.2. Proposed Action

Drilling and completion activities in nesting areas could impact up to 1,980 acres or 4.3% of the 45,874 acres of habitat within ½ mile of known nests and 6,410 acres within 1-mile of known nests.

Estimated long-term impacts (following interim reclamation) would cover 636 acres within 0.5 mile and 2,052 acres within 1-mile of known nests. However, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.3.3. *Alternative A*

Without protection measures, impacts to nesting areas under Alternative A/No Action could affect up to 1,114 acres or 2.3% of estimated breeding and home range habitat within ½ mile of known nests during drilling and completion. Approximately 3,506 acres within 1-mile of known nests would be impacted by short term disturbance. Long-term impacts (following interim reclamation) would be estimated to be 309 acres within ½ mile of known nests and 973 acres within 1-mile of known nests. However, per the 1997 ROD, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.3.4. *Alternative B*

The total number of proposed wells and the overall short-term disturbance over the LOP would be identical to Alternative C. However, the overall surface disturbance at any one time would remain at or below the 10,921 acres predicted for Alternative A/No Action. The Operators would employ development and reclamation techniques to reduce surface disturbance, which would also benefit raptors. These techniques include drilling multiple wells from a single well pad (Table 4-2); centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors. The higher number of wells that would be allowed under Alternative B would create impacts that would be greater than Alternative A/No Action. However, over the LOP, successful reclamation required to remain under the 10,921 acre disturbance level would help to reduce impacts to a level below that which would be anticipated for Alternative C. Short-term impacts could be significant under Alternative B if techniques such as directional drilling from existing pads are not used.

4.8.2.3.5. *Alternative C*

Drilling and completion activities in raptor nesting areas could impact up to 4,498 acres or 9.8% of the 45,874 acres of estimated breeding and home range habitat within ½ mile of known nests. Approximately 14,819 acres of short-term impacts would occur within 1-mile of known nests. Short-term impacts would be significant for raptors under Alternative C. Estimated long-term impacts (following interim reclamation) would cover 1,515 acres within ½ mile and 4,968 acres within 1-mile. However, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.4. Mitigation

Raptor mitigation measures and BLM stipulations would be similar for all alternatives. The following seasonal and spatial mitigation measures are included for reference. However, the Kemmerer RMP would take precedence in determining the seasonal and spatial restrictions for development. BLM-established stipulations for all raptor nests would apply on a project-specific basis and would restrict activities depending on species and season. Raptor nest surveys would be conducted in suitable habitat within a minimum 0.5-mile radius of activities proposed to take place between February 1 and July 31. Where active nests are identified, surface-disturbing activity would be seasonally restricted within a 0.5-mile radius between these dates. Seasonal restrictions apply within a 1-mile radius of active bald eagle and ferruginous hawk nests between February 1 and August 15, as well as a 1-mile radius for bald eagle roosts between November 1 and April 1. A nest site should be considered active if it has been used within the past 3 years.

Seasonal restrictions would be evaluated on a case-by-case basis, and may be relaxed or waived at the discretion of the BLM. With these stipulations, the estimated impacts to raptor nests would be reduced and/or eliminated.

Additional measures that would help to mitigate impacts to raptors would include:

- Installing raptor perch avoidance structures, burying distribution power lines and/or gathering pipelines, and locating wellheads below ground surface would discourage raptor perching in the MAA. These BMPs are intended to reduce potential predation of BLM sensitive species by raptors and reduce potential for electrocution of raptors.
- Implementing noise reduction techniques and designs would reduce stress on wildlife from high noise levels. This may include remote monitoring which would reduce field visits during operations.
- Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would result in less surface disturbance and would reduce impacts to wildlife habitat. These impacts would be the same as described in the surface geology and topography section earlier in Chapter 4.

Reducing raptor perch areas would potentially protect sensitive wildlife such as sage-grouse and prairie dogs. This measure may reduce predation by golden eagles, great-horned owls, and ravens, but it would not deter some other predators (coyote, badger, red fox, and bullsnake). However, reduction of available perch areas could adversely impact raptors by reducing foraging opportunities.

4.8.2.5. Residual Impacts

Mitigation measures will reduce long-term impacts by re-establishing vegetative cover. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts to habitat from vegetation removal are likely to continue after the LOP.

4.8.3. Big Game

4.8.3.1. Introduction

Pronghorn, mule deer, elk, and moose are the big game species that occur in the MAA and are managed by the WGFD. Impacts may occur to big game seasonal ranges and migration corridors, which may affect big game populations. However, the population levels for some big game herds naturally fluctuate over time.

Fragmentation from roads and other infrastructure can affect big game and other wildlife when patch size and interior habitat availability decrease. Greater separation between suitable habitat patches can prevent dispersal and gene sharing among populations, especially smaller species, thus decreasing population viability and/or creating overcrowded habitats. As an example, a major source of pronghorn habitat fragmentation is fences with bottom wires too low for the animals to pass under, usually placed along roadways (Sawyer 2005). Creation of roads often includes addition of “edge” habitats that are less valuable to native wildlife and can harbor invasive plant and animal species that threaten the viability of interior habitats.

Modification of the behavioral or physiological state and reproductive success of some affected animals may occur as they expend more effort to avoid humans or equipment. Wildlife responses to new development will vary by species and will range from abandonment of a particular habitat to habituating to the disturbances over time (Langbein and Putman 1992). Wildlife responses to either vehicular or human disturbances also vary by factors, including type, timing, location, frequency, and predictability of disturbance (Miller 1998). Miller’s report states that wildlife can habituate to disturbances primarily if the disturbances are predictable and are perceived as non-threatening (e.g., vehicles on a well-traveled road). Another study from Wyoming reported that elk have become adapted to human activities that are repetitive or constant, such as traffic, but are displaced by people

on foot (Ward 1984). The greatest effects to wildlife would occur in areas that currently have little human presence. More roads added to an area usually attract more people to an area and can present opportunities for increased illegal and legal hunting or animal harassment.

The WGFD analysis of impact thresholds for wildlife species from oil and gas development focused on large-scale development projects occurring in sagebrush/steppe ecosystems, which includes many game species that occur in the MAA. As outlined in the WGFD report, in addition to the direct loss of habitat attributed to well pads, accompanying impacts to wildlife can occur due to roads, tanks, equipment staging areas, compressor stations, shops, pipelines, power supplies, traffic, and human activity. WGFD-prioritized big game habitat values and impact thresholds from well pad density are presented in Table 4-7.

All alternatives would require the removal or crushing of sagebrush and other woody vegetation and trampling of forbs and grasses. These vegetation impacts would affect big game breeding and foraging habitats. Direct impacts to big game habitats are shown in Table 4-9. Surface disturbance estimates for Alternative B are not included in Table 4-9 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. These acreages do not take into account BLM wildlife stipulations and mitigation measures to reduce wildlife impacts.

Of the big game species in the MAA, pronghorn are most likely to be affected by additional development because of their year-round use of the entire MAA (Map 3-8). A recent analysis determined that 60% of pronghorn habitat is included in areas of potential oil and gas development in Wyoming (Stalling 2004). A five-year research study partially funded by Shell Oil Company is underway to evaluate the effects of gas field development on pronghorn winter survival, short- and long-term responses, effects to body condition, and habitat fragmentation (Berger, Berger, and Beckman 2006). First year results showed continuing problems related to habitat fragmentation and range limited by snow depths. No significant differences in condition of pronghorns around oil and gas operations were observed. However, first year results are preliminary and might not reflect the total impact of oil and gas development.

Where mule deer come in contact with oil and gas operations there may be increased likelihood for changes in habitat use (Sawyer et al. 2006).

4.8.3.2. Significance Criteria

Impacts to big game species would be significant if the following occurred:

- Actions that result in irreplaceable loss or abandonment of vital and high value habitats, as defined by WGFD (WGFD 2004).
- Greater than 5% increase in disturbance in crucial ranges or greater than 10% increase in disturbance in non-crucial ranges in the MAA.

4.8.3.3. Direct and Indirect Impacts

4.8.3.3.1. *Impacts Common to All Alternatives*

Habitat fragmentation as a result of an expanded road network in the MAA is difficult to quantify. However, it is anticipated that Alternative C would have the highest habitat fragmentation impact because of the large number of new well pads. Alternative B and the Proposed Action would likely have lower levels of habitat fragmentation but would have a greater impact than would Alternative A/No Action.

Table 4-9. Potential Impacts to Big Game Species in the MAA.

Disturbance Type	Core/ Flank	Pronghorn Range					Mule Deer Range		Elk Range	Moose Range	
		Crucial Severe Winter Relief	Crucial Winter Yearlong	Winter Yearlong	Yearlong	Spring/Summer/Fall	Winter Yearlong	Yearlong	Crucial Severe Winter Relief	Yearlong	Winter Yearlong
Acres Available Within the MAA		17,382	153,584	25,874	69,826	209,143	37,971	23,962	35,753	45,214	7,276
Alternative A											
Drilling and Completion	Core	123	605	201	1174	3868	85	364	358	458	11
	Flank	369	590	204	412	2705	453	218	429	274	0
After Interim Reclamation	Core	34	167	56	326	1074	24	101	99	127	3
	Flank	102	164	57	114	751	126	60	119	76	0
Proposed Action											
Drilling and Completion	Core	322	3744	286	1854	6165	151	1387	427	1909	38
	Flank	351	1697	686	1445	2101	1026	151	146	610	84
After Interim Reclamation	Core	103	1205	92	596	1990	48	444	141	612	12
	Flank	112	543	220	462	672	328	48	47	195	27
Alternative C											
Drilling and Completion	Core	905	10322	613	3790	17596	608	2567	3249	3701	100
	Flank	636	3752	1106	2482	4370	1716	273	357	940	262
After Interim Reclamation	Core	305	3481	207	1278	5948	204	862	1103	1239	33
	Flank	213	1258	371	832	1465	576	92	120	315	88

4.8.3.3.2. *Proposed Action*

Pronghorn

Impacts to pronghorn under the Proposed Action are not anticipated to be significant. However significant impacts could occur if development encroaches on the pronghorn migration corridors that have been identified in the MAA.

Pronghorn use the entire MAA as seasonal range. Impacts to pronghorn crucial severe winter relief habitat from the Proposed Action would cover approximately 673 acres (3.9%) in the short term and 215 acres (1.2%) after interim reclamation (Table 4-9).

A portion of the pronghorn population uses crucial winter yearlong range all year, while other pronghorn depend on this range from December 1 to April 30 for winter survival. Short-term impacts would increase the disturbed habitat by an estimated 5,441 acres (3.5%), and long-term impacts would be increased by an estimated 1,748 acres (1.1%) within the MAA.

Activities in winter yearlong habitat from this alternative would impact 972 acres or 3.8% of available habitat in the short term, and 312 acres (1.2%) in the long term. Yearlong range short-term impacts would cover 3,299 acres (4.7%), and long-term impacts would cover 1,058 (1.5%). Short-term impacts to spring-summer-fall habitat would cover approximately 8,266 acres (4%), and long-term impacts would cover 2,662 acres (1.3%).

This alternative uses an average density of eight wells per section within the MAA core area, which is considered a “high” impact to pronghorn by the WGFD (Table 4-7). Impacts to the 12 pronghorn migration/movement routes in the MAA cannot be estimated at this time; however, the nine routes in the core area are most likely to be affected. WGFD considers greater than four wells per section, or any development causing further constriction, within narrow big game corridors to be an “extreme” impact (WGFD 2004). Only two wells per section are proposed in the flank; this would be considered a moderate impact on crucial pronghorn range.

Mule Deer

The Proposed Action alternative would increase short-term disturbance in available habitat by an estimated 1,538 acres (6.4%), and long-term disturbance by 492 acres (2%) (Table 4-9). Short-term impacts to mule deer winter yearlong range would cover an estimated 1,177 acres or 3% of the available habitat, and long-term impacts would cover 376 acres (1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to portions of mule deer habitats. No crucial mule deer ranges (winter or yearlong) or migration routes were identified within the MAA. Significant impacts to mule deer habitat would not be expected under the Proposed Action.

Elk

The Proposed Action would impact approximately 573 acres (1.6%) of the crucial severe winter relief elk habitat in the northern portion of the MAA, with 188 impacted acres (less than 1%) remaining after interim reclamation. In the core, development of more than four wells per section in elk crucial winter ranges would be considered an “extreme” impact (Table 4-7). The Proposed Action would have 8-12 wells per section in the core creating an extreme impact under WGFD definitions. The two wells per section in the flank would be considered a “high” impact. Disturbance to elk crucial severe winter relief habitat that would result from the Proposed Action would not exceed the 5% significance threshold.

Moose

Approximately 2,519 acres (5.6%) of available yearlong moose range would be impacted by this alternative (Table 4-9), with 807 acres (1.8%) of long-term impacts after interim reclamation. BLM stipulations would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Effects to moose winter yearlong habitat would cover 122 acres (1.7%) of available habitat in the short term, and 39 acres (less than 1%) after interim reclamation.

Four moose migration/movement corridors have been mapped within the MAA; however, because exact drilling pad locations have not yet been determined, impacts are difficult to predict. The known movement corridor south of Granger, where the species crosses US 30, is near the town and likely within the MMTA area; therefore, wells planned for this area should be minimal. However, construction activities near riparian areas at dawn or dusk may affect daily moose movements. Impacts may be greater seasonally as moose travel along the Blacks Fork River to and from winter yearlong habitat. Increased traffic along US 30 could increase the number of animal-vehicle collisions with moose.

4.8.3.3.3. *Alternative A*

Pronghorn

Disturbance from Alternative A/No Action within the crucial severe winter relief range would cover an estimated 492 acres (2.8%) in the short term, and 136 acres (less than 1%) in the long term (Table 4-9). Within the crucial winter yearlong range, short-term impacts would cover an estimated 1,195 acres (less than 1%), and long-term impacts would cover 331 acres (less than 1%).

Estimated impacts to winter yearlong habitat from this alternative would cover 405 acres or 1.6% of available habitat in the short term, and 113 acres (less than 1%) in the long term. Yearlong range short-term impacts would cover 1,586 acres (2.3%), and long-term impacts would cover 440 acres (less than 1%). Short-term impacts to spring-summer-fall habitat would cover 6,573 acres (3.1%), and long-term impacts would cover 1,825 acres (less than 1%).

This alternative uses an average density of four to eight wells per section within the MAA core area, which is considered a moderate to high impact to pronghorn by the WGFD (Table 4-7). Because final well pad and road alignments have not yet been decided, impacts to the 12 pronghorn migration/movement routes present in the MAA cannot be estimated at this time. The mapped routes in the core area are most likely to be affected, however.

Alternative A would maintain the four zones identified for crucial big game habitats and the cumulative limits on well pads would remain in place. Continued implementation of the No Action would not cause significant impacts to occur for pronghorn.

Mule Deer

Alternative A/No Action would increase short-term disturbance in yearlong range by an estimated 582 acres (2.4%), with long-term effects at 161 acres (less than 1%). Short-term impacts to mule deer winter yearlong range, also in riparian corridors, would cover an estimated 538 acres or 1.4% of available habitat, and long-term impacts would cover 148 acres (less than 1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to riparian habitats that occur on federal lands within the MAA. No crucial mule deer ranges (winter or yearlong) or migration routes were identified within the MAA. Continued implementation of the No Action would not cause significant impacts to occur for mule deer.

Elk

Alternative A/No Action would impact approximately 787 acres (2.2%) of crucial severe winter relief elk habitat, with a remaining 218 acres (less than 1%) after interim reclamation. This alternative uses

an average density of four to eight wells per section within the MAA core area creating an extreme impact under WGF recommendations (Table 4-7). In the flank, development would generally consist of fewer than four wells per section, which would be considered a “high” impact to crucial elk habitat. Continued implementation of the No Action would not cause significant impacts to occur for elk.

Moose

Approximately 732 acres (1.6%) of available yearlong range found along the Hams Fork and Blacks Fork Rivers would be impacted by this alternative, with 203 acres (less than 1%) of long-term impacts after interim reclamation. BLM stipulations would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Short-term impacts to moose winter yearlong habitat would cover 11 acres (less than 1%) of available habitat, and 3 acres after interim reclamation. Continued implementation of the No Action would not cause significant impacts to occur for moose.

Impacts to the four moose migration/movement corridors would be approximately the same as discussed for the Proposed Action.

4.8.3.3.4. Alternative B

Although the number of wells would be identical to Alternative C, it is likely that surface disturbance and habitat fragmentation would be reduced to stay under the 10,921 acre disturbance cap. Techniques described for Alternative B in Chapter 2 could be utilized to reduce surface disturbance reduce impacts to big game. However, even with this reduction, Alternative B would have impacts to big game species that would be greater than the No Action. Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would reduce impacts to wildlife habitat and reduce traffic in the MAA. Mowing or mat drilling could increase the rate of recovery for sagebrush and other vegetation. Because it is unknown how the operators will develop to remain under the 10,921 acre limit, Alternative B could have significant impacts to all species.

4.8.3.3.5. Alternative C

For all big game species the increased habitat fragmentation that would occur under Alternative C as a result of the increased travel network and high density development could cause significant impacts. While the long-term disturbances associated with Alternative C generally fall below the significant thresholds, the increased road density and habitat fragmentation could change the way the big game species use the MAA and push them into less favorable habitats in the flank or outside of the MAA.

Pronghorn

Surface disturbance in pronghorn crucial severe winter relief habitat under Alternative C would cover approximately 1,541 acres (8.8%) of available habitat in the short term, and 518 acres (3%) in the long term. Within the crucial winter yearlong range, short-term impacts would cover an estimated 14,074 acres (9.2%), and long-term impacts would cover 4,739 acres (3.1%). Impacts to crucial pronghorn ranges would be significant for Alternative C.

Winter yearlong habitat impacts estimated from this alternative would cover 1,719 acres or 6.6% of available habitat in the short term, and 578 acres (2.2%) in the long term. Yearlong range short-term impacts would cover 6,272 acres (9%), and long-term impacts would cover 2,110 acres (3%). Short-term impacts to spring-summer-fall habitat would cover approximately 21,966 acres (10.5%), and long-term impacts would cover 7,413 (3.5%). Significant impacts would occur for spring-summer-fall habitat and could occur for yearlong range if development is more focused in that habitat type than what is assumed for this DEIS.

This alternative uses an average density of 16 wells per section within the MAA core area, which is considered a “high” impact to pronghorn by the WGFD (Table 4-7). Impacts to the 12 pronghorn migration/movement routes in the MAA cannot be estimated at this time; however, the 9 routes in the core area are most likely to be affected. For migration routes, WGFD considers greater than four wells per section or any development causing further constriction within narrow big game corridors to be an “extreme” impact (WGFD 2004). Development of four wells per section in the flank would be considered a “moderate” impact to crucial pronghorn habitat.

Mule Deer

This alternative would increase short-term disturbance in available mule deer habitat by an estimated 2,840 acres (11.9%), with long-term effects of 954 acres (4%). Short-term impacts to mule deer winter yearlong range would cover an estimated 2,324 acres or 6.1% of the available habitat, and long-term impacts would cover 780 acres (2.1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to portions of mule deer habitats. Significant impacts would occur to mule deer habitat under Alternative C.

Elk

This alternative uses an average density of 16 wells per section within the MAA core area and four wells per section on the flank. WGFD considers greater than four wells per section in elk crucial winter ranges to be an “extreme” impact and between one and four wells to be a “high” impact. This alternative would impact approximately 3,606 acres (10.1%) of crucial severe winter relief elk habitat, with a remaining 1,223 acres (3.4%) of impact after interim reclamation. Impacts to crucial elk ranges would be significant.

Moose

Approximately 4,641 acres (10.3%) of available yearlong moose range found along the Hams Fork and Blacks Fork Rivers would be impacted by this alternative, with 1,554 acres (3.4%) of long-term impacts after interim reclamation. BLM stipulations to avoid drilling within 500 feet of wetland/riparian areas would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Effects to moose winter yearlong habitat would cover 362 acres (5%) of available habitat in the short term and 121 acres (1.7%) after interim reclamation. Impacts to moose habitat would be significant.

Impacts to the four moose migration/movement corridors within the MAA would be similar to those discussed for the Proposed Action

4.8.3.4. Mitigation

The use of seasonal development restrictions would be evaluated on a case-by-case basis in crucial winter and crucial severe winter relief habitats and should be consistent with the approved RMP for the KFO.

Any habitat lost to development in the crucial severe winter relief ranges for pronghorn and elk would need to be fully mitigated/replaced to be available to support the existing herds in severe winters. Final well pad and road alignment can be adjusted to reduce the impacts to this crucial range during the APD process. Additional proposed mitigation is presented in Appendix A and includes:

- Implementing noise reduction techniques and designs to reduce stress on wildlife from high noise levels.
- Using remote monitoring and control technologies to reduce the overall human disruptive disturbance associated with the production phase of the development. This would reduce truck traffic in the MAA by up to 50% and the associated risk of truck/wildlife collisions.

4.8.3.5. Residual Impacts

Mitigation measures would reduce long-term wildlife impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts to big game habitat from vegetation removal are likely to continue after the LOP.

4.8.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

The nature of impacts to wildlife is similar for all alternatives. With increasing surface disturbance, the potential for direct and indirect impacts to wildlife increases. The more well pads, roads, and pipelines within the MAA, the higher the level of fragmentation and decrease in habitat patch size. Raptor nests and big game habitat are protected by seasonal stipulations to protect critical breeding and overwintering periods and reduce impacts associated with surface development. Mitigation measures would reduce long-term impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some wildlife habitat takes over 30 years to return to pre-disturbance conditions, residual impacts from vegetation removal are likely to continue after the LOP.

4.9. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species

4.9.1. Federally Listed and Candidate Species

4.9.1.1. Introduction

ESA-listed threatened, endangered, or candidate species that are known to occur, or potentially occur, in the MAA include black-footed ferret, Ute ladies'-tresses orchid, and western yellow-billed cuckoo. Impacts to these species from development in the MAA include habitat loss and increased stress from human presence and equipment. Four endangered Colorado River fish species (Colorado pikeminnow, razorback sucker, bonytail, and humpback chub) found downstream of the MAA could be affected by depletions to the Colorado River system. No USFWS-designated critical habitat has been mapped for federally listed species within the MAA.

Direct impacts from project implementation, development, and operations to federally listed species that may be present in the MAA would be similar to those analyzed for general wildlife (Section 4.8). Indirect effects would also be similar to those described for general wildlife, including impacts from additional noise, dust, and human presence. These species may alter their behavior and home range use within the area of potential effect and adjacent areas. Bird species tend to be more sensitive to noise impacts and would benefit from late summer project start dates. All federally listed species that breed in the area are most sensitive to disturbance during the spring season.

No black-footed ferrets are known to occur in the MAA. However, any surface disturbance within the mapped prairie dog complex, which was determined by the USFWS to provide suitable black-footed ferret habitat, could directly impact potential black-footed ferret habitat.

4.9.1.2. Significance Criteria

Impacts to federally listed species would be significant if activities adversely affected or jeopardized threatened, endangered, or candidate species and/or any recovery program.

4.9.1.3. Direct and Indirect Impacts

4.9.1.3.1. *Impacts Common to All Alternatives*

Significant impacts would not occur to ESA protected species under the Proposed Action or any of the project alternatives. Because BLM-established BMPs and Wyoming Pollutant Discharge Elimination System (WYPDES) Program permits will be followed to prevent alteration of stream flows and reduce soil movement into drainages, no significant additional sediments are expected to enter local stream systems or affect downstream water quality.

BLM stipulations restricting construction within 500 feet of streams and in wet meadows, springs, and seeps would protect potential habitat. Therefore, no effects to the Ute ladies'-tresses orchid or western yellow-billed cuckoo are expected from any of the alternatives. The development of additional road crossings would be avoided unless no existing crossing can reasonably be used to gain access to an area of potential development. In this case, impacts to riparian habitat would be assessed on a site-by-site basis. Pipeline crossings within the MAA on federal surface are typically drilled to reduce the impacts to perennial waters.

Colorado River Fishes

Several streams within the MAA are tributaries to the Green River, which flows to the Colorado River. Impacts to streams within the MAA could potentially affect downstream suitable and occupied habitat for listed endangered fish species. These impacts include water depletions, increased sedimentation, and alterations of stream flows. Because BLM-established BMPs will be followed, which prevent alteration of stream flows and reduce soil movement into drainages, no significant additional sediments are expected to enter local stream systems or affect downstream water quality.

Also, if water depletions over 100 acre-feet annually occur, consultation with the USFWS would need to occur and appropriate mitigation decided by that agency. Impacts to Colorado River fishes resulting from water depletions are discussed in the water resource section earlier in this chapter. There is potential for greater than 100 acre-feet in depletions for all alternatives.

4.9.1.3.2. *Proposed Action*

The Proposed Action would result in short-term impacts to approximately 2,233 acres (4% of available habitat) of prairie dog habitat (Table 4-10), which could also impact black-footed ferret, and 720 acres (1.3%) after interim reclamation. Impacts to riparian habitat, which would impact Ute ladies'-tresses and yellow-billed cuckoo, would cover an estimated 365 acres (4.2% of available habitat) in the short term, and 117 acres (1.3%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

4.9.1.3.3. *Alternative A*

Alternative A/No Action would result in short-term impacts to approximately 1,898 acres (3.4% of available habitat) of prairie dog habitat, which could also impact black-footed ferret, and 524 acres (less than 1%) after interim reclamation (Table 4-10). Impacts to riparian habitat, which would impact Ute ladies'-tresses and yellow-billed cuckoo habitat would cover an estimated 125 acres (1.5% of available habitat) in the short term, and 35 acres (less than 1%) after interim reclamation (Table 4-10). However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Table 4-10. Impacts to Prairie Dog Habitat.

Prairie Dog Habitat Available in the MAA		<u>55,482 Acres</u>
Disturbance Type	Core/ Flank	Disturbance to habitat (in acres)
Proposed Action		
Drilling and Completion	Core	1,678
	Flank	555
After Interim Reclamation	Core	542
	Flank	178
Alternative A		
Drilling and Completion	Core	1,080
	Flank	818
After Interim Reclamation	Core	300
	Flank	224
Alternative C		
Drilling and Completion	Core	4,920
	Flank	1,050
After Interim Reclamation	Core	1,663
	Flank	352

4.9.1.3.4. Alternative B

The total number of proposed wells would be similar to Alternative C, however surface disturbance would be maintained below 10,921 acres at any given time. This surface disturbance cap, and the techniques employed to reduce surface disturbance and increase reclamation, would reduce impacts to protected species to levels similar to Alternative A. Reductions in surface disturbance as a result of collocation of production facilities, using common rights-of-ways, and drilling multiple wells from common pads would reduce overall impacts to protected species and their habitats.

4.9.1.3.5. Alternative C

Alternative C would result in short-term impacts to approximately 5,970 acres of prairie dog habitat, which could also impact black-footed ferret, and 2,015 acres (3.6%) after interim reclamation. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo habitat would cover an estimated 721 acres (8.3%) in the short term and 242 acres (2.8%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

4.9.1.4. Mitigation

Mitigation measures and BLM stipulations would be the same for all alternatives. Noise reduction measures would be as described in the Fisheries and Wildlife section. Qualified biologists would conduct surveys for federally listed species prior to commencement of construction activities. Black-footed ferret presence-absence surveys would be required in prairie dog colonies not included in the USFWS block clearance areas. If populations of Ute ladies'-tresses were discovered, a 500-foot buffer around those populations would be required.

4.9.1.5. Residual Impacts

Residual impacts to federally listed and candidate species would be the same as those for general wildlife.

4.9.2. Wyoming BLM Sensitive Species

4.9.2.1. Introduction

Several BLM-listed sensitive species are known to occur or potentially occur within the MAA. The BLM manages these species in an effort to prevent federal listing. Direct impacts to these species would occur from habitat loss. Indirect impacts would be similar to those discussed for general wildlife. Table 4-11 presents general impacts thresholds used for BLM sensitive species and their habitats.

Table 4-11. WGFD Impact Thresholds for BLM Sensitive Species and Habitat from Oil and Gas Development Activities

Species and Habitat	Impact Threshold	
	No. of Well Pads per Section	Cumulative Ground Disturbance per Section (acres)
Sage-grouse	>16 (<i>extreme impact</i>)	>80 (<i>extreme impact</i>)
Long-eared myotis	5-16 (<i>high impact</i>)	20-80 (<i>high impact</i>)
Trumpeter swan	1-4 (<i>moderate impact</i>)	<20 (<i>moderate impact</i>)
Pygmy rabbit		
Peregrine falcon		
Ferruginous hawk		
Long-billed curlew		
White-faced ibis		

Adapted from WGFD 2004

4.9.2.1.1. Raptors

Effects to sensitive raptor species (peregrine falcon, ferruginous hawk, and burrowing owl) that may be present within the MAA would be identical to those analyzed for non-sensitive raptors and their nests (section 4.8.2). Impacts to prairie dog habitat (Table 4-9) would directly impact burrowing owl nesting habitat and would indirectly affect other raptors by decreasing foraging habitat. With the exception of burrowing owls seasonal restriction dates cover the timeframes used by sensitive raptors and would be identical to those impacts described for general raptor species. Burrowing owls nest later and could potentially be impacted by disturbances as late as September 15th. In addition, due to the fossorial nature of this species and the fact that new nesting burrows may be chosen from year to year nest locations may be missed during field reviews of project locations.

Because of the recent removal of the bald eagle from the list of endangered and threatened species it will be analyzed as a BLM sensitive species. One bald eagle nest site has been identified in the northern MAA on Fontenelle Reservoir. Nest surveys would likely be required for all raptor species prior to individual project APD processes. Because habitat and nest protections are in place, no direct effects to bald eagles are expected from any of the alternatives. Bald eagles would likely avoid the MAA during the drilling phase and would use other suitable habitat in the region. Therefore, the project may affect individual bald eagles but is not likely to affect viability of the species in the MAA. Impacts in riparian habitats could impact the species and potential nesting and roosting sites. However, direct impacts in riparian areas are expected to be minimal. Indirect impacts to riparian habitats might cause eagles to not use roost sites during development. Increased traffic and potential collisions with wildlife could increase the potential for eagle mortality for birds scavenging along roadways that might be killed or injured by passing vehicles.

4.9.2.1.2. Greater sage-grouse

In 2005, 41 leks were determined to occur within the MAA and were identified as “occupied” (actively used within the last 10 years). As is true for all sagebrush obligate species, loss of mature sagebrush cover, which takes up to 30 years to mature, directly affects year-round habitat for the greater sage-grouse. Installation of more tanks resulting from all alternatives will increase potential perch opportunities for raptors, thereby increasing predation of sage-grouse. Table 4-12 presents potential impacts to greater sage-grouse habitat for all alternatives. These impacts would be expected to occur for up to 30 years beyond the LOP because of the time it takes for sagebrush to mature and return to its pre-disturbance size. Increased traffic during sage-grouse breeding periods could decrease breeding and nesting success (Lyon and Anderson 2003).

Table 4-12. Impacts to Potential Sage-Grouse Wyoming Big Sagebrush Habitat Over the LOP.

Greater Sage-grouse Area within 2 miles of Leks in the MAA		173,332Acres
Greater Sage-grouse Available Habitat (Desert Shrub/Sagebrush Vegetation Type) in the MAA		316,800 Acres
Disturbance Type	Core/ Flank	Disturbance (in acres)
Proposed Action		
Lek Buffer	Core	3,884
	Flank	2,433
Available Habitat	Core	7,398
	Flank	4,400
Alternative A – No Action/Low Development		
Lek Buffer	Core	2,872
	Flank	1,757
Available Habitat	Core	4,168
	Flank	3,054
Alternative C – High Field Development		
Lek Buffer	Core	11,638
	Flank	4,505
Available Habitat	Core	20,629
	Flank	8,536

It is likely that significant impacts to leks and breeding and nesting habitat have already occurred in portions of the MAA. Holloran (2005) indicated that 4.7 well pads or more within 2-miles of leks result in decreased use of leks and decreased overall nesting success. Many areas of the MAA already have densities greater than this level. Of the 41 leks in the MAA, all but 8 have more than 5 wells within 2-miles. One of the eight leks is located in the MMTA where oil and gas development is prohibited and the other 7 leks are located in the western and southern portions of the flank.

4.9.2.1.3. Sagebrush Obligate Birds

In addition to the direct loss of mature sagebrush habitat, indirect effects from edge effects and fragmentation can reduce populations of sagebrush obligates. A study conducted in the Pinedale Anticline oil and gas project area determined that breeding bird numbers, primarily sagebrush obligates, decreased by 50% within 100 m of a road due to increased traffic and predators (Ingelfinger 2001). The sagebrush obligates prefer dense sagebrush with heights above surrounding habitats and, therefore, may avoid edge habitats (Ingelfinger 2001). Additionally, fragmentation of nesting habitat could reduce the areas suitable for nesting and maintaining current population levels in the MAA.

Impacts to sagebrush obligates would increase as sagebrush disturbance increases, as analyzed by alternative in Table 4-12. Impacts for Alternative B are not included in Table 4-12 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. As with sage-grouse these impacts would be expected to occur for up to 30 years beyond the LOP because of the time it takes for sagebrush to mature and return to its pre-disturbance size.

4.9.2.1.4. Other Sensitive Birds

Impacts to sensitive birds that use the limited water habitat in the MAA, such as the long-billed curlew, white-faced ibis, and trumpeter swan would be proportional to impacts to wetland and riparian habitats. These species should not be affected if BLM protection measures to protect wetland and riparian habitat are followed. The loggerhead shrike and mountain plover would be impacted by the direct loss of habitat. Effects to suitable mountain plover habitat would be similar to those described for prairie dog habitat (Table 4-10).

The sensitive birds are migratory species; therefore, the degree of direct and indirect impacts varies by season. During reclamation, grass and forb regrowth may establish in one growing season, providing suitable mountain plover habitat. Loggerhead shrikes prefer brushy habitat that would likely take longer to establish, but because the species is widespread, they should be able to recolonize fairly readily.

4.9.2.1.5. BLM Sensitive Mammals

Impacts to pygmy rabbits would be similar to the impacts analyzed for sagebrush habitat, discussed by alternative below. However, pygmy rabbits typically only use old growth/mature sagebrush. Because sagebrush can require up to 30 years to attain a mature height able to support pygmy rabbits, its removal is considered a long-term impact. In addition to sagebrush habitat, impacts to vegetated sand dunes with tall sagebrush and ephemeral channels would also impact pygmy rabbits. Because disturbance of dunes may rarely be fully reclaimed to the original vegetative composition and structure it is felt that the removal will be a long-term impact.

Prairie dogs and most other burrowing mammals would be expected to leave areas once construction begins. However, mortality may occur to these and other burrowing animals (e.g., Idaho pocket gopher, sagebrush vole, Preble's shrew) if grading activities take place in the spring when young are present. Impacts to prairie dog complexes are shown in Table 4-10 and are discussed by alternative below. The long-eared myotis may be most affected by loss of foraging habitat and disturbance near riparian areas, primarily where road crossings would impact riparian habitat. Long-eared myotis mortality could also occur from accidental poisoning at open produced-water pits and tanks.

4.9.2.1.6. BLM Sensitive Amphibians

Impacts to riparian habitat would potentially affect the northern leopard frog and Great Basin spadefoot. Impacts to open water and wetland habitats would potentially impact the boreal chorus frog. With BLM stipulations and mitigation in place to protect riparian and wetland habitat, impacts to amphibians are not anticipated from any of the alternatives. Amphibians may attempt to use open produced-water pits for breeding, which could lead to accidental poisoning. Installation of silt fences around pits may reduce this potential impact.

4.9.2.1.7. BLM Sensitive Fish

Potential impacts to BLM sensitive fishes include water depletions, increased sedimentation, and alterations of stream flows. With BLM stipulations and mitigation in place to protect riparian and wetland habitats, impacts to BLM sensitive fish species are not anticipated from any of the alternatives.

4.9.2.1.8. *BLM Sensitive Plants*

Trelease's racemose milkvetch and large-fruited bladderpod have not been documented in the MAA, but suitable habitat is present and may be impacted by the project. Other sensitive plant species are unlikely to occur due to lack of suitable habitat, and no impacts to these species are expected. If populations were discovered, adherence to BLM stipulations would prevent impacts to these species.

4.9.2.2. Significance Criteria

BLM sensitive raptors:

- Activities contributed to unlawful 'take' of any migratory bird, including raptors, as defined by the MBTA.
- Actions resulted in an irreplaceable loss, or abandonment of vital and high value habitats as defined by WGFD (WGFD 2004).
- Surface disturbance from drilling and completion activities of more than 5% of area within 1 mile buffer around bald eagle and ferruginous hawk nests as a measure of potential forage loss around nesting areas.

Greater sage-grouse

- Well densities in the MAA greater than or equal to one well pad per 40-acres that could result in decreased use of leks or decreased nesting success and recruitment (Holloran 2005).
- Decreased lek attendance resulting from disturbance within a 2-mile buffer around each lek. Significant impacts would be expected if more than 5 wells are within the 2-mile buffer surrounding any of the 41 leks (Holloran 2005).

Sensitive fish species

- Decrease in baseflows of MAA rivers and streams that would result in loss of habitat.

Other sensitive species

- Disturbance of more than 5% of available habitat

4.9.2.3. Direct and Indirect Impacts

4.9.2.3.1. *Proposed Action*

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 2,233 acres (4% of available habitat) in the short term, and 720 acres (1.3%) after interim reclamation (Table 4-10).

Impacts to sage-grouse habitat would occur over the LOP and would not be substantially reduced after interim reclamation; however, after final abandonment, habitat will begin to recover. Approximately 11,800 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 6,300 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). Increasing well density to 8-12 wells per section in the core area proposed under the Operator's Proposed Action would constitute a "high" impact if allowed in sage-grouse breeding habitat (Table 4-11) and could cause significant impacts to occur in some areas. However, the overall impacts across the MAA would not exceed the 40-acre spacing significance threshold. The impacts within the 2-mile sage-grouse lek buffers would be significant. All of the leks in the MAA would be expected to have more than 5 well pads within the 2-mile buffer under the Proposed Action.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat would cover an estimated 365 acres (4.2% of available habitat) in the short term, and 117 acres (1.3%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Impacts to sagebrush habitat, which would impact sage-grouse as well as sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat would cover an estimated 11,798 acres (less than 1% of available habitat). Additionally, construction of new well pads and their associated roads and ancillary facilities would cause further habitat fragmentation and would likely reduce the number of habitat patches suitable for nesting.

4.9.2.3.2. *Alternative A*

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 1,898 acres (3.4% of available habitat) in the short term, and 524 acres (less than 1%) after interim reclamation.

Approximately 7,200 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 4,600 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). Well density increase to an average of four to eight wells per section would constitute a "moderate" impact if allowed in sage-grouse breeding habitat (Table 4-11) and would not exceed the significance threshold of 40-acre spacing for well pads. Continued implementation of the No Action would likely cause additional impacts to leks and brood rearing habitats within the 2-mile buffers around lek locations. Continued implementation of the No Action would be expected to decrease the number of leks in the flank that have fewer than 5 well pads within 2 miles from 8 that exist currently to 4 or 5. The decreased number of leks with fewer than 5 wells within the 2-mile buffer would be a significant impact.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat would cover an estimated 125 acres (1.5% of available habitat) in the short term, and 35 acres (less than 1%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Impacts to sagebrush habitat, which would impact sage-grouse as well as sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat, would cover an estimated 6,164 acres (less than 1% of available desert shrub/sagebrush habitat).

4.9.2.3.3. *Alternative B*

The total number of proposed wells would be identical to Alternative C. However techniques to decrease surface disturbance and increase reclamation would reduce the overall impacts to sensitive species. Consolidated facilities and drilling multiple wells from common well pads would reduce the overall foot print associated with the development of oil and gas resources as described for the surface geology and topography section as well as the vegetation section. Mowing and mat drilling could improve reclamation of sagebrush and other vegetative habitats. Because it is unknown how the operators will develop to remain under the 10,921 acre threshold for Alternative B, significant impacts could occur to BLM sensitive species; especially sage-grouse and sagebrush obligates. It is likely that under Alternative B significant impacts would occur to leks as more than 5 wells would be expected within 2 miles of all 41 leks in the MAA.

4.9.2.3.4. *Alternative C*

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 5,970 acres (10.8% of available habitat) in the short term, and 2,015 acres (3.6%) after interim reclamation. This would be a significant impact to prairie dogs.

Impacts to sage-grouse habitat would occur over the LOP and would not be substantially reduced after interim reclamation because of the time it takes for sagebrush regrowth. Approximately 29,000 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 16,000 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). The addition of 16 wells per

section in the core area proposed under the Operator's Proposed Action would constitute a "high" impact if allowed in sage-grouse breeding habitat (Table 4-11). This level of impact would be significant for sage-grouse per the 40-acre spacing significance threshold. All of the 41 leks would have more than 5 wells within the 2-mile buffer area. Alternative C would have significant impacts for sage-grouse.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat, would cover an estimated 721 acres (8.3%) in the short term, and 242 acres (2.8%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer which would reduce the total acreage that would be disturbed.

Impacts to sagebrush habitat, which would impact sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat, would cover an estimated 29,165 acres (1.7% of available habitat). Habitat fragmentation would be greatest for Alternative C creating fewer patches suitable for sage obligate nesting and life-history requirements. This could cause significant impacts to sage obligates.

4.9.2.4. Mitigation

Mitigation measures and BLM stipulations would be the same for all alternatives. Seasonal stipulations for specific BLM sensitive species are listed in Table 4-13.

Table 4-13. Recommended Seasonal Stipulations for BLM Sensitive Species.

Species	Restriction Dates	Surface Disturbance Restriction
Ferruginous hawk	February 1 – July 31	1 mile around active nests
	All Seasons	No surface occupancy within 1000 feet of active nest
Peregrine falcon	February 1 – August 15	0.75 mile around active nests
Burrowing Owl	April 1 – September 15	½ mile of known active nest or within colony where active nest was identified within previous 3 years.
Greater sage-grouse	March 1 – May 15 (lek) March 15 – July 15 (nesting)	Within 0.25 mile of leks Within 2 miles of leks or within habitats identified by biologist during onsite evaluations.
	November 15 – April 30 (winter)	In known habitat
Mountain plover	April 10 – July 10	Within potential habitat

BLM Sensitive Raptor Species

Seasonal restrictions would apply within a 1-mile radius of active ferruginous hawk nests and a 0.75-mile radius of active peregrine falcon nests. A nest site would be considered active if it has been used within the past three years. For all other raptors, including burrowing owl, the restriction would apply within 0.5-mile of active nests. Permanent structures would not be allowed within 825 feet of active raptor nests. Permanent structures would not be allowed within 1,000 feet of active ferruginous hawk nests.

Prairie dogs

Any prairie dog colony where burrowing owls have been observed in past 5 years would have seasonal restriction between April 1 and September 15. Biological contractors who conduct Black-footed ferret surveys will be required to report all observations of this species to BLM officials.

Sage-grouse

Despite the BLM-mandated buffer of two miles around active leks, studies indicate that only 45% of sage-grouse nests are likely to occur in this area; therefore, approximately 55% of sage-grouse nests could be affected by project activities outside these buffers and nesting and brood rearing habitats should be protected outside the buffers on a case-by-case basis.

Seasonal buffers and reclamation measures that replace breeding, nesting, or brood rearing habitat could reduce impacts to this species.

All wells within sage-grouse habitat should be remotely monitored and controlled to reduce impacts resulting from traffic.

If more than 5 visible well pads occur within 2-miles of any of the 41 leks, new wells within 2-miles of the lek should be drilled directionally from outside the 2-mile buffer, hidden from sight of the lek, or drilled outside the lekking and brood rearing period providing that facilities are constructed to be hidden beneath the existing vegetative height.

BLM-mandated stipulations for temporal and spatial restrictions of activity in sage-grouse habitat have been developed to reduce adverse effects (Table 4-13). No surface disturbance would occur within 0.25 mile of a lek; other human activities within 0.25 mile of an occupied lek would be avoided between 8:00 pm and 8:00 am from March 1 through May 15; activities that would potentially disturb sage-grouse would be avoided between March 15 and July 15 in suitable nesting and early brood-rearing habitat within two miles of a lek or in suitable nesting and early brood-rearing habitats that have been identified beyond two miles of a lek. On a case-by-case basis in the checkerboard area of the MAA, BLM should consider development of well facilities or pipeline facilities within 0.25 miles of a lek provided that the height of permanent structures not exceed the surrounding vegetation. If directional drilling can be used to develop the federal minerals within 0.25 miles of a lek it should be used. If not, allowing operators to develop within 0.25 miles of a lek could provide BLM greater flexibility in protecting leks on federal surface as operators would not be as likely to move well locations to immediately adjacent sections of private surface where the timing and spatial stipulations do not apply. Field evaluations may be necessary to determine presence of leks and/or nests if existing information is not current or available.

BLM Sensitive Fish Species

BLM stipulations that prohibit construction within 500 feet of streams would protect fish habitat. BMPs to control sedimentation would also protect BLM sensitive fish species. Pipelines will be bored under perennial streams to protect riparian and aquatic habitat. Impacts to BLM sensitive fish would be the same as those presented in section 4.8. Operators should use existing, valid water rights for drilling fluids to minimize reductions to baseflows.

Additional BMPs that would reduce impacts to sensitive species include:

- Installing raptor perch avoidance structures, burying distribution power lines and/or gathering pipelines, and locating wellheads below ground surface would discourage raptor perching in the MAA. These BMPs are intended to reduce potential predation of BLM sensitive species by raptors and reduce potential for electrocution of raptors.
- Implementing noise reduction techniques and designs would reduce stress on wildlife from high noise levels. This may include remote monitoring which would reduce field visits during operations.
- Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would result in less surface disturbance and would reduce impacts to wildlife habitat as previously described.

Using remote monitoring and control technologies to reduce the overall human disruptive disturbance associated with the production phase of the development. This would reduce truck traffic in the MAA by up to 50% and the associated risk of truck/wildlife collisions and decreased sage-grouse breeding and brood rearing habitat.

4.9.2.5. Residual Impacts

Residual impacts to sensitive raptors would be the same as those for general raptors.

Residual impacts to sagebrush obligate sensitive species would be directly proportional to the length of time necessary to reestablish necessary sagebrush habitats. Sagebrush obligate species may be impacted for 30 years or more after final abandonment until density of sagebrush has reestablished.

4.9.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Impacts to ESA-listed threatened, endangered, or candidate species, and BLM sensitive species would increase as the density of wells increases. Impacts include direct loss of habitat, as well as indirect impacts from increased fragmentation, noise, and human disruptive activities. Mitigation measures would protect these species and their habitat during breeding season. Residual impacts include continued habitat loss while vegetation matures to pre-construction conditions.

4.10. Cultural and Historical Resources

4.10.1. Introduction

Impacts to cultural and historical resources result directly from increased ground disturbance. Overall indirect impacts, as well as direct impacts, to cultural and historical resources would occur in direct proportion to the volume of new surface disturbance. Because of the existing level of disturbance in the MAA core, avoidance of impacts to cultural/historical resource sites is anticipated to be more difficult in the core than in the flank as a result of ground-disturbing development (Table 4-14). More acres of disturbance would make avoidance of sites more difficult, would increase the need for direct mitigation on sites, and would result in more discoveries and archaeological excavation. Indirectly, development would increase human presence and access in the MAA, which would increase the potential for illegal artifact collection and/or vandalism, as well as impacts to sites, locales, and places considered sacred, sensitive, or of importance to modern-day Native Americans. Vandalism and illegal collection impacts would occur in relative proportion to the amount of human use and the level of development in the MAA.

Table 4-14. Anticipated Impacts to Cultural Resources by Alternative.

Disturbance Type	Core/ Flank	Anticipated Impacts
ALTERNATIVE A		
Drilling and Completion	Core	Direct disturbance to cultural and historical resource sites, vandalism, and illegal collection continue at current rate, coincident with continued development of the MAA at previously approved levels. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core, with the added note that the flank has overall lower levels of disturbance and impacts to cultural/historical resources and is not planned for the density of the development intended for the core.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to visual setting at cultural/historical resource sites.
	Flank	Flank impacts are anticipated to be the same as for the core.
PROPOSED ACTION		
Drilling and Completion	Core	Increased direct disturbance to cultural and historical resource sites, vandalism, and illegal collection are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance. Implementation of BMPs will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core, except greater opportunity to avoid impacts through construction design or redesign due to fewer disturbances.
After Interim Reclamation	Core	Same as No Action Alternative; reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces the level of impact to the visual setting of cultural and historical resource sites. Implementation of BMPs will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core.
ALTERNATIVE B		
Drilling and Completion	Core	Increased direct disturbance to cultural and historical resource sites, vandalism, and illegal collection are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance; however, implementation surface disturbance reduction techniques will further aid in reducing extent of impacts, particularly in regard to visibility of development in impact to cultural and historical resource setting and in regard to potential for direct impacts to cultural and historical resources from ground disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to the visual setting of cultural and historical resource sites. Increased emphasis on reclamation success will further aid in reducing extent of impacts, particularly in regard to visibility of development in impact to cultural and historical resource setting and in regard to potential for direct impacts to cultural and historical resources from ground disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core.
ALTERNATIVE C		
Drilling and Completion	Core	More intense direct disturbance to cultural and historical resource sites, more vandalism, and more illegal collection than for any other Alternative are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance. Some mitigation from implementation of standard BMPs, as in the Proposed Action, will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core, except that effects to visual setting at cultural/historical site may be contrastingly heightened due to minimal previous flank development.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to the visual setting of cultural and historical resource sites. However greater level of ground disturbance and development under Alternative C will result in less correction of impacts as a result of reclamation than other Alternatives.
	Flank	Flanks impacts are anticipated to be the same as for the core.

Adverse impacts to properties considered important to Native American groups, would be significant under all alternatives if not satisfactorily mitigated, as determined through consultation with the SHPO, the Advisory Council on Historic Preservation (ACHP), and other interested parties. 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, including sites with human funerary remains (grave sites). Probability of significant impacts to Native American sensitive sites and TCPs would increase proportionally with the level of ground disturbance estimated for each alternative.

The Kemmerer RMP (BLM 1985) identifies management goals/objectives associated with all cultural and historical resources. These goals and objectives direct cultural and historical resource management pursuant to the NHPA, ARPA, and other statutes. Because of the requirement for compliance with federal statutes, especially 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 inventoried for cultural and historical resources. These inventories would preserve cultural heritage by protecting most cultural properties from significant damage, increasing cultural/historical resource site databases, and furthering the understanding of history and prehistory.

4.10.2. Significance Criteria

Impacts to cultural and historical resources would be considered significant if they resulted in non-mitigated impacts to National Register-eligible properties (including benchmark sites), diminishment of the aspects of site integrity, loss of scientifically important data or artifacts, a violation of the NHPA and/or ARPA, disturbance of sites that are culturally sensitive to Native American tribes, or if they violated the Kemmerer RMP (BLM 1985) goals/objectives.

In the absence of a Programmatic Agreement and Cultural Resource Management Plan, potential significant impacts to cultural and historical resources could occur under any alternative. These potential impacts arise primarily from the reactive nature of the current management situation for cultural and historical resources.

Impacts would be significant if development decreased the cultural integrity of intact trail segments or if direct disturbance of the physical trace of trail segments occurred.

4.10.3. Direct and Indirect Impacts

For all alternatives, impacts would be proportional to the amount of surface disturbance that would occur. Alternatives that have higher disturbance potential would increase the likelihood of disturbing or destroying cultural resources in the MAA. However, increased surface disturbance would also lead to increased survey and data recovery potential and could increase the knowledge of cultural and historic resources in the MAA and southwest Wyoming.

4.10.3.1. Proposed Action

BMPs that would be implemented in accordance with agency policy would aid in reducing vandalism and collection through reclamation of access routes to areas previously developed, reduction of impacts to integral historic setting of cultural and historical resources, restoration of the natural contour of ground disturbances and the painting of facilities colors that blend with the natural background, and reduction of direct impacts to cultural/historical resource sites by using development designs that minimize the extent or ‘footprint’ of ground disturbance, such as in limiting access road build-up and size and placement of facilities.

4.10.3.2. Alternative A

Prior NEPA documents concluded that there would be no significant adverse impacts to cultural and historical resources as a result of the project. Significant impacts have occurred, such as in discovery situations, and new significant impacts could still occur. Under Alternative A/No Action, fewer new cultural/historical resource inventories would be conducted as development is concluded, and fewer sites would be recorded and added to the cultural/historical resource database. Vandalism and illegal artifact collecting may decrease with reduced human presence in the area at conclusion of development, but would still continue (although at lower levels) for the LOP along eased paths of access created by development and with the continuance of human-serviced operations for production and maintenance. With the conclusion of development and in the absence of new ground disturbance, no additional unanticipated discoveries are likely to occur. Approved development (BLM 1995a) is expected to conclude in six years, after which cultural/historical resource impacts would continue for the LOP under Alternative A. No new impacts to Native American religious or culturally significant sites are anticipated beyond current levels.

4.10.3.3. Alternative B

Under Alternative B, impacts to cultural and historical resources would be greater than those of Alternative A/No Action and less than those of Alternative C. If operators implement techniques such as directional or mat drilling the impacts would likely be less than for the Proposed Action. Vandalism and illegal artifact collection would likely continue to be greatest during drilling and completion, and the duration of these impacts would continue for the LOP. Collocation of roads, power lines, and some pipelines, use of common utility ROW corridors, drilling of multiple wells from single well pads, and centralizing production facilities would reduce the amount of ground disturbance and, therefore, reduce the potential for encroachment on cultural/historical resource sites by development, while simultaneously avoiding cultural/historical resource site locations through project design or redesign. Increased use of buried lines during utility construction and minimization of the footprint of development will further reduce potential for visual disturbance impacts to cultural/historical resource settings.

4.10.3.4. Alternative C

Implementation of Alternative C would result in an increase in potential impacts to cultural and historical resources compared to the other alternatives. Cultural property avoidance may be more difficult under Alternative C compared to other development alternatives, because greater development in both the MAA core and flank area would leave less room to maneuver construction design around known cultural/historical resource sites and would increase cultural/historical resource discoveries and impacts during ground-disturbing activities. Increased development and surface disturbance would also increase the impacts to the visual setting of cultural and historical resources, particularly in the MAA flank, where fewer preexisting disturbances occur. Vandalism and artifact collection would likely be greatest during initial development, but duration of these impacts would continue for the LOP. BMPs would be the same as under the Proposed Action. The pervasiveness of development under Alternative C would necessarily cause a greater operational need for collocating access and utility routes and some other well facilities than under the Proposed Action. However, the extensive development required under Alternative C would likely negate any reduction of repetitive impacts it would achieve in comparison to the Proposed Action. Additionally, under Alternative C, human presence in the MAA would increase and ease of access to more portions of the MAA would be more pervasive, which would increase the opportunity for illegal artifact collection, cultural/historical resource site looting, and vandalism. Vandalism and illegal artifact collection would likely be greatest during development, which would be longer under the increased regime of Alternative C and would continue until project personnel are no longer required for the LOP.

4.10.4. Mitigation

The cultural/historical resource-specific mitigation measures described within this section will be the same under all development alternatives; however, BMPs required under each alternative will have varying effects on direct and indirect impacts, as described above.

Trail segments that have been identified by BLM as having high levels of integrity and convey a sense of their historic period of use (especially segments of the Blacks Fork Cutoff on federal lands in the flank of the MAA) would be managed as VRM Class II.

For trails not managed as VRM Class II, a ¼-mile buffer within which development would not occur would be applied to all traces of national historic trails. This buffer could be reduced if visual impacts can be eliminated.

Additional mitigation measures applied to cultural resources are presented in Appendix A.

4.10.5. Residual Impacts

No significant impacts will remain at cultural and historical resources after mitigation is completed. Residual impacts may only persist at cultural/historical resource sites where unavoidable adverse impacts occur without mitigation.

Unavoidable adverse impacts may occur under all alternatives. 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. Unmitigated adverse effects to eligible sites could also occur on State of Wyoming lands and private fee lands, because fewer protections are afforded to cultural and historical resources on lands falling outside BLM jurisdiction. Unexpected discoveries on state and private 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 and historical resources on State of Wyoming or private lands are implemented.

4.10.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

The greatest identifiable threats to cultural and historical resources result directly from increased ground disturbance. Under all alternatives, the overall direct and indirect impacts to cultural and historical resources would mostly occur in direct proportion to the volume of new surface disturbance. More acres of disturbance would make direct cultural property avoidance more difficult and, therefore, would increase the need for mitigation measures for cultural/historical resource sites, both known and newly discovered. Because of the existing level of disturbance in the MAA core, avoidance of impacts to cultural/historical resource sites is anticipated to be more difficult in the core areas than in the flank areas as a result of ground-disturbing development, under all alternatives. The difference in BMPs required among the alternatives affords differing levels of cultural/historical resource protection, with the more extensive BMPs providing better opportunities to avoid effects to resources; cultural/historical resource-specific mitigation measures remain the same under all alternatives. Alternatives with the highest level of proposed ground disturbance have the greatest potential to impact cultural/historical resources.

4.11. Social and Economic Impacts Including Environmental Justice

4.11.1. Introduction

This section is an evaluation of potential social and economic impacts of the proposed project. Evaluation of the impacts associated with the proposed project and alternatives must consider the existing social and economic environment of the local area, including the substantial growth that has occurred there during the past four years. Potential temporary and permanent impacts must also take into account changes in the overall economic picture of the area, including continued oil and gas exploration, expansion, and development, and construction of other proposed industrial and commercial projects.

The economic study area for this analysis includes the counties and communities most likely to be affected, as described in Chapter 3. The impacts of the Proposed Action and alternatives on the economic study area were analyzed using IMPLAN (Minnesota IMPLAN Group 2000), which is an econometric impact assessment input/output (I/O) modeling system. I/O modeling is a mathematical accounting of the flow of dollars and commodities through a region's economy. The IMPLAN database consists of two major parts: 1) a national-level technology matrix; and 2) estimates of sectorial activity for final demand, final payments, industry output, and employment for each county in the U.S., along with state and national totals.

Standard socioeconomic analysis methodology was used to estimate increases in demands on local and regional infrastructure, and state and federal revenue generation (ad valorem, severance, and mineral royalties), based on state and federal historical estimates and rate structures. Impacts from the Project are discussed for both the development (drilling and completion) and production phases (based on current production values). Economic impacts are presented in terms of nominal impacts. As presented herein, the nominal value of project activities is the simple calculation of dollars with no adjustments for inflation. No discount rates have been incorporated into revenue projections.

The Moxa Arch Area (MAA) is considered a typical Rocky Mountain oil and gas field with production levels typical of other oil fields in the region. The Moxa Arch formation does not represent a unique field; however, at current production levels the field is economically viable and meets investment criteria. Table 4-15 shows the average annual natural gas production and total production for the Moxa Arch Area compared to the estimated 2030 United States national demand. According to the estimates the total production in the Moxa Arch Area would represent between 2.5 % and 9.9% of total US natural gas consumption for one year (2030). Average annual production would supply less than 1% of the demand in the United States for any year.

Natural gas consumption in the United States has grown considerably since 1990 when the US consumed approximately 19.0 trillion cubic feet. Demand for natural gas continues to grow and is projected to increase from 22.0 trillion cubic feet in 2005 to 26.1 trillion cubic feet in 2030 depending on market conditions. Most of this growth is projected to occur before 2020. Price will be a large factor in how growth in natural gas demand occurs, as well as the price of competitive energy sources such as oil (http://www.eia.doe.gov/oiaf/aeo/pdf/trend_4.pdf).

Table 4-15. MAA Natural Gas Production Compared to National Annual Demand. 2007 national natural gas demand estimated as 22 TCF, 2030 national natural gas demand estimated as 26.1 TCF

	Average Annual Production (trillion cubic feet)	% of 2030 National Demand	Peak Annual Production (trillion cubic feet)	% of 2030 National Demand	Total Production (trillion cubic feet)	% of 2030 National Demand
Proposed Action	.036	0.14%	.121	0.46%	1.8	6.9%
No Action	.017	0.07%	.075	0.29%	0.66	2.5%
Alternatives B and C	.040	0.15%	.129	0.49%	2.59	9.9%

Source: Energy Information Administration: Annual Energy Outlook 2007 with Projections to 2030, February 2007: Report #:DOE/EIA-0383(2007)

Natural gas economic activity in the MAA will depend on 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 monthly per-well operation costs are estimated to range between \$2,500 and \$5,000, depending on operator and other factors (EOG Resources 2006). An average of \$3,500 per-well monthly operating cost will be used for the purpose of this analysis and includes direct labor and overhead, as well as non-labor costs for fuel, chemicals, disposal, surface maintenance, subsurface maintenance, gas, and electricity (EOG Resources 2006). Direct labor and overhead represents approximately 10% of all operating costs, as shown in Table 4-16. Therefore, total annual cost of operation for an average well is \$42,000. Total production and operating costs for directionally drilled wells are assumed to be the same as those for vertically drilled wells (personal communication, Matthew Warren, Kemmerer Field Office Petroleum Engineer).

Table 4-16. Average Annual Well Operating Costs (2006 \$\$).

Annual Per Well Operating Costs	Annual Cost per Well
Annual Production (average)	24,245 MCF to 27,551 MCF over LOP
Direct Labor and Overhead	\$4,200
Non-labor	\$37,800
Total Annual per Well Costs	\$42,000

Source: EOG Resources, Inc. June 2, 2006

4.11.2. Significance Criteria

According to criteria set forth by the Kemmerer RMP (BLM 1985) Green River RMP (BLM 1997b) and land use plans for the State of Wyoming (Wyoming State Land Use Commission 1979), impacts to socioeconomic resources would be considered potentially significant if any of the following were to occur:

- Increased demand for housing that exceeds supply and results from project activities;
- 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% or greater change in county government or in countywide employment.

4.11.3. Direct and Indirect Impacts

The major socioeconomic issues relevant to all alternatives are:

- The majority of the workforce associated with the Project is likely to come from outside the study area (60%). Transfer of workforce from other job sites to the Project would be minimal.
- Temporary rental and permanent housing availability is limited for all surrounding towns (Rock Springs, Kemmerer, Evanston, and outlying areas). Existing motel units and RV/mobile home spaces are insufficient to accommodate the in-migrating workforce. Housing development is rapidly occurring in the Rock Springs area, and supply should be close to meeting demand by 2009 (Robbins 2006; Crandall 2006; Kaumo 2006).
- School capacity in the region is sufficient to meet current needs. Increases in population of school-age children would impact local schools.
- Although sewer capacity is currently being doubled in Rock Springs, county water and sewer districts are currently incapable of handling large-scale development, and no mechanism is available to improve this situation for the foreseeable future. Roads throughout the counties and municipalities have already been impacted by increased truck traffic from oil and gas operations, and these impacts would be exacerbated by traffic related to the proposed project.
- Additional law enforcement personnel may be required throughout the area, depending on where workers locate. Rock Springs has recently added nine police officers to its force. Although oil and gas Operators require drug tests of their workforce, crime has increased in the area, particularly methamphetamine use.
- Increased employment during the 7- to 25-year drilling period would occur. An estimated 9.9 direct jobs and 2.4 indirect jobs would be created per well (Minnesota IMPLAN Group 2000).
- Increased employment during the 40-year production period would occur. An estimated 15.1 direct jobs and 36.4 indirect jobs would be created for every \$100 million in oil and gas production output (Minnesota IMPLAN Group 2000).
- Increased incremental annual income from employment payroll would be generated in the local study area, and associated induced economic effects of local spending by operations workers would occur. Adjusted earnings per job for direct, indirect, and induced employment is estimated at approximately \$58,300 (2006\$) (Minnesota IMPLAN Group 2000).
- Increased cost of living, especially increases resulting from housing and rental costs, has flattened the effect of the increased annual income in the study area.
- Additional expenditures by the Operators include collection of additional sales and use tax for the state, counties, and communities. Estimated severance taxes, ad valorem production and property taxes, federal mineral royalties, and PILT taxes would accrue to the federal, state, and local governments.

4.11.3.1. Labor

The estimated direct hire labor force is presented in Table 4-17 for all alternatives. 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 purpose 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 are not necessarily the earnings for each job created/maintained. Actual wages are determined on an individual basis by employers and are influenced by market forces.

Table 4-17 depicts the types of jobs that would be ongoing during development and production, but does not necessarily represent the number of actual workers per well. One person could potentially fill several of the employment positions during development and production of a well. All of the wells drilled during a given year will likely be staggered, employing many of the same people during drilling and production activities; therefore, actual employment is somewhat exaggerated in Table 4-17.

Table 4-18 was created to show the annual employment impact for each alternative. Again the numbers shown reflect total number of jobs, but do not reflect total number of workers in the area because many of the jobs will be filled by one worker moving from one rig to the next to perform similar jobs. Actual jobs do not represent number of workers. On average the actual number of workers is estimated to represent a factor of 60 % of the total jobs or 62 people out of a total of 103 jobs created during the development, production and reclamation phases (Jacquet and Kathol 2007). This number was derived from the fact that many of the jobs take from 2 to 5 days to complete, therefore a single worker can work on up to 4 or 5 rigs per month. Table 4-18 shows the number of annual jobs, annual worker years, and estimated actual number of workers for one well, but does not reflect the actual number of people that would be necessary to fill these jobs (Jacquet 2007). In the Moxa, an estimated 9 to 10 wells would be operating at any one time. With this many rigs operating there is likely to be many workers working shifts on several rigs. Based on 62 estimated actual workers per well an estimated total of 620 workers could be employed at any one time during peak drilling activity.

4.11.3.2. Employment Estimate Methodology

The following paragraphs will help to clarify generation of employment estimates and economic statistics in Tables 4-17 through 4-21. The estimates of employment are based on two different methodologies. Tables 4-17 and 4-18 are based on counting heads at the well site and then estimating the number of days that each type of worker would be at the well site. The result is an estimate of worker-days. Tables 4-20 and 4-21 are based on the ratio of employment per dollar of expenditures. For example the latest estimates for Wyoming are one job per \$3.7 million of production for the oil and gas extraction sector; one job per \$135,986 of expenditures to the oil and gas drilling sector, and one job per \$90,813 of expenditures to the oil and gas support activities sector. These ratios may vary by region of the state. With this approach total expenditures are aggregated and then converted to an estimate of employment.

Table 4-17. Estimated Work Force Requirements for All Wells, All Alternatives.¹

Employment Category	Avg Number of Days	Total workers per well	Worker-Days per Well	Proposed Action Worker-Years for 1,861 ² wells	Alternative A Worker Years for 670 wells	Alternatives B and C Worker Years for 5,165 wells
Well Pad and Access Road Construction	4	4	16	115	42	317
Rig transportation/Setup	5	15	75	537	193	1,490
Drilling ³ Roughnecks (Straight Holes)	15	12	180	1,288	464	3,576
Tool-Pushers and Supervisors	15	9	135	966	348	2,682
Completion Testing - Cementing, Stimulation, Perforating, Logging	2 6 3 1	6 13 5 3	12 78 15 3	86 558 107 21	31 201 39 8	238 1,550 298 60
Pipeline construction	4	6	24	172	62	477
Total Well Construction and Development		73	538	3,850	1,388	10,688
Production ^{4,5}		13	305	2,183	786	6,059
Workovers ⁶ (every 10 to 20 years)	10	7	210	1,503	541	4,171
Total Production and Maintenance Activities		20	515	3,686	1,327	10,230
Total Abandonment and Reclamation	5	10	50	358	128	993⁷
Total		103	1,103	7,894	2,843	21,911

¹ Assumes all wells are drilled and completed as producers² 260 worker-days = 1 worker year. Implementation of BMPs such as drilling multiple wells from single well pads could change the work force requirements. Detailed analysis of these changes is presented below for alternative B.³ Assumes all vertical (straight) wells⁴ Assumes one pumper can visit 20 wells/day, all pads are visited every 3 days, and a productive well life of 40 years.⁵ Assumes six full time production foreman and six full-time field clerks in addition to pumpers.⁶ Assumes three workovers per well.⁷ Actual number for abandonment and reclamation might be slightly higher for Alternative B because of the increased emphasis on reclamation efforts.

Table 4-18. Estimated Annual Work Force Requirements for All Alternatives Expressed in Worker Days.¹

Employment Category	Avg Number of Days	Total workers per well	Worker-Days per Well	Proposed Action Worker-Years for 186² wells	Alternative A Worker Years for 112 wells	Alternatives B and C Worker Years for 205 wells
Well Pad and Access Road Construction	4	4	16	11	7	13
Rig transportation/Setup	5	15	75	54	32	59
Drilling ³ Roughnecks (Straight Holes)	15	12	180	129	77	142
Tool-Pushers and Supervisors	15	9	135	97	58	106
Completion Testing -	2	6	12	87	5	10
Cementing, Stimulation,	6	13	78	56	34	61
Perforating,	3	5	15	11	6	12
Logging	1	3	3	2	2	2
Pipeline construction	4	6	24	17	11	19
Total Well Construction and Development		73	538	385	232	424
Production ^{4,5}		13	305	218	132	240
Workovers ⁶ (every 10 to 20 years)	10	7	210	150	91	166
Total Production and Maintenance Activities		20	515	368	223	406
Total Abandonment and Reclamation	5	10	50	36	21	39⁷
Total		103	1,103	789	476	869

¹ Assumes all wells are drilled and completed as producers and that workers represents a specific job, but does not necessarily represent a single worker. One worker can fill many jobs.

² 260 worker-days = 1 worker year. Implementation of BMPs such as drilling multiple wells from single well pads could change the work force requirements. Detailed analysis of these changes is presented below for alternative B.

³ Assumes all vertical (straight) wells

⁴ Assumes one pumper can visit 20 wells/day, all pads are visited every 3 days, and a productive well life of 40 years.

⁵ Assumes six full time production foreman and six full-time field clerks in addition to pumpers.

⁶ Assumes three workovers per well.

⁷ Actual number for abandonment and reclamation might be slightly higher for Alternative B because of the increased emphasis on reclamation efforts.

The two estimates are not comparable. The Head Counting Method provides a detailed description of on-site employment at the well site. However, it does not consider off-site employment associated with oil and gas development. The Employment/Expenditure Method, on the other hand, provides less detail regarding employment but does consider off-site employment. Off-site employment could result from direct expenditures by operators for goods and services used in drilling oil and gas wells. This could include such things as equipment rentals (surface, down hole, etc.), consumables (fuel, drilling fluids, bits, etc.), tangibles (pipe, facilities equipment, wellhead equipment, etc.), transportation, and miscellaneous expenses. Information from operators in Southwest Wyoming suggests that these off-site expenditures represent about 40 percent of the total cost of a well and generate about one-third of the direct employment. Off-site employment would also include secondary employment associated with oil and gas development. This would include employment associated with expenditures by companies involved in drilling oil and gas well with other firms in the region (Indirect Effects). It would also include expenditures by employees of companies involved in drilling oil and gas wells with other firms in the region (Induced Effects). Because most economic impact models use the Employment/Expenditure Method to estimate employment, the Head Counting Method is not applicable to estimating secondary employment. Overall, previous work in Southwest Wyoming indicates that total off-site employment represents about 50 percent of the total employment associated with oil and gas development.

The units of measurement are also different. The Counting Heads Method measures employment in terms of number of workers. While the Employment/Expenditure Method measures employment in terms of jobs. Because one worker can hold more than one job, the units of measurement are not the same. Another difference is that the employment in Table 4-17 and 4-18 are expressed as worker-days. The Employment/Expenditures Method expresses employment as a twelve month average, but does not consider whether the job was full-time or part-time each month. As a result 12 months of employment does not necessarily equal 260 days of employment. Due to the differences in units of measurement it is not possible to convert from one unit of measurement to the other. While the Head Counting Method is more detailed, it is generally not comparable with published employment estimates because published employment estimates are not generally collected on a worker-day basis. For example, the U.S. Department of Commerce estimates that there were 42,633 jobs in Lincoln, Sublette, and Sweetwater Counties in 2005. However, the number of worker-days for the three counties is unknown.

Double Counting. Because workers will probably work at more than one oil and gas well during the year it is important to estimate worker-days in the Head Counting Method in order to avoid double counting of workers. Because the Employment/Expenditure Method does not count workers at all, but rather counts expenditures and then converts those expenditures to employment estimates, double counting should not be a major issue, at least in terms of jobs, as long as there is no double counting of expenditures. It is important to note however, that the Employment/Expenditure Method estimates employment in terms of jobs and not workers.

Summary. 4-17 and 4-18 provide detailed employment estimates at the well-site, but do not consider off-site employment and is not comparable with published employment data. Table 4-20 and 4-21 provide less detailed employment estimates, but do consider off-site employment and is comparable with published employment data. Because of the differences in the two estimates they are not comparable (Taylor 2007). In the report Tables 4-17 and Table 4-18 represent employment at the well-site expressed in worker-days and Tables 4-20 and 4-21 represent total employment expressed in the number of jobs

4.11.3.3. Economic Activity from Development and Production

Well-cost estimates for the MAA are based on price structure, mechanics, and completion techniques in 2006. Vertical drilling costs include surveys, permits, fees, location and roads, drilling contractor

services and equipment, open-hole logging, mud logging, rentals, casing crews, contract labor and supervision, drilling water, drilling overhead, and transportation and hauling. Completion costs include completion rig and auxiliary services, snubbing unit, contract supervision, professional services, casing crews, pumping services, transportation and hauling, location and roads, completion water, rentals installation labor, and frac flowback. Reclamation costs include contractor services and equipment, monitoring, seed, etc. The costs vary significantly by operator, depth drilled, area drilled, types of facility, and pipeline lengths. Additionally, the specialized equipment and labor associated with directional drilling cause costs to vary (Table 4-19). Table 4-19 shows the range and average costs associated with drilling and completion of a single well and the amount of time it would take on average for the well to be paid out once production begins.

Table 4-19. Moxa Well Drilling and Completion Cost Estimates (2006 \$).

	Drilling	Completion	Total	Estimated Payout/well @ 2007 spot prices³
High Range ¹	\$1.3 million	\$900,000	\$2.2 million	16 months
Low Range ¹	\$550,000	\$500,000	\$1.05 million	8 months
Average ¹	\$850,000	\$650,000	\$1.5 million	11 months
Directional Well ²	\$948,300	\$809,560	\$1,757,860	13 months

Source:

¹ EOG 2006

² Data contained in this table was derived from estimate for one well in the MAA (Westport Oil and Gas 2005). Matthew Warren, BLM petroleum engineer, indicates that on average, \$300,000 to \$350,000 in additional costs can be expected for each well that is drilled directionally in the MAA (personal communication).

³ Well production will vary depending on well location, but average payout is estimated to be 11 months for vertical wells and 13 months for directionally drilled wells based on current gas spot prices.

Average estimated payout for drilling and completion costs in the MAA per conventional well is approximately 11 months based on an estimated spot price for natural gas in 2007 of \$7.84/mcf (Henry Hub spot price- Energy Information Administration (DOE) May 1, 2007). For directionally drilled wells the average payout is slightly longer, approximately 13 months, at the same rate. Summaries of expected economic activity and employment from one conventionally drilled well is presented in Tables 4-20 and Table 4-21. Table 4-20 shows total economic activity and employment and earnings from drilling activity, and Table 4-21 shows average annual economic activity by alternative. Table 4-22 shows total economic activity and employment from production activities and Table 4-23 shows average annual economic activity by alternative. The results shown in these tables are derived from the IMPLAN I/O model runs and are estimated in 2006 dollars. Employment represents direct, indirect, and induced (secondary) jobs. The employment figures in these tables are not comparable to the direct worker figures in Tables 4-17 and 4-18 because employment in Tables 4-20 and 4-21 represent all direct, indirect and induced jobs created locally and regionally and do not represent actual direct, indirect, or induced workers but are estimates derived from oil and gas expenditures based on the I/O model methodology.

Direct drilling and completion expenditures of \$ 1,615,331, with direct local spending of \$1,301,957 for one conventional well, are estimated to generate economic activity (direct, indirect, and induced) of \$1,553,452. An estimated 12.4 new direct and secondary jobs would be created during drilling activity, assuming that 40% of the labor force comes from the local area. Employment projections were generated from the average expenditures per job for the oil and gas industry from the I/O model inputs. Average earnings per job are estimated at \$55,628. Each well would generate this level of economic activity, which is assumed to remain constant across all alternatives on a per-well basis. The timing of economic activity will depend on the number of approved wells and the rate of development.

Table 4-20. Economic Activity from Gas Drilling and Completion per Vertically Drilled Well (40% Local), Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006 (2003 \$).

Estimated Activity	Conventional Well
Direct Drilling Expenditures¹	
Total Cost	\$ 1,615,331
Local Direct Expenditures	\$ 1,301,957
Secondary ² Expenditures	\$ 251,495
Total Local Economic Activity	\$ 1,553,452
Employment (Jobs)	
Direct Annual Job Equivalent (AJE) ³	9.9
Secondary AJE	2.4
Total	12.4
Average Earnings Per Job	\$55,628⁴

Source: IMPLAN

¹ Includes proposed labor costs.² Includes indirect and induced³ AJEs are jobs indirectly created as a result of the activity. They do not include the direct labor jobs.⁴ This estimated average annual starting wage per job would not necessarily be the actual wage paid for each created job. Actual wages are determined on an individual basis by employers as influenced by market forces.**Table 4-21.** Average Annual Economic Activity from Gas Drilling and Completion by Alternative (40% Local Labor) over Life of the Project (2006 \$).

Average Annual Estimated Activity	Proposed Action (186 wells)	No Action (126 wells)	Alternatives B & C (205 wells)
Drilling Costs¹			
Total Annual Cost	\$300.4 M	\$203.4 M	\$331.1 M
Local Direct Expenditures	\$242.1 M	\$164.0M	\$266.8 M
Secondary ² Expenditures	\$ 46.3 M	\$ 31.6 M	\$ 51.5 M
Total Local Ave. Ann. Economic Activity	\$288.5 M	\$195.6 M	\$318.3 M
Local Employment	1,193	808	1,315
Secondary Employment	1,105	749	1,218
Avg. Ann. Employment (jobs)³	2,298	1,557	2,533
Avg. Ann. Earnings	\$127.8 M	\$86.6 M	\$140.9 M
Avg Annual AEPJ	\$55,614	\$55,620	\$55,626

Source: IMPLAN

¹ Includes proposed labor costs.² Includes indirect and induced³ Total Annual Employment represents local, regional and national employment derived from the drilling activities. Much of the secondary employment would occur outside the region.

AEPJ – Adjusted Earnings Per Job

M = million

Table 4-21 shows annual average direct drilling and completion expenditures by alternative. Direct drilling and completion costs range from \$203.4M for the No Action, to \$300.4M for the Proposed Project and Alternative B, and \$331.1M for Alternative C. Direct local spending is estimated between \$164.0M, \$242.1M, and \$266.8 million per year per respective alternative, over the life of the project. Local expenditures represent 80% of total expenditures based on information collected on oil and gas activities in the Southwest region of Wyoming and outputs from the IMPLAN I/O model. Total average annual economic activity generated (direct, indirect, and induced) would range between \$195.6M for the No Action and \$318.3M for Alternative C. Average annual estimated new direct and

secondary jobs of between 1,557 and 2,533 would be created during drilling and completion activity for the alternatives. Average earnings per job are estimated at approximately \$55,620 for all alternatives. Each alternative would generate this level of economic activity annually. These average annual estimates are assumed to remain constant across all alternatives on a per-well basis.

The value of natural gas and condensate production is based on revenues less the cost of operation. Table 4-22 illustrates economic activity that would be generated by \$100 million of natural gas and condensate production output per well, based on CREG 2005 prices. The value of \$100 million in direct natural gas and condensate production would generate economic activity of \$107,114,999 (including secondary activity of \$7.1 million) and would create 15.1 direct jobs and 36.4 secondary jobs during the production period. Direct and secondary earnings would total \$2.7 million, \$1.33 million in direct earnings and \$1.37 in secondary earnings. Average earnings per job are estimated at \$52,605.00.

Table 4-22. Economic Activities from Gas Production Per Well, Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006.

Estimated Activity	Conventional Well (2006 \$)
Economic Impact of \$110 million in Natural Gas and Condensate Production ¹	
Direct	\$ 110,450,000
Secondary	\$ 7,858,516
Total Economic Activity	\$ 118,308,516
Employment per \$110 million in production	
Direct	15.1
Secondary	36.4
Total	51.5
Earnings per \$110 million in production	
Direct	\$ 1,468,450
Secondary	\$ 1,523,810
Total Earnings	\$ 2,992,260
Average Earnings per Job per \$110 million in production	
Direct	\$ 97,248
Secondary	\$ 41,863
Average Earnings Per Job	\$ 58,102²

¹ Price is \$5.02/MCF based on (CREG 2006) the value of production is based on revenues less cost of operation. Price is \$33.47/bbl based on (CREG 2006). Assumes natural gas recovery costs include recovery of condensate.

² 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 and condensate production is based on revenues less the cost of operation. Table 4-22 illustrates economic activity that would be generated by \$110 million of natural gas and condensate production output per well, based on CREG 2005 prices. The value of \$110 million in direct natural gas and condensate production would generate economic activity of \$118,308,516 (including secondary activity of \$7.9 million) and would create 15.1 direct jobs and 36.4 secondary jobs during the production period. Direct and secondary earnings would total \$3.0 million, \$1.47 million in direct earnings and \$1.52 million in secondary earnings. Average earnings per job are estimated at \$58,102.

Table 4-23 shows average annual economic activity from oil and gas production by Alternative. The Table shows average annual generation of economic outputs (market value of oil and gas sales), employment, and earnings over the life of the project. Average annual economic activity by alternative ranges from \$103 M for the No Action to \$322 M for Alternative C. Average annual total employment by Alternative ranges from 45 annually for the No Action to 140 for Alternative C. Most of the

employment during the production phase is secondary employment and is likely to be regional and national employment rather than local employment. Average annual earnings per job are approximately \$58,000.

Table 4-23. Average Annual Economic Activity from Oil and Gas Production.

Economic Impact of Natural Gas and Condensate Production by Alternative (2006\$)			
Average Annual	Proposed Action	No Action	Alternatives B and C
Direct Economic Impact	\$208,973,611	\$96,595,692	\$300,569,141
Secondary	\$14,837,126	\$6,858,294	\$21,340,409
Total Economic Activity	\$223,810,737	\$103,453,987	\$321,909,550
Average Annual Employment			
Direct	28.4	13.2	41
Secondary	68.6	31.8	99
Total Employment	97	45	140
Average Annual Earnings			
Direct	\$2,778,321	\$1,284,255	\$3,996,115
Secondary	\$2,883,063	\$1,332,671	\$4,146,766
Total Earnings	\$5,661,384	\$2,616,926	\$8,142,881
Average Earnings Per Job			
	\$97,687	\$97,292	\$97,466
	\$42,027	\$41,907	\$41,887
Average Earnings/Job	\$58,365	\$58,154	\$58,163

4.11.3.4. Housing

Population in the study area is anticipated to increase as a result of increased employment opportunities generated both directly and indirectly by the Project. All three affected counties in the study area are facing a housing shortage, and any additional pressure would exacerbate an already-tight housing market (Robbins 2006; Hanks 2006; Archibald 2006; Harris 2006). Moreover, the increased demand for housing would likely cause housing prices (rental costs and home sales prices) to rise. Housing rental costs increased between 41% and 46% in Sweetwater County from 1998 to 2004. Residential sales prices increased by 34% between 1998 and 2004 in Sweetwater County (Sublette County Socioeconomic Analysis Advisory Committee 2006). Additionally, affluence in the study area is likely to cause an increase in the demand for higher-quality housing, which also would drive the cost of housing upwards. Some town homes and apartment complexes are in the construction or development phases in all affected communities, and these will ease the housing shortage; however, single family housing continues to be unaffordable for any of the gas field workers who would like to provide housing for their families or to move their families to the area in spite of the higher income levels that most of these workers maintain..

4.11.3.5. Quality of Living

Quality of life could be impacted by oil and gas development and production in the area. Potential beneficial effects include increased local economic activity and reduced poverty, and the potential for improved public facilities and services once ad valorem taxes, severance taxes, and other revenues become available to the local counties and communities. The short-term impacts (1 to 2 years) to local communities and other local jurisdictions, however, would be negative, because increased population from the gas development workforce would exacerbate impacts on the already-tight housing market and would increase demands on facilities and services. Increased economic activity could enhance the availability of goods and services, as well as cultural, educational, and recreational opportunities. However, the conversion of large tracts of land to gas development is seen by some as industrialization and a diminishment of the characteristics they value in the region: natural beauty and quiet, vast reaches of unpopulated and undeveloped open space, fresh air, and wildlife.

Because of the population increase anticipated as a result of new oil and gas development and production jobs, along with the record of increasing criminal activity already affecting the CIAA, the Project could potentially 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”). Although the number of arrests in Sweetwater, Lincoln, and Uinta Counties decreased from 1999 to 2004, crimes related to alcohol and substance abuse, assaults, driving under the influence (DUI) charges, and traffic offenses represented the largest number of crimes in the area. Additional law enforcement personnel may be required to serve the increasing population base related to the proposed project.

For the purpose of this analysis, the rate of development and an average decline curve for individual well production (Chase 2006; EOG Resources 2006; Fetzer 2006) was used to estimate total annual field production; well production life was assumed to be 40 years for all alternatives. Increases in taxes and revenues would provide counties and communities with more discretionary dollars to develop infrastructure and support the population. However, short-term budgetary impacts to local governments would occur, due to population growth and its effects on housing and local infrastructure, services, and facilities. Receipt of taxes generally lags one year behind production; therefore, affected counties and communities would not receive any funds until two years after drilling activities begin. Over the LOP, all counties and communities in the study area would benefit from increased revenues from ad valorem taxes, as shown in Table 4-24. Some state mineral royalties and severance taxes would also be distributed to the counties and communities, based on a state distribution formula. Other tax revenues generated, but not included in the table, would include sales, use, and lodging taxes. These amounts have not been estimated, even though they will represent a significant increase in local revenues throughout the region. Other taxes not estimated include state mineral royalties and PILT payments.

Because development and production would occur within Sweetwater, Lincoln, and Uinta Counties, increases in ad valorem production and property taxes would impact all three counties and affected communities. Ad valorem taxes on production were estimated for this analysis, but because of limited information provided by the Operators, property taxes related to equipment and facilities could not be estimated. These tax revenues could be substantial. In addition, real property values are likely to change as population fluctuates within the study area. Housing costs have escalated during the past several years and with increased demand for housing in the region, these housing cost increases are likely to continue. Population growth will also stimulate additional commercial and residential activity, but indirect property taxes generated by this activity are beyond the scope of this analysis and are not addressed further.

Table 4-24. Estimated Taxes and Revenues Received by Governments from Moxa Arch Area Infill Gas Development Project (LOP) (2006\$ using 2005 mill levies).

	Proposed Action	Alternative A - No Action	Alternatives B and C
Ad Valorem¹	(nominal values)	(nominal values)	(nominal values)
Sweetwater County, WY	\$185,979,606	\$85,966,973	\$267,496,600
Lincoln County, WY	\$139,602,007	\$64,529,451	\$200,791,167
Uinta County, WY	\$110,994,250	\$51,305,839	\$159,644,302
Severance Tax²			
State of Wyoming	\$398,668,099	\$184,279,828	\$573,408,897
Mineral Royalties Tax			
Federal	\$336,070,701	\$155,344,887	\$483,374,343
State of Wyoming ³	\$168,035,350	\$77,672,444	\$241,687,171

¹ Ad valorem tax estimated is for natural gas and condensate production. Due to limited information from the proponent no ad valorem tax was estimated for equipment or facilities. Additional ad valorem taxes would be generated from residential, commercial and industrial properties constructed as a result of project development to serve the new population and increased industry demands.

² Severance tax revenue would be returned to local jurisdictions based on a distribution formula generated by the State Treasurer's Office. These revenues would typically go for road construction to the counties and miscellaneous capital expenditures for the local communities. All three counties, the impacted communities of Rock Springs, Kemmerer/Diamondville, and Evanston, as well as any other communities impacted by the proposed project, would receive a portion of the severance taxes.

³ This represents the Federal Mineral Royalties returned to the state, which is 50% of the total Federal Mineral Royalty.

Sales and Use taxes were not estimated due to limited information provided by the proponent. State mineral royalties and PILT payments were not estimated.

4.11.3.6. Proposed Action

The Project would result in increased population in Sweetwater, Lincoln, and Uinta Counties as a result of job seekers moving to the area. Current employment levels in the study area are estimated at full employment, due to ongoing natural resource development projects. Temporary workers are being transported in and out of the area due to limited housing availability and a shortage of permanent, reliable gas field workers in the labor pool. Continued in-migration of labor is anticipated as a result of the proposed project; without adequate planning at the local level, increases in population would likely have both beneficial and negative effects on communities in the study area.

4.11.3.6.1. Population

It is difficult to estimate population related to the influx of new workers into the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 3,221 for the Proposed Action during drilling and completion, based on annual average local employment of 1,193. However it has been discussed that the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 716 vs. 1,193 and the total population impact would be 1,933 vs 3,221. Population impacts during production would depend on the number of local workers in the area. Total average annual employment generated by production activities ranges from 2 to 326 workers based on the number of wells producing. Assuming 30% of these annual production workers live locally, peak population related to 97 local workers would be 262, based on a household size of 2.7.

4.11.3.6.2. *Employment and Income*

The Proposed Action would directly provide up to 7,894 worker years (Table 4-25). Employment per year tallied through the LOP totals 22,993 jobs during development and 4,872 jobs during production (Table 4-25). Estimated average annual total employment would be 2,298, of which 1,193 would be local during drilling and completion. Actual workers would be less than this perhaps more in the range of 716. The duration of these impacts and, the number of actual jobs would depend on the rate of development. Employment generated during production ranges between 2 and 326 annually based on the number of wells producing and the level of production, but averages 97 over the 40 year production period.

Table 4-25. Summary of Economic Activity Resulting from Natural Gas Development and Production over the LOP, Moxa Arch Area Infill Gas Development Project, Sweetwater, Lincoln, and Uinta Counties, 2006 (2006 \$).

Nominal Value of Economic Activity	Proposed Action	Alternative A	Alternatives B and C
Drilling			
Total Spending	\$3,005 billion	\$1,222 billion	\$8,343 billion
Local Spending	\$2,423 billion	\$985 million	\$6,724 billion
Total Employment for all Years	22,993	9,353	63,814
Average Annual Employment	2,298	1,557	2,533
Local Employment for all Years	11,938	4,856	33,133
Average Annual Local Employment	1,193	808	1,315
Local Earnings	\$1,279 billion	\$520 million	\$3,550 billion
Average Earning per Job	\$55,614	\$55,620	\$55,626
Production			
Natural Gas Production	1.8 trillion CF	832 BCF	2.6 trillion CF
Average Annual	36 BCF	16 BCF	51 BCF
Condensate Production	12.5 million barrels	5.8 million barrels	18.1 million barrels
Average Annual	251,108 barrels	116,072 barrels	361,172 barrels
Value of Total Production	\$10.4 billion	\$4.7 billion	\$15.0 billion
Average Annual Value of Production	\$209 million	\$96.6 million	\$300 million
Total Employment for all Years	4,872	2,252	7,007
Average Annual Employment	97	45	140
Total Earnings	\$283 million	\$130 million	\$407 million
Average Annual Earnings	\$5.6 million	\$2.6 million	\$8.2 million
Average Earning per Job	\$58,365	\$58,154	\$58,163

* See discussion of impacts for Alternative B for detailed analysis regarding changes that might occur to these values compared to Alternative C.

Natural gas development jobs are in high demand and are competing with other service positions and lower-paying jobs, which is causing an increase in wage rates throughout all economic sectors. The Proposed Action 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. Because of the status of full employment in the area, the new jobs could be considered both beneficial and detrimental to the region. This situation will continue, and new workers will likely be brought in temporarily to fill the new positions either for gas and service field jobs or secondary jobs. Currently, local businesses are soliciting workers from various parts of the country to fill industrial retail and service positions, that have lost workers to the oil and gas industry due to higher wages (Robbins 2006).

In 2005, the oil and gas extraction mean and median wages in the southwest Wyoming region were \$48,629 and \$48,846, respectively (Wyoming Department of Employment 2005b). These estimated annual wages are higher than most other sectors of the southwest Wyoming regional economy. Thus, there would likely be beneficial impacts on income and poverty reduction as a result of the Proposed Action.

4.11.3.6.3. *Economic Effects*

Because up to 1,861 new wells would be drilled under the Proposed Action, up to 1.8 trillion CF of gas and 12.5 million barrels of oil (MBO) would be recovered. Over the LOP, economic activity is estimated at \$3.0 billion (nominal value) during drilling and completion (Table 4-25). For every \$110 million in production value, an estimated \$7.9 million will be generated in secondary output, including total earnings of \$3.0 million for direct, indirect, and induced workers (Table 4-22). The LOP total value of production is estimated at \$10.4 billion, with an estimated \$283 million in earnings for the Proposed Action.

An estimated \$185 million (nominal value) in ad valorem taxes would accrue to Sweetwater County, \$139 million to Lincoln County, and \$111 million to Uinta County over the LOP (Table 4-24). In addition, the Proposed Action is estimated to generate severance tax revenues of \$399 million (nominal value) over the LOP, and \$336 million (nominal value) in Federal Mineral Royalties, of which \$168 million would go to the State of Wyoming.

Under the Proposed Action, local area government operating budgets would likely expand in the long term, increasing the level of services and infrastructure provided to community residents. Annual jobs created, as mentioned above, are estimated to total 22,993 during development and 4,872 during production, with an average wage ranging from \$55,628 to \$58,102.

In the short term, before revenues from production activity accrue to the local governments, significant social and economic impacts to local governments could occur, due to increased demands on public services and facilities, housing, and social services. In the long term, increased revenues to the state and local governments in the form of ad valorem, severance, mineral royalties, sales and use, and other taxes from direct project activity and secondary activity would be beneficial to the State of Wyoming and its regional governments. In addition, increased employment would occur throughout the area from indirect and induced employment opportunities stemming from the Proposed Action. Significant adverse and beneficial social and economic impacts from the Proposed Action would occur throughout the LOP. Most adverse impacts would occur in the short term (2 to 5 years).

4.11.3.7. *Alternative A*

The socioeconomic effects of Alternative A/No Action would be similar to those described for the Proposed Action, but they would have a lesser impact in terms of employment, revenue generation, and local jurisdiction infrastructure and housing, due to the lower level of resource recovery and the lower number of wells drilled annually. Tables 4-21 and 4-23 show the economic activity, employment, and earnings related to the No Action alternative.

4.11.3.7.1. *Employment and Income*

Alternative A would directly provide up to 3,211 worker years (Table 4-17). Employment per year, tallied through the LOP, totals 9,353 jobs during development and 2,252 jobs during production (Table 4-25). Estimated average annual total employment during drilling and completion would be 1,557, of which 808 would be local, with an average wage ranging from \$55,620 to \$58,154. The duration of these impacts and, therefore, the number of actual jobs would depend on the rate of development. Employment during production would range from 1 to 204 depending on how many wells are producing and at what level, but average employment for the 40 year production period is estimated at 45.

4.11.3.7.2. *Population*

It is difficult to estimate population related to the influx of new workers in the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 2,182 for Alternative A during drilling, based on annual average local employment of 808. However it has been discussed that the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 485 vs. 808 and the total population impact would be 1,309 vs 2,182. Population impacts during production would depend on the number of local workers in the area. Total average annual employment generated by production activities would range from 2 to 204 workers depending on how many wells are producing and at what level. Assuming 30% of these annual production workers live locally, peak population related to 61 local workers would be 165, based on a household size of 2.7.

4.11.3.7.3. *Economic Effects*

An estimated 832 BCF of gas and 5.8 MBO would be recovered under this alternative. Over the LOP, Alternative A is estimated to generate up to \$1.2 billion (nominal value) (Table 4-25) in total spending, of which \$985 million would be spent locally during drilling and completion. For every \$110 million in production value, an estimated \$7.9 million would be generated in secondary output, including total earnings of \$3.0 million for direct, indirect, and induced workers (Table 4-22). Total LOP production value for Alternative A is estimated at \$4.7 billion, with estimated earnings of \$130 million.

An estimated \$86 million in nominal ad valorem taxes would accrue in Sweetwater County, \$64 million in Lincoln County, and \$51 million in Uinta County over the LOP (Table 4-24). In addition, an estimated \$184 million in nominal severance taxes would be generated over the LOP, and \$155 million in Federal Mineral Royalties, of which \$77.6 million would go to the State of Wyoming. Under this alternative, local area government operating budgets would likely expand in the long term, increasing the level of services and infrastructure provided to community residents.

Beneficial impacts from increased local government revenues would be similar to those under the Proposed Action, but they would generate less money for local government budgets than would the Proposed Action. In summary, Alternative A would have effects similar to the Proposed Action, but on a smaller scale because of fewer number of wells, less production, and a shorter drilling phase. Social and economic adverse and beneficial impacts would still be considered significant.

4.11.3.8. *Alternative B*

The socioeconomic impacts of Alternative B would be similar to those of Alternative C. The following sections describe those impacts that are not the same as Alternative C. Most of the changes would be related to different costs associated with different development techniques that might be used by the operators, including directional drilling. Because the technologies that will be used by the operators to remain below the disturbance threshold for Alternative B, the following sections are meant to describe the potential impacts of the alternative for disclosure and decision-making purposes only.

4.11.3.8.1. *Employment and Income*

If all wells for Alternative B are conventionally drilled from individual well pads, the impacts would be identical to those described for Alternative C. However, if wells are drilled directionally the employment and income would be slightly different from Alternative C. Additionally, increased emphasis on reclamation for Alternative M might slightly increase the employment related to reclamation activities compared to Alternative C.

Analysis completed by Westport Oil and Gas (Westport 2005) indicates that drilling a directional well in the MAA takes approximately eight additional days when compared to drilling a vertical well to the same depth and target. Time and labor for completion and operations of a directional drilled well are assumed to be the same as for a vertically drilled well ((Westport 2005), Matthew Warren BLM Kemmerer Field Office Petroleum Engineer, personal communication). For every well that is drilled directionally rather than conventionally, there would be an increased of approximately 1 worker year and increased wages of approximately \$55,000. However, because of the specialized workers necessary to complete some phases of directional drilling, wages could be higher than the \$55,000 projected for the other alternatives.

4.11.3.8.2. Population

As described in the previous section, for every directionally drilled well, there would be an increase of approximately 1 worker year. Based on this estimate a total of an additional 1,995 worker years could be generated by Alternative B when compared to Alternative C if all wells on federal lands in the core were drilled directionally. However, as discussed in the following section, approximately 913 worker years would be saved through decreased construction, rig transport, and pipeline construction costs resulting in 1,197 more jobs more than Alternative C. The estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that 60% of the jobs would require actual new workers resulting in 718 more jobs than Alternative C. Assuming 30% of the labor would be local, approximately 1 household would be added for every 9-10 wells drilled directionally. Assuming 2.7 persons per household, directionally drilling 1,995 wells (100% of all wells on federal lands in the core for Alternative C) would increase the area population by approximately 539-599 individuals more than Alternative C.

4.11.3.8.3. Economic Effects

Drilling multiple wells from a single pad would have the greatest short-term economic impact to the area because wells would have to be drilled directionally. This would require additional specialized equipment and crews during the drilling phase of the project. Analysis completed by Westport Oil and Gas (Westport 2005) indicates that drilling a directional well in the MAA costs, on average, \$300,000 to \$350,000 more than drilling a vertical well. Much of this additional cost is associated with drilling labor, specialized outside services, and increased equipment rental and purchase expenses. Westport's analysis indicated that labor associated with drilling a vertical well in the MAA would cost approximately \$42,000. When drilled directionally, labor costs would increase to \$132,000 as a result of increased drilling time and specialized labor required to complete drilling activities.

Completion costs for a directional well are typically higher than a vertically drilled well (Westport 2005). While labor costs for completion would be expected to be similar for a directionally drilled well, the equipment and materials costs for completion would be higher. Much of the increased completion costs would be associated with the need for a longer length of production casing and increased cementing costs.

Directionally drilled wells also potentially have higher operational costs than vertically drilled wells. In much of the MAA, plunger lift systems are used to reduce liquid loading problems and maximize well flow rates. However, in a directional bore, increased wear on the plunger lift system and tubing can limit the usefulness of this technology and increase operations costs.

Total drilling costs in the MAA would increase as a result of using directional drilling technologies. For comparison with the Alternative C, directionally drilling 100% of wells on federally administered surface (1,995 wells) could increase cost to operators by approximately \$600 million over the LOP. However, because multiple wells would likely be drilled from each pad, costs associated with pad construction, rig transportation and set-up, and pipeline construction would likely be reduced on a per well basis. Assuming a 40% decreased in the worker years presented in Table 4-17 for Alternatives B and C, a reduction in approximately 913 worker years would be expected. This would result in a

savings of \$50.8 million and would reduce the increased cost to operators to approximately \$550 million. Table 4-19 indicates that the total time to payout for a directionally drilled well can be increased by as much as 2 months. Increased number of days to payout would likely decrease the revenues generated for both the operators and the State of Wyoming and counties.

4.11.3.9. Alternative C

The socioeconomic effects of Alternative C would be similar to those described for the Proposed Action, but they would have a greater impact in terms of employment, population, revenue generation, and infrastructure and housing. Tables 4-21 and 4-23 show the economic activity, employment, and earnings related to Alternative C.

4.11.3.9.1. *Employment and Income*

Alternative C would directly provide up to 21,911 worker years (Table 4-17). Employment per year tallied through the LOP would total 63,814 jobs during development and 7,007 jobs during production (Table 4-25). Estimated average annual total employment would be 2,533, of which 1,315 would be local during development. The duration of these impacts and, therefore, the number of actual jobs would depend on the rate of development. Employment during production would range from 1 to 349 annually depending on the number of producing wells and the level of production, but an average of 140 would be employed annually through the 40 year production phase. Average earnings per job would range from \$55,626 during drilling and completion to \$58,163 during production.

4.11.3.9.2. *Population*

It is difficult to estimate population related to the influx of new workers in the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 3,550 for Alternative C during drilling and completion, based on annual average local employment of 1,315. However the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 789 vs. 1,315 and the total population impact would be 2,130 versus 3,550. Total average annual employment generated by production activities ranges from 1 to 349 workers, depending on number of wells producing and level of production. Assuming 30% of these annual production workers live locally, peak population related to 104 local workers would be 283, based on a household size of 2.7.

4.11.3.9.3. *Economic Effects*

Under Alternative C, changes in economic activity would be expected from the development of up to 5,165 wells and the recovery of up to 2.6 trillion CF of gas and 18.1 MBO (Table 4-25). Over the LOP, Alternative C is expected to generate up to \$8.3 billion (nominal value) (Table 4-25) total spending, of which \$6.7 billion would be spent locally during development. For every \$110 million in production value, an estimated \$7.9 million will be generated in secondary output, including total earnings of \$3.0 million for direct, indirect, and induced workers (Table 4-22). Total LOP production value for Alternative C is estimated at \$15.0 billion, with estimated earnings of \$407 million. An estimated \$114 million in total nominal ad valorem taxes would accrue in Sweetwater County, \$86 million in Lincoln County, and \$68 million in Uinta County over the LOP (Table 4-24). In addition, Alternative C is expected to generate total LOP severance tax revenues of \$245 million and \$207 million in Federal Mineral Royalties, of which \$103 million would go to the State of Wyoming.

Under Alternative C, local area government operating budgets would likely expand more than under the Proposed Action, Alternative A, or Alternative B. Alternative C would generate the most overall taxes and revenues compared to all other alternatives.

In summary, this alternative would generate more economic activity related to development and production than all other alternatives because of the high level of resource recovery. Alternative C would have both adverse and beneficial social and economic impacts on the study area. The impacts from Alternative C would be greater than any of the other alternatives, due to the number of new wells drilled and the length of the project drilling, completion, and production phases.

4.11.4. Mitigation

Due to the significance of the socioeconomic issues, particularly in the short term, several potential mitigation measures are proposed for all alternatives:

- Assist local government with funding of public service projects that have been impacted by population growth related to oil and gas development.
- Work with impacted communities to develop and fund “portable” infrastructure enhancements (infrastructure provided by Operators during “boom” peaks and removed by Operators during “bust” times).
- Work with the Wyoming Department of Transportation and/or Sweetwater, Lincoln, and Uinta County Road and Bridge Departments to install appropriate road-side signs outside the MAA that indicate potential hazards (e.g., school bus stops, high-traffic volume turnouts, trucks entering roadway).
- MAA Operators could provide incentives or land for local builders to build housing prior to start-up of MAA drilling activities. The City of Evanston has adequate utility capacity for significant growth. Therefore, these incentives would be best provided in the Evanston area.

4.11.5. Residual Impacts

Residual and unavoidable short-term and long-term adverse socioeconomic impacts would occur as a result of the proposed project. Some short-term impacts could be reduced by implementation of suggested mitigation measures.

4.11.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Both beneficial and adverse socioeconomic impacts are anticipated as a result of (1) the effects of employment and population growth on the region, and (2) the increases in federal, state, and local revenues from direct and indirect production and expenditures. Under the No Action/Low Development Alternative, effects of increased employment, economic activity, and substantial federal, state, local, and county revenues would occur to a lesser degree than for the Proposed Action or alternatives.

Under all alternatives (including the No Action/Low Development), the Project would generate substantial revenues for state, county, and local governments, including area school districts, through state sales tax, federal income tax, ad valorem taxes (production property taxes), severance taxes, federal minerals royalties, and other taxes on facilities and production. Estimated ad valorem taxes, severance taxes, and federal mineral royalties (shown as nominal values) resulting from the Project, through the production phase (LOP), are presented in Table 4-24, including the likely distribution of those funds to the U.S., State of Wyoming, and affected counties, based on current statutes and distribution trends.

4.12. Land Use

4.12.1. Land Status/Prior Rights

Current land uses in the MAA include livestock grazing, natural gas production, wildlife habitat, recreation, and some limited residential use. Ownership of surface and mineral estates would not be expected to change under any alternative and no significant impacts to land status or prior rights would be expected.

4.12.2. Livestock Grazing and Rangeland Health

4.12.2.1. Introduction

Impacts to rangeland health, livestock, grazing allotments, and all resource uses of rangelands would result with implementation of the Proposed Action or any of the action alternatives. In particular, fish, wildlife, and domestic animals depend upon rangeland health for food and habitat. The impacts upon fish, wildlife, and other uses of rangelands are discussed in their respective sections, and impacts upon livestock grazing are discussed in this section. Impacts would occur throughout the LOP and would vary in intensity depending upon vegetation and soil disturbance, reclamation success, weed control, road construction and use (i.e., dust and animal/vehicle collisions), success of rangeland improvements, and additional resources and costs incurred by government officials and grazing permittees. Under the Proposed Action and all alternatives, cattle and sheep grazing would likely continue throughout the duration of the project with stocking rate adjustments and requests for temporary non-use made annually by each livestock operation.

4.12.2.2. Significance Criteria

Impacts to livestock grazing would be significant if project activities precluded livestock grazing use of the MAA for the long term, if there were a reduction in AUMs 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.

4.12.2.3. Direct and Indirect Impacts

4.12.2.3.1. *Impacts Common to All Alternatives*

Under the Proposed Action and all alternatives, cattle and sheep grazing would continue throughout the duration of the project. Livestock management impacts include reclamation failures, loss of functions of rangeland improvements, loss of palatability of vegetation from road dust, and livestock losses. Livestock grazing is a primary land use of the Project Area, and over 91% of the MAA is part of a grazing allotment. Impacts would occur throughout the LOP from vegetation and soil disturbance associated with construction activities, reclamation, weed control, road construction and use (i.e., dust and animal/vehicle collisions), and rangeland improvements functionality.

The primary impact to grazing resources would be short-term loss of available forage as a result of construction and production-related disturbance. Available forage would be reduced during drilling and construction phases but would be reclaimed as soon as feasible for the production phase. A long-term loss of forage would occur due to construction of roads and ancillary facilities that remain in place during the LOP. Dust from roads reducing the palatability of adjacent vegetation and the threat of health issues such as dust pneumonia would also be impacts of field development activities, in addition to the effects associated with direct loss of vegetation.

The potential exists for disruptions to livestock management actions. There is also potential for damage to range improvements from the movement of heavy trucks, drilling equipment, and heavy construction equipment. Traffic along roads that pass through active shipping pastures or corrals may interrupt or complicate this work, extending the time and increasing the cost to complete it. Cattle guards and gates may be damaged by drill rigs that are too wide/heavy, leading to added maintenance and unwanted mixing of livestock. Direct loss of livestock is possible if vehicle collisions and the resulting mortality increase with field development.

Disturbance of soils and increased vehicle activity would increase the introduction, establishment, and spread of undesirable non-native/noxious weedy species. This can reduce forage availability and animal weight gains, in addition to affecting trail routes and overall animal health. Proper reclamation of disturbed sites (Appendix E) would help reduce these potential impacts.

4.12.2.3.2. Proposed Action

The Proposed Action would result in an estimated initial disturbance to allotments of about 11,063 acres (1,106 acres per year for the 10 years of drilling) in the core and 6,085 acres (608 acres per year) in the flank. This represents about 3.9% of the total land area of the grazing allotments. Successful interim reclamation would replace forage removed from short-term disturbances. Reclamation of short-term disturbance will probably compensate for a portion of the forage lost. However, this is dependent on commitment by Operators for successful reclamation and weed control. During the LOP, this disturbance would be reduced to about 5,511 total acres, or about 1.3% of the combined land area of the allotments. Potential short-term and long-term impacts to grazing allotments and AUMs within the MAA are presented in Table 4-26. Impacts for Alternative B are not included in Table 4-26 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Some impacts would occur within the Rock Springs allotment; however, due to the lack of data for this allotment, it is not included in impact analysis.

Long-term impacts would occur where proposed well pads, new roads, and other facilities replace current allotment acreages. Short-term impacts would be expected from staging, storage, and other temporary use facilities for construction/exploration occurring on allotments that would later be reclaimed. Reseeding of allotments with perennial forage grasses would occur within the next growing season. Revegetation of the allotments is dependent on many factors including soil moisture, precipitation, soil type, and a number of other environmental correlates. Revegetation is expected to occur within three years of disturbance and no long-term reduction in quality of current grazing allotments would be expected, as long as an appropriate seed mix is used for interim reclamation of well pads, access roads, and pipelines. The short-term reduction in AUMs from the Proposed Action would not be a significant loss (Feeley 2006).

4.12.2.3.3. Alternative A

Some AUMs would be directly lost each year to short-term oil and gas activities, as shown in Table 4-26. Continued activities under Alternative A/No Action would result in an estimated initial disturbance of 5,686 acres (948 acres per year for the 6 years of drilling) in the core and 4,124 acres (687 acres per year) in the flank, which represents about 2.3% of the total land area of the allotments. These impacts would decrease as interim reclamation continues to take place on an annual basis. During the LOP, disturbance would be reduced to about 3,100 total acres, or about 0.7% of the land area of the allotments. The quality of grazing allotments within the MAA would remain stable as current management practices continue to be implemented.

Table 4-26. Potential Disturbance to Grazing Allotments within the MAA.

Disturbance Type	Core/Flank	Austin Triangle	Carter Lease	Christ-ensen	Indian Flat	Cow Hollow	Granger Lease	H.F.	Hassett	Lyman Cattle	Monu-ment	Nelson Section	Nutria	Opal	Seeds-kadee	Slate Creek	Sage Creek	South Monument
Alternative A																		
Drilling and Completion	Core	0	444	0	0	12	3998	17	13	347	0	0	12	0	30	813	0	0
	Flank	46	215	108	141	174	2,500	0	134	202	0	0	45	0	54	538	0	13
AUMs Affected		1.0	82.4	4.5	10.1	12.4	203.1	1.1	9.2	39.2	0	0	4.8	0	2.7	67.6	0	unk
After Interim Reclamation	Core	0	123	0	0	3	1,110	5	4	96	0	0	3	0	8	226	0	0
	Flank	13	60	30	39	48	694	0	37	56	0	0	12	0	15	149	0	4
AUMs Affected		0.3	22.9	1.3	2.8	3.4	56.4	0.3	2.6	10.9	0	0	1.3	0	0.3	18.8	0	unk
Long Term % of AUMs Affected		0.1%	0.3%	1.4%	0.5%	0.6%	0.2%	0.8%	0.9%	0.6%	0%	0%	1.4%	0%	0.06%	0.7%	0%	unk
Proposed Action																		
Drilling and Completion	Core	0	1,523	0	0	85	8,083	51	10	452	0	0	27	0	69	763	0	0
	Flank	317	1,083	51	299	160	1943	0	130	705	129	33	16	20	313	419	35	11
AUMs Affected		7.0	325.8	2.1	21.4	16.3	313.3	3.4	8.75	82.6	11.7	0	3.6	0.9	12.3	59.1	4.4	unk
After Interim Reclamation	Core	0	490	0	0	27	2,603	16	3	145	0	0	9	0	22	251	0	0
	Flank	101	347	16	96	51	622	0	41	225	41	11	5	6	100	134	11	3
AUMs Affected		2.2	104.6	0.7	6.9	5.2	100.8	1.1	2.8	26.4	3.7	1.1	1.2	0.3	3.9	19.3	1.4	unk
Long-term % of AUMs Affected		1.0%	1.4%	0.7%	1.3%	0.9%	0.3%	3.0%	1.0%	1.3%	1.2%	1.1%	1.1%	0.9%	0.8%	0.7%	0.2%	unk
Alternative C																		
Drilling and Completion	Core	0	3,918	0	0	174	20,731	97	16	800	0	0	74	0	479	4643	0	0
	Flank	523	1,691	109	388	289	5,024	0	178	1,203	184	50	39	35	565	761	48	14
AUMs Affected		11.6	701.1	4.5	27.7	30.9	804.8	6.5	12.1	143.1	16.7	5	9.4	1.6	7.1	270.2	6.0	unk
After Interim Reclamation	Core	0	1,322	0	0	59	6,997	33	5	270	0	0	25	0	161	1577	0	0
	Flank	175	567	37	130	97	1,684	0	60	403	62	17	13	12	189	255	16	5
AUMs Affected		3.9	236.1	1.5	9.3	10.4	271.3	2.2	4.1	48.1	5.6	1.7	3.2	0.55	7.1	91.6	2.0	Unk
Long-term % of AUMs Affected		1.8%	3.1%	1.7%	1.7%	1.8%	0.9%	6.1%	1.4%	2.4%	1.8%	1.7%	3.1%	1.9%	1.5%	3.2%	0.32%	unk

4.12.2.3.4. *Alternative B*

Long-term surface disturbance resulting from Alternative B would be the same as that from the No Action/Low Development Alternative; therefore, loss of available grazing and AUMs on the allotments within the MAA would also be the same. Application of techniques to reduce surface disturbance, as defined in Chapter 2, would not significantly reduce direct or indirect impacts to grazing allotments. The increased emphasis on reclamation success under this alternative would further reduce impacts to grazing allotments, and could possibly improve the quantity and quality of available forage for livestock. The reduction in AUMs from Alternative B would not be a significant loss (Feeley 2006) and would not result in economic impacts to the grazing lessees within the MAA.

4.12.2.3.5. *Alternative C*

Potential short-term and long-term impacts to AUMs on the grazing allotments within the MAA are presented in Table 4-26. Due to increased well density and surface disturbance, direct impacts to AUMs and economic costs to grazing lessees would increase as a result of Alternative C over those of the Proposed Action. Alternative C would result in an initial disturbance of about 30,932 acres (1,237 acres per year for the 25 years of drilling) in the core and 11,857 acres (474 acres per year) in the flank. This represents about 9.9% of the total land area of the allotments. During the LOP, this disturbance would be reduced to about 14,424 total acres, or about 3.3% of the combined land area of the allotments. The reduction in AUMs from Alternative C would not be a significant loss (Feeley 2006) and would not result in economic impacts to the grazing lessees within the MAA.

4.12.2.4. Mitigation

Protection measures that benefit rangelands include those that prevent weed spread or introduction of new noxious weed infestations (see Section 4.7). Other Operator-committed measures include repairing fences damaged or removed for construction and avoiding impacts to range improvements such as stock ponds, guzzlers, and other watering amenities.

Increasing the amount of field automation would reduce traffic in the MAA, and would thereby reduce the impacts on vegetation from fugitive dust. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

As mitigation for the initial temporary loss of AUMs, use of a reclamation seed mix that fits the needs of affected permittees and complies with BLM standards should continue to be implemented in the MAA (see Reclamation Plan, Appendix E).

4.12.2.5. Residual Impacts

No residual impacts are expected after successful reclamation.

4.12.3. Recreation

4.12.3.1. Introduction

Recreational resources are an important value for residents in the vicinity of the Project Area, as well as a source of income for the state of Wyoming and its cities and towns. One of the goals of the Kemmerer RMP is to assure that these resources are preserved and continue to be available to residents and visitors.

4.12.3.2. Significance Criteria

Impacts to recreation would be considered significant if project development changes the recreational use of the MAA or results in a violation of RMP or other land use plan recreation objectives. Impacts to recreation in most cases are assumed to be proportional to the amount of development for all alternatives (Tables 2-3, 2-4, and 2-5). Dispersed recreation opportunities may be impacted in the MAA for the LOP under all project alternatives, including the No Action/Low Development Alternative.

4.12.3.3. Direct and Indirect Impacts

4.12.3.3.1. *Impacts Common to All Alternatives*

Impacts to recreational sites and facilities are expected to be minimal for all alternatives. The MAA has two campground facilities within its boundaries. Slate Creek Campground is located on the west side of the Green River, approximately four miles south of the Fontenelle Reservoir, and the Weeping Rock Campground is located on the west side of the Green River, approximately one mile south of the Fontenelle Reservoir. Though both of these facilities occur in the MAA, significant impacts are not expected as development in this flank area is anticipated to be minimal.

The MAA does not currently have a high level of recreational use. As such, direct impacts to recreational opportunities are expected to be minimal. Project-improved roads may promote some increased recreational use (e.g., access for hunting and sightseeing). However, long-term displacement of existing dispersed recreation (if any) due to increased levels of gas field development activity is anticipated. In addition, some potential recreational visitors would likely avoid the MAA because of a perceived reduction in the quality of the recreational experience.

Hunting

Hunting pressure on any species within the MAA is likely to be directly related to wildlife population size, structure, and availability. Under all alternatives, displacement of populations of pronghorn and other hunted species could impact the quality or perceived quality of recreational hunting opportunities in the MAA. Lands adjacent to or in the flank of the MAA would likely absorb some of the displaced hunting pressure, because displaced wildlife would likely move to adjacent lands.

Fishing

BLM-permitted development activities within the KFO area are restricted by a 500-foot buffer along streams and creeks to protect aquatic and riparian resources. This would benefit anglers, as well as water resources, in that no direct effects to fishing resources are expected. Other protection measures designed to keep sedimentation out of water bodies would benefit fish and, therefore, angling resources. Impacts to surface waters that may indirectly affect fishing opportunities include increases/decreases in levels of water flow and runoff, sedimentation (downstream and offsite), salinity changes, and turbidity. Potential visual and noise effects to anglers will depend on the proximity of development activity to fishing access areas and will be analyzed on a case-by-case basis. Fishing access to the Hams Fork and Blacks Fork Rivers may be temporarily affected when project activities are occurring in the immediate area.

Camping

Camping occurs in well-established areas that are not expected to be impacted by oil and gas development activities. Potential visual and noise effects to campers will depend on the proximity of development activity to camping areas and will be analyzed on a case-by-case basis.

Open Recreation (Hiking, Off-highway Vehicles [OHVs], Wildlife Watching)

Because recreation of this type is primarily dispersed throughout the MAA, specific effects are difficult to determine. Roads created for oil and gas resource development may be used by OHVs for

access or other recreational opportunities. During concentrated development activities, some of these recreational pursuits may be temporarily affected by access limitations, noise, and/or visual intrusions. Long-term impacts may include reduced ecologic or aesthetic value of the area for activities such as wildlife watching and hiking. Additionally, some areas may be off-limits due to safety issues, reducing recreation access.

4.12.3.3.2. Proposed Action

Under the Proposed Action, impacts to recreational opportunities are anticipated to increase from levels under the Alternative A as 1,861 new well pads are constructed and the approximate 931 miles of new roads are built. Duration of impacts would be for the 60-year LOP and until areas are adequately reclaimed.

4.12.3.3.3. Alternative A

Current and continuing permitted/approved resource developments in the MAA would not be expected to change the opportunities for access to recreational resources. Disturbance would continue through the LOP of current development projects.

4.12.3.3.4. Alternative B

Impacts to recreation under Alternative B would be similar to that of Alternative C. However, surface disturbance reduction techniques could potentially reduce impacts to recreational resources to that of Alternative A.

4.12.3.3.5. Alternative C

Under Alternative C, impacts to recreational opportunities are anticipated to increase from levels under the Proposed Action, as 5,165 new well pads and approximately 2,583 miles of new roads are constructed. Duration of impacts would be for the 75-year LOP and until areas are adequately reclaimed. The types of impacts are expected to be the same as those described for the Proposed Action.

4.12.3.4. Mitigation

No specific mitigation for recreational resource impacts is anticipated, as disturbance is not expected to be significant. However, 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. Additional techniques employed to reduce surface disturbance in Alternative B may reduce impacts to recreational resources. Mitigation measures for wildlife and big game species would likely benefit recreation.

4.12.3.5. Residual Impacts

Residual impacts after final reclamation and the LOP are expected to be minimal and not significant. Recreational hunting opportunities in the MAA and other wildlife-related recreation may still be slightly impacted after the LOP until displaced species return to the area.

4.12.4. Transportation

4.12.4.1. Introduction

Transportation effects of natural gas development and production would include increased traffic on federal and state highways and county roads providing access to the MAA, primarily I-80, US 30, and US 189. Primary access from Green River and Rock Springs is from I-80 and US 30. Access from Evanston and the Bridger Valley is from I-80. Primary access from Kemmerer and Diamondville is

from US 30 and US 189. Wyoming Secondary Highways WY 372, WY 240, and WY 374 also provide access to portions of the MAA. The BLM, cooperating agencies, and the Operators would continue to cooperatively develop long-term transportation management plans for existing and future roads. Total number of trips would increase in proportion to the level of development for each alternative (Table 4-27).

Table 4-27. Total Number of Trips by Alternative.

Trip Type	Proposed Action	Alternative A	Alternatives B and C
Drilling	22,320	12,960	24,620
Cementing and Production casing	11,160	6,480	12,310
Completion and Testing	37,220	21,612	41,000
Operations/Maintenance	2,880	1,672	12,972
Frac Operations	7,812	4,536	8,610
Road and Pad Construction	3,906	2,268	4,305
Total trips for peak year	85,298	49,528	103,817

* Total trips for Alternative B could be reduced through use of techniques such as mat drilling, drilling multiple wells from a single pad, and remote monitoring/control.

4.12.4.2. Significance Criteria

The following criterion is used to determine whether transportation impacts would be significant: increases in traffic levels in the local public transportation system that would cause the level of service to fall below acceptable levels, as defined by the responsible government agency.

4.12.4.3. Direct and Indirect Impacts

4.12.4.3.1. Proposed Action

Table 4-28 shows the estimated number of annual round trips associated with drilling, field development, and well field operations activities in the 10th (peak) year of drilling. Drill rigs and other heavy equipment would be transported to the MAA and remain within the Project Area until relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to the MAA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

Table 4-28. Proposed Action Traffic Estimates in Peak 10th Year of Drilling.

Trip Type	Vehicle Requirements	Days/well	Well	Annual Round Trips
Drilling	6 vehicles/day	20	186	22,320
Cementing and Production casing	6 vehicles/day	10	186	11,160
Completion and Testing	20 vehicles/day	10 days	186	37,220
Operations/Maintenance	*	*	1861	2,880
Frac Operations	6 vehicles/day	7 days	186	7,812
Road and Pad Construction	3 vehicles/day	7 days	186	3,906

*Assumes each pumper visits 20 wells and that telemetry is installed within 60 days. Each well is visited twice monthly during the 10th year with the exception of newly installed wells that will require daily visits for the first 60 days.

Average annual daily traffic (AADT) estimates were developed based on current drilling activities occurring in the MAA since the 1997 ROD, including drilling activities for typical conventional gas wells, construction of ancillary facilities, performance of routine operations activities and well workovers, and miscellaneous visits. Based on past and current operations, the Proposed Action would generate an estimated AADT of 467 (233 round trips) during the peak drilling year (Year 10). Year 10 will have the same number of wells drilled as year 1, with the continuance of routine maintenance and operations activities for all wells drilled to that point. This would include an AADT of 429 for drilling and field development activities. AADT is calculated on a 365-day basis, and drilling and field development activities would be limited due to weather-related activities. Therefore, average daily traffic would be substantially higher during the active drilling period. Drilling and field development traffic would remain relatively constant through the 10 years of drilling requested under the Proposed Action. Operations traffic would increase through the 10 years of drilling and would remain constant thereafter until the life of the wells begin diminishing during year 30 of production. Under the assumptions used for this assessment, Proposed Action-related AADT would be relatively constant after the peak year, consisting of operations and maintenance, and would average approximately 12 trips per day (20 pumpers per well twice monthly).

Table 4-29 contrasts peak drilling year (Year 10) AADT for federal and state highways providing access to the MAA, with 2005 and projected 2015 AADT on those highways. AADT for individual highways was derived by using the percentage of total AADT for each highway from the BLM approved Expanded Moxa Arch Area Draft EIS, April 1995, and extrapolating the data to the same highways using current estimated AADT data.

Table 4-29. Proposed Action Peak Drilling Year (Year 10) AADT Compared with 2005 AADT and Projected 2015 AADT on Affected Highways.

Highway Segment	2005 AADT	Projected 2015 AADT	Estimated Peak Year Drilling Year AADT	% 2005 AADT	% Projected 2015 AADT
I-80 (mp 6.26-107.09)	13,146 (5,877 Trucks)	15,652 (6,696 Trucks)	225	1.7	1.4
U.S. 30 (mp55.13-100.03)	1,983 (928 Trucks)	2,554 (1,684 Trucks)	184	9.2	7.2
U.S. 189 (mp 0.0-66.86)	1,232 (162 Trucks)	1,443 (189 Trucks)	29	2.4	2
WY 372 (mp 0.114- 48.59)	1,207 (321 Trucks)	1,344 (358 Trucks)	20	1.7	1.5
WY 240 (mp 0.0-12.29)	399 (120 Trucks)	484 (121 Trucks)	8	2	1.7

Source: Wyoming Department of Transportation (Adkison 2006; Carpenter 2006)

Given the potential for increased drilling and field development in the area, these traffic forecasts may change. The Proposed Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues and the State's share of federal mineral royalty revenues associated with the Proposed Action would offset these costs. The Proposed Action-related increase of traffic on federal and state highways would result in a corresponding increase in the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

4.12.4.3.2. *Alternative A*

As part of Alternative A/No Action, the BLM would reject the Operators' proposal and continue with implementation of the 1997 ROD for the previous Moxa Arch EIS. Authorizations for and impacts from previously approved or analyzed development and surface disturbance would continue. Traffic volumes (Table 4-28) would be approximately equal to those described in the Expanded Moxa Arch Gas Development EIS (BLM 1995a).

4.12.4.3.3. *Alternative B*

Alternative B would have well numbers similar to those of Alternative C, and surface disturbance estimates similar to those of Alternative A. Consolidation of production facilities and drilling multiple wells from single pads would decrease traffic as a result of fewer operations and maintenance trips and fewer construction trips. The level of this decrease would depend on how the operators develop the field. If multiple wells are drilled from single pads, traffic could decrease proportionally to the number of directional wells drilled.

Drilling multiple wells from single pads could increase localized traffic impacts. If wells are drilled directionally the rigs sit on the pads for a longer duration and traffic follows the same route the entire time the rig is on site rather than dispersing among multiple rigs.

4.12.4.3.4. *Alternative C*

Table 4-30 shows the estimated number of annual round trips associated with drilling, field development, and well field operations activities in the 25th (peak) year of drilling. Drill rigs and other heavy equipment would be transported to the MAA and remain within the Project Area until relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to MAA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

Table 4-30. Alternative C Traffic Estimates in Peak 25th Year of Drilling.

Trip Type	Vehicle Requirements	Days/well	Well	Annual Round Trips
Drilling	6 vehicles/day	20	205	24,620
Cementing and Production casing	6 vehicles/day	10	205	12,310
Completion and Testing	20 vehicles/day	10	205	41,000
Operations/Maintenance	*	*	5,165	12,972
Frac Operations	6 vehicles/day	7	205	8,610
Road and Pad Construction	3 vehicles/day	7	205	4,305

*Assumes each pumper visits 20 wells and that telemetry is installed within 60 days. Each well is visited twice monthly during the 25th year with the exception of newly installed wells, which will require daily visits for the first 60 days.

Based on past and current operations, Alternative C would generate an estimated AADT of 568 (284 round trips) during the peak drilling year (Year 25). Year 25 will have the same number of wells drilled as year 1 with the continuance of routine maintenance and operations activities for all wells drilled to that point. This would include an AADT of 498 for drilling and field development activities. AADT is calculated on a 365-day basis and drilling and field development activities would be limited due to weather related activities. Therefore, average daily traffic would be substantially higher during the active drilling period. Drilling and field development traffic would remain relatively constant through the 25 years of drilling requested under Alternative C. Operations traffic would increase through the 25 years of drilling and would remain constant thereafter until the life of the wells begin diminishing during the subsequent 15 years. Under the assumptions used for this assessment, Alternative C-related AADT would be relatively constant after the peak year, consisting of operations

and maintenance, and would average approximately 34 trips per day (20 wells per pumper twice monthly).

Table 4-31 contrasts peak drilling year (Year 25) AADT for federal and state highways providing access to the MAA with 2005 and projected 2025 AADT on those highways. Given the potential for increased drilling and field development in the area, these traffic forecasts may change. The Proposed Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues and the State's share of federal mineral royalty revenues would offset these costs. The increase of traffic on federal and state highways would result in a corresponding increase in the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

Table 4-31. Alternative C Peak Drilling Year (Year 25) AADT Compared with 2005 AADT and Projected 2025 AADT on Affected Highways.

Highway Segment	2005 AADT	Projected 2025 AADT	Estimated Peak Drilling Year AADT	% 2005 AADT	% Projected 2025 AADT
I-80 (mp 6.26-107.09)	13,146 (5,877 Trucks)	18,234 (8,934 Trucks)	275	2.1	1.5
U.S. 30 (mp55.13-100.03)	1,983 (928 Trucks)	2,713 (1,832 Trucks)	224	11.2	8.2
U.S. 189 (mp 0.0-66.86)	1,232 (162 Trucks)	1,652 (228 Trucks)	35	2.8	2.1
WY 372 (mp 0.114- 48.59)	1,207 (321 Trucks)	1,453 (425 Trucks)	24	2.0	1.7
WY 240 (mp 0.0-12.29)	399 (120 Trucks)	579 (160 Trucks)	10	2.5	1.7

4.12.4.4. Mitigation

Operators will be required to participate in and assist with funding of development of an area-wide transportation plan which will include transportation network design, dust control measures, and address other transportation-related issues.

Increasing the amount of field automation would reduce traffic impacts in the MAA. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

4.12.4.5. Residual Impacts

No residual impacts would be expected after the LOP.

4.12.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

4.12.5.1. Livestock and Grazing Allotments

Impacts to livestock and grazing allotments would be greatest for Alternative C, which approximately doubles the amount of disturbance to allotments that would occur under the Proposed Action. Generally, impacts to allotments would be lowest under the No Action/Low Development Alternative.

However, impacts to smaller leases in several of the zones used in the 1997 EIS could be slightly greater under the Alternative A. Alternative B would be expected to have similar levels of surface disturbance as Alternative A. Implementation of techniques to reduce total project surface disturbance and increase reclamation success in order to remain under the disturbance cap could reduce the impacts to livestock and grazing allotments. Loss of forage, death or disruption of livestock, and other impacts that might affect livestock or allotments would be approximately proportional to the level of disturbance that would occur in each allotment.

4.12.5.2. Recreation

Impacts to recreational resources in the MAA are not expected to be significant, as the current recreational opportunities in the MAA are minimal. Indirect effects to recreational opportunities associated with wildlife may occur due to the displacement of species during construction and reclamation and continue until these species return to the area. Other dispersed recreational opportunities may also be affected during the LOP, though not significantly. Of all alternatives, Alternative B would most likely have the least amount of impacts to recreational resources. Implementation of mitigation and techniques that reduce surface disturbance and minimize impacts to wildlife have the potential to reduce impacts to recreational resources. Alternative C would have the most impact on recreational opportunities, due to the high levels of disturbance.

4.12.5.3. Transportation

Impacts to transportation would be proportional to the number of well pads that would be constructed in the MAA. Alternative C would generate the greatest increase in traffic because of the higher number of well pads that would be constructed. Alternative A would generate the lowest increase in traffic, with volumes similar to those currently observed in the MAA. Alternative B could generate traffic volumes similar to those of Alternative C. However, implementation of surface disturbance reduction techniques, such as drilling multiple wells from single pads, consolidating production facilities, remote monitoring and remote control of wells, and implementing traffic planning, would minimize the total traffic volume.

4.13. Visual Resources

4.13.1. Introduction

Potential impact areas in the MAA include historic trails; views from surrounding recreation areas; and views from I-80, U.S. 30, Hwy 189, and railroads. For the most part, these are VRM Class II and III areas and are associated with the Hams Fork and Green Rivers and the Fontenelle Reservoir. A majority of the interior of the project area is Class IV and is not typically seen by the public. Visual resource impacts from natural gas development can result from increases in well pad density, miles of road and pipeline, traffic, and ancillary facilities within the MAA. Construction equipment and temporary facilities cause short-term impacts to contrasts in the characteristic line, form, color, and texture of the landscape. Fixed structures cause long-term impacts to the landscape. The severity of impact to sites depends on the existing scenic quality, level of disturbance, reclamation potential, and visibility to viewers. Note that the project is located within “checkerboard” land ownership, and visual impacts are not regulated on private or state lands.

4.13.2. Significance Criteria

Impacts to visual resources in the MAA would be significant if project-related development did not meet the BLM VRM class objectives described in Section 3.12 or caused a change in the overall character of the landscape. The VRM analysis process determines whether the potential visual

impacts from proposed surface-disturbing activities meet the management objectives established for the area, or whether design adjustments will be required. A visual contrast rating process is used for this analysis, which involves comparing the project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture. Site-specific analyses would occur after approval of the project and issuance of the ROD by the BLM and before surface disturbance would be allowed to take place on federal surface or minerals, pursuant to an individual APD or ROW grant.

In addition to VRM management, the Wyoming BLM analyzes impacts to National Historic Trails (NHT) and their associated viewsheds. Visual surveys determine the visibility of structures and ground level visibility from NHTs. To provide a protective corridor for the trail; generally visual intrusion and surface disturbance will be restricted or prohibited within 1,320 feet from either side of an historic trail (may depend on topography and existing surface disturbance), or within the visual horizon of the trail, whichever is closer.

4.13.3. Direct and Indirect Impacts

Table 4-32 shows the acres of impact within the MAA by VRM Class. Impact estimates for Alternative B are not included in Table 4-32 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. In general, wells, roads, and pipelines will be evenly distributed throughout the MAA and, therefore, are proportionate to the VRM Class acreages within the MAA. For all alternatives, the greatest amount of surface disturbance will take place in VRM Class IV areas, while the least impact will take place in Class II. However, even low levels of disturbance within Class II areas can be significant, because these areas are more visible to the observer.

Table 4-32. Impacts to VRM Class Areas within the MAA.

Disturbance Type	Core/ Flank	Class II		Class III		Class IV	
		# Wells	Acres	# Wells	Acres	# Wells	Acres
Alternative A							
Drilling and Completion	Core	28	431.5	63	957.4	299	4582.4
	Flank	18	270.2	78	1187.0	185	2830.2
After Interim Reclamation	Core	28	119.8	63	265.8	299	1272.1
	Flank	18	75.0	78	329.5	185	785.7
Proposed Action							
Drilling and Completion	Core	155	1555.6	293	2944.5	785	7870.3
	Flank	66	661.5	184	1842.8	377	3774.8
After Interim Reclamation	Core	155	497.5	293	937.5	785	2510.7
	Flank	66	211.7	184	589.7	377	1207.9
Alternative C*							
Drilling and Completion	Core	359	3164.6	1158	10231.2	2245	19829.4
	Flank	116	1013.9	459	4044.9	828	7286.3
After Interim Reclamation	Core	359	1059.9	1158	3414.7	2245	6623.1
	Flank	116	339.9	459	1355.9	828	2442.6

Acres includes surface disturbance from well pads, roads, pipelines, and additional disturbance

* Includes MMTA

4.13.3.1. Proposed Action

Under the Proposed Action, natural gas field development would increase from existing development in the MAA with the addition of wells, increased miles of roads and traffic, and ancillary facilities. Total surface disturbance area resulting from the Proposed Action would be 2,217 acres in VRM Class II, 4,787 acres in VRM Class III, and 11,645 acres in VRM Class IV. The highest level of visual impact would occur during construction and drilling, which would be a 10-year duration. Visual impacts would continue to a lesser degree over the 40-year life of the wells and for additional time as reclamation continues.

The additional wells in the MAA would increase the likelihood of people seeing a landscape that includes oil and gas structures, areas of bare soil around well pads and other facilities sites, and roads. These would contrast with the natural landscape, especially in areas of continuous vegetation. Locations with the greatest potential for visual contrasts from the Proposed Action would be viewpoints along the major roads passing through the MAA. These roads would likely be traveled by private property owners and recreational visitors, as well as by oil and gas-related personnel. Sensitivity to the level of visual contrast from oil and gas development would likely be highest among recreation users, including hunters, sightseers, and wildlife observers. Visual impacts related to the Proposed Action would be significant and long term, beginning during development and lasting beyond the LOP.

The Operators' commitment to reduce visual impacts through the use of BLM-approved paint colors for production facilities will help to mitigate visual resource impacts. This mitigation would occur for all project alternatives.

4.13.3.2. Alternative A

Under Alternative A/No Action, there would be no new impacts to visual resources beyond existing Moxa Arch developments approved by the 1997 ROD. Disturbance in VRM classes would include 702 acres in VRM Class II areas, 2,144 acres in VRM Class III areas, and 7,413 acres in VRM Class IV areas.

For Alternative A/No Action, the 1996 Moxa EIS and 1997 ROD determined that short-term impacts would exceed the level of contrast permitted in Class II, III, and IV. Application of mitigation measures would reduce contrasts to levels permitted in Class IV areas, and impacts in Class II and III areas would be reduced with mitigation, but not to levels below significance.

4.13.3.3. Alternative B

Under Alternative B, development would be similar to Alternative C. However, additional techniques employed to reduce surface disturbance and increase reclamation would reduce visual impacts. These techniques include drilling multiple wells from single well pads, collocating gathering and power lines with roads, and minimizing vegetation and topsoil removal. Therefore, impacts to visual resources would be reduced to levels similar to Alternative A.

4.13.3.4. Alternative C

Total surface disturbance in VRM Classes would include 4,179 acres in VRM Class II, 14,276 acres in VRM Class III, and 27,116 acres in VRM Class IV. The highest level of visual impact would occur during construction and drilling, which would occur over a 25-year period. Visual impacts would continue to a lesser degree over the 40-year expected production life of the wells following drilling and for additional time as reclamation continues.

With the additional wells and associated infrastructure in Alternative C, visual changes to the characteristic landscape would be more noticeable. While Alternative A has already significantly impacted many of the VRM areas, higher development under Alternative C would be more likely to attract the attention of the casual observer. It could also cause reduced visitation by recreators and would likely increase the significance of the VRM impacts; therefore, it would not meet VRM objectives.

4.13.4. Mitigation

BLM management objectives that protect visual resources include evaluating the visual sensitivity (e.g., VRM classes) of the Project Area and ensuring compatibility of projects with management objectives for visual resources; blending long-term facilities with the natural environment; and restricting visual intrusion and surface disturbance within Class I and II areas and within 0.25 mile of either side of a NHT or within the visual horizon of the trail, whichever is closer. Also, the required 500-foot riparian buffer would prevent wells from being located in portions of VRM Class II areas along rivers.

When final siting decisions are made, design and location strategies would be used to screen features from view in VRM Class II and III areas visible from major roads. Using existing topography to screen roads, pipeline corridors, drill rigs, wellheads, and production facilities is included in agency requirements for visual resources.

Reclamation and road standards, which would be applied for all alternatives, would reduce the amount of bare ground that contrasts with the natural environment, reducing short-term and residual visual impacts of disturbed sites.

4.13.5. Residual Impacts

Residual impacts on the visual resources would occur even after final reclamation at the end of the LOP because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. Shrubland communities and impacted sensitive soils could take as long as 30+ years to recover, depending on factors such as soils, climate, and maintenance. The MAA would also likely retain numerous improved project roads, which would create lasting linear features that detract from the existing character of the area.

4.13.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

As development in the MAA increases, observers would be able to notice a change in the characteristic of the landscape. Structures, roads, and bare ground will interrupt basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape, depending on the number of wells planned for visible areas. Therefore, Alternative C would have the most impact on visual resources, while the Alternative A/No Action would have the least impact. Impacts would be long-term, existing during the LOP and while the natural landscape recovers after reclamation.

4.14. Hazardous Materials/Health and Safety

4.14.1. Introduction

Potential health and safety impacts associated with all alternatives are similar to those associated with existing conditions in the MAA, although the risk of certain types of impacts would increase as the

amount of natural gas development increases. Potential health and safety impacts include occupational hazards associated with oil and gas exploration and development, risk associated with vehicular travel on improved and unimproved roads, and range fires.

4.14.2. Significance Criteria

No specific health and safety standards were identified in the Kemmerer RMP (BLM 1985). General health and safety effects of the alternatives would be considered significant if they resulted in substantially increased risk to the public, results in the “release” (40CFR300.5) of hazardous substances at or above reportable quantities to the environment, and/or fails to comply with all federal, state, or local regulations.

4.14.3. Direct and Indirect Impacts

Direct and indirect impacts of development in the MAA would be proportional to the level of development under each alternative. As these impacts are proportional, additional analysis for each alternative will not be completed. The following are the direct and indirect impacts that would be expected for all project alternatives and the proximity to sensitive resources (i.e. water, wildlife, human receptors).

4.14.3.1. Health and Safety

Potential health and safety effects associated with development in the MAA include hazards associated with natural gas development and operations; risk associated with vehicular travel on county, BLM, and Operator-maintained roads; firearms accidents during hunting season and by casual firearms use such as plinking and target shooting; and natural events such as range fires.

Deep formations in the Church Buttes Unit in the southern third of the MAA have produced hydrogen sulfide (H₂S), a gas that could cause concerns with regard to health and safety. However, the Proposed Action and alternatives are producing the Frontier and Dakota formations and H₂S is not expected to be a problem. Also, operations of the Shute Creek gas plant could create health and safety issues related to the accidental release of H₂S. The Proposed Action and alternatives will not modify the operations of this plant. However, oil and gas activities in the vicinity of the Shute Creek plant should have contingency plans should an accidental upset occur at the plant.

The potential for firearms-related accidents would occur primarily during hunting season. However, the increased activity in the MAA during drilling and field development would likely discourage hunting in the vicinity during that period. Consequently the risk of fire arms-related accidents should be minimal.

Scoping identified concerns with wells placed within one-mile of the Fontenelle Reservoir dam and directional drilling under the dam. If wells are placed in close proximity to the dam, some possibility exists that structural damage could occur.

4.14.3.2. Occupational Hazards

Adherence to relevant safety regulations on the part of the Operators and enforcement by the respective agencies would reduce the probability of accidents. Additionally, given the remote nature of the Project Area and the relatively low use of these lands by others (primarily grazing operators and hunters), occupational hazards associated with the Proposed Action and alternatives would mainly be limited to employees and contractors rather than the public at large.

4.14.3.3. Pipeline Hazards

Increasing the miles of gathering and transmission pipelines within the MAA would increase the chance of a pipeline failure. However, the low probability of failure, the remoteness of the Project Area, and the low level of anticipated non project-related construction and excavation would result in minimal risk to public health and safety. Compliance with signing requirements for pipeline ROWs and Wyoming One call standards would reduce the likelihood of pipeline ruptures caused by excavation equipment, particularly in the vicinity of road crossings or areas likely to be disturbed by road maintenance activities.

4.14.3.4. Hazardous Materials

Drilling, field development, and production activities require use of a variety of chemicals and other materials, some of which would be classified as hazardous. A Hazardous Materials Management Plan is provided as Appendix B, pursuant to BLM Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all NEPA documents list and describe any hazardous and/or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project. Potential impacts associated with hazardous materials include human contact, inhalation, or ingestion; and the effects of exposure, spills, or accidental fires on soils, surface and ground water resources, and wildlife. A Hazard Communication Program, Spill Prevention Control and Countermeasure (SPCC) Plans, and other mitigation measures, would reduce the risk of human contact, spills, and accidental fires, and would provide protocols and employee training to deal with these events should they occur.

4.14.3.5. Fire and Natural Hazards

The risk of fire in the Project Area would increase under the Proposed Action and would be associated with construction activities, industrial development, and the presence of fuels, storage tanks, natural gas pipelines, and gas production equipment. However, this risk would be reduced by the placement of facilities on pads and locations that are graded and devoid of vegetation. In the event of a fire, property damage would likely be limited to construction- or production-related equipment and range resources. Fire suppression equipment, a no smoking policy, shutdown devices, and other safety measures typically incorporated into gas drilling and production activities would help to minimize the risk of fire.

A heightened risk of wildfire would occur where construction activities place welding and other equipment in close proximity to native vegetation. Given the limited public use and presence in the Project Area, the risk to the public would be minimal. There would be a small increase in risk to area fire suppression personnel associated with the Proposed Action and alternatives.

There would be an increased potential for weather-related hazards associated with the Proposed Action and alternatives. Many development locations in the MAA are remote, and rapidly moving storms can impair driving conditions in a fairly short time. Workers may get stranded in remote locations, requiring rescue operations by emergency management personnel. Proper training of development and operations workers, coordination with emergency management agencies, and frequent mapping of development locations can reduce the potential for weather-related impacts.

4.14.4. Mitigation

The Operators should coordinate emergency response planning with the Uinta, Sweetwater, and Lincoln Counties Emergency Management Agency and provide documentation regarding compliance with Federal Hazardous Material Regulations and the Uniform Fire Code.

To avoid the unlikely possibility of structural damage to the Fontenelle Reservoir dam, wells should not be drilled within one mile of the dam.

4.14.5. Residual Impacts

Risk to health and safety of workers, contractors, and other users of the Project Area associated with industrial accidents, transportation accidents, shooting accidents, and natural fire disasters would remain for the LOP and may exist for years after due to chemicals within reserve pits, misinterpretation of laws [i.e. Resource Conservation and Recovery Act (RCRA)] and regulations regarding the handling and disposal for hazardous materials, and unreported chemical spills. However, risks to the public would be small, given the remoteness of the area, the low visitor numbers, and the proposed mitigation measures.

4.14.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Given the remote nature of the Project Area, health and safety risks to the public due to project development activities are expected to be generally low. Occupational hazards would be limited to project employees and contractors, rather than the general public.

The potential for impacts related to the use of hazardous materials would be reduced by implementing a Hazard Communication Program, SPCC Plans, and other mitigation measures. Although a heightened risk of wildfire would occur where construction activities place welding and other equipment in close proximity to native vegetation, risk to the public would be minimal, given the limited public use and presence in the Project Area.