BUREAU OF INDIAN AFFAIRS

Wind River Agency

Fort Washakie, Wyoming

DRAFT ENVIRONMENTAL IMPACT STATEMENT

Wind River Gas Field Development Project, Fremont County, Wyoming

Volume I

July 2004

DRAFT ENVIRONMENTAL IMPACT STATEMENT

WIND RIVER

NATURAL GAS FIELD DEVELOPMENT PROJECT

Prepared for

Bureau of Indian Affairs
Wind River Agency,
Fort Washakie, WY

Prepared by

This Environmental Impact Statement was prepared by *Buys and Associates, Inc.*, an environmental consulting firm, with the guidance, participation, and independent evaluation of the Bureau of Indian Affairs (BIA). The BIA, in accordance with Federal Regulation 40 CFR 1506.5(a) and (b) is in agreement with the findings of the analysis and approves and takes responsibility for the scope and content of this document.

July 2004

MISSION STATEMENT

The Bureau of Indian Affairs' mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian Tribes, and Alaska Natives. We will accomplish this through the delivery of quality services, maintaining government-to-government relationships within the spirit of Indian self-determination.

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
Wind River Agency
P. O. Box 158
Fort Washakie, Wyoming 82514-015

July 9, 2004

Dear Reader:

This Draft Environmental Impact Statement (DEIS) on the proposed Wind River Natural Gas Field Development Project is submitted for your review and comment. This DEIS has been prepared by the Bureau of Indian Affairs (BIA) to analyze the potential impacts of drilling and production operations of natural gas wells and associated access roads, pipelines, and production facilities proposed by Tom Brown, Inc., Samson Resources, and Saba Energy of Texas ("Operators") within the proposed project area located in Fremont County, Wyoming.

This DEIS consists of three volumes. Volume I discusses the purpose and need for the project, the proposed action and alternatives, the affected environment, environmental consequences, and cumulative impacts that may result from the proposed project. Volume II contains the appendices to Volume I.. Volume III is the Technical Support Document (TSD), which was prepared in conjunction with this DEIS. The TSD document contains detailed technical information for air quality modeling.

The Wind River Project Area (WRPA) encompasses approximately 91,520 acres. The surface ownership of the lands is as follows: 51.4 percent (47,066 acres) is privately owned, 32.2 percent (29,489 acres) consists of the Bureau of Reclamation Withdrawal Area, 15,7 percent (14,409 acres) is owned by members of the Shoshone and Arapaho Tribes, and less than 1 percent (546 acres) is State of Wyoming land. The mineral ownership in the WRPA is 88.4 percent (80,869 acres) tribal and 11.6 percent (10,651 acres) private.

Three action alternatives have been analyzed. Under the Proposed Action, an analysis was conducted of the effects of developing the natural gas resource by drilling up to 325 new wells at up to 325 locations over the next 20 years and developing additional infrastructure needed to link the wells with existing roads and pipelines. Alternative A analyzes the effects of developing up to 485 new wells at up to 485 locations and developing the necessary infrastructure to link the wells with existing roads and pipelines over the next 20 years. Alternative B analyzes the effects of developing up to 233 new wells at up to 233 locations and developing additional infrastructure needed to link the wells with existing roads and pipelines over the next 20 years.

In addition, a No Action Alternative was analyzed. The National Environmental Policy Act (NEPA) requires that a No Action Alternative be evaluated for comparison with the other alternatives analyzed. The No Action Alternative is denial of the drilling and development proposal, as submitted by the Operators. However, drilling of wells would be granted on a case-by-case basis on private minerals by the Wyoming Oil and Gas Conservation Commission (WOGCC) and on tribal minerals by the BIA, to prevent the drainage of adjacent tribal minerals. Up to 100 wells at up to 100 locations may be drilled under this alternative.

Public comments on this DEIS will be accepted for 45 days following the date the U.S. Environmental Protection Agency published the Notice of Availability of this DEIS in the *Federal Register.* The BIA will publish a notification in the Riverton Ranger, Wind River News, and Wyoming State Journal to all parties wishing to comment on this DEIS and the dates during which comments will be accepted. During this time period, you are welcome to submit written comments. If you wish to submit comments on the DEIS, we request that you make them as specific as possible. Comments will be more helpful if they include suggested changes, sources, or methodologies. Comments that contain only opinions or preferences, will not receive a formal response. However, they will be considered and included as part of the BIA decision-making process.

Two public meetings will be scheduled during the review period to obtain public comments on the proposed project and the DEIS: one in Pavillion, Wyoming at the Wind River Recreation Center, and a second meeting in Fort Washakie, Wyoming at the Shoshone Rocky Mountain Hall. All meetings will be announced at least 15 days in advance through public notices, media news releases, and/or mailings.

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

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

A copy of the DEIS has been sent to the affected tribal, federal, state, and local government agencies and to those persons who submitted written or oral comments on the scoping notice, attended either of the public scoping meetings, or who specifically requested to receive a copy of the DEIS. Hard copies of the DEIS and CDs are available for review by the public at the following locations:

Bureau of Indian Affairs
Wind River Agency
1st and Washakie
Fort Washakie, WY 82514

Bureau of Land Management
Lander Field Office
1335 Main Street
Lander, WY 82520

Midvale Irrigation District
305 3rd Street
Pavillion WY, 82523

Sincerely,

[hard copy signed]

George E. Gover
Superintendent

Wind River
Natural Gas Field Development Project

Fremont County, Wyoming

DRAFT ENVIRONMENTAL IMPACT STATEMENT

Lead Agency:
U.S. Department of the Interior, Bureau of Indian Affairs

Cooperating Agencies:
Eastern Shoshone and Northern Arapaho Tribes Joint Business Council, Bureau of Land Management, Board of Fremont County Commissioners

Counties That Could Be Directly Affected:
Fremont County

Abstract:
This Draft Environmental Impact Statement (DEIS) analyzes a proposal by Tom Brown, Inc., Saba Energy of Texas, and Samson Resources ("Operators") to drill additional exploratory and development wells within their leased acreage in the Wind River Gas Field Development Area (approximately 91,520 acres) in north-central Wyoming.

The Wind River Project Area (WRPA) is located in Townships 3 and 4 North and Ranges 2 through 5 East in Fremont County, Wyoming approximately 20 miles northwest of Riverton, Wyoming. The WRPA contains five development areas: Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South, and Coastal Extension. The surface ownership of the project area includes the Eastern Shoshone and Northern Arapaho Tribes (14,409 acres), private non-Indian landowners (47,066 acres), Bureau of Reclamation (29,489 acres), and State of Wyoming (546 acres). The mineral ownership includes the Eastern Shoshone and Northern Arapaho Tribes (80,869 acres) and non-Indian private owners of mineral rights (10,651 acres). Access to the WRPA is by a network of federal and state highways and county roads. Federal and state highways providing access to the WRPA include US 26/789 and Wyoming Highway 133 and 134.

The Proposed Action involves drilling approximately 325 natural gas wells at up to 325 well locations, with a forecasted success rate of 81 percent (263 producing wells) over the next 20-year planning period. Drilling projections were based on drilling projections and spacing orders within the WRPA, where exploration and development activities would occur. The proposed development is in addition to 178 producing wells within the WRPA. The proposed well sites, access roads, pipelines and ancillary facilities would be permitted by the BIA and BLM for tribal minerals and the Wyoming Oil and Gas Conservation Commission (WOGCC) for private minerals. Facilities located on private surface would be permitted with the surface landowner. The exact number of wells and timing of drilling associated with the proposed natural gas development project would be directed by the success of exploration and development drilling and technical and economic feasibility.

This DEIS analyzes the impacts of the Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action). The DEIS describes the resource elements that may be affected by the Proposed Action and alternatives and includes geological, mineral, and paleontological resources; soil resources; climate and air quality; surface water and groundwater resources; vegetation and wetland resources; land use; wildlife resources; threatened, endangered, and state-sensitive species; recreational resources; cultural resources; and visual resources. It also discusses socioeconomics, environmental justice, transportation, health and safety, and noise and addresses issues and concerns raised during public scoping.

The "moderate, short-term" adverse impacts that may occur from the Proposed Action include reduction in visibility, increased runoff and erosion and other water quality effects, reduction in night sky quality, and increased noise from construction and drilling operations. All other short-term impacts range from negligible to minor.

Impacts from the Proposed Action that may be "moderate and long term" include impacts to agricultural lands and residential properties, visual impacts (alternation of landscape character, reduction in scenic quality), split-estate conflicts, change in rural character, and increased traffic and maintenance demand on county roads.

"Moderate to major" long-term beneficial impacts from the Proposed Action include regional economic output, employment, personal income, revenues to the Eastern Shoshone and Northern Arapaho Tribes, and revenues to Fremont County taxing entities. Overall cumulative effects are expected to be minor, with the exception of the beneficial economic effects.

Other Environmental Review or Consultation Requirements

In compliance with Section 7 (c) of the Endangered Species Act (as amended), this DEIS includes a Biological Assessment prepared for the purpose of identifying any endangered or threatened species which are likely to be affected by the Proposed Action.

Lead Agency Contact:

For further information, contact Mr. Ramon Nation, Environmental Coordinator, BIA, Wind River Agency, Fort Washakie, Wyoming at 307-332-3718.

Comments on this Draft EIS should be submitted in writing to:

Mr. Ramon A. Nation
Bureau of Indian Affairs
Wind River Agency
P.O. Box 158
Fort Washakie, WY 82514

Comments must be received at the above address within 45 days following publication of the EPA Notice of Availability of the DEIS in the *Federal Register*. Notice of the closing date of the comment period will also be published in the local newspapers.

INTRODUCTION

This Draft Environmental Impact Statement (DEIS) analyzes the impacts of construction, drilling and production operations from the Wind River Natural Gas Field Development Project in north-central Wyoming. The Wind River Project Area (WRPA) is located in Townships 3 through 4 North and Ranges 2 through 5 East in Fremont County, Wyoming, approximately 20 miles northwest of Riverton, Wyoming (see Figure 1-1). The WRPA contains five development areas: Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South, and Coastal Extension, and encompasses approximately 91,520 acres of federal, tribal, private, and state lands. Of this total approximately 47,066 surface acres are privately owned, 29,489 surface acres are Bureau of Reclamation lands, 14,409 surface acres are owned by the Eastern Shoshone and Northern Arapaho Tribes, 546 surface acres are owned by the State of Wyoming, and 10 acres of water bodies belonging to tribal, federal or state governments. The mineral ownership is divided into tribal and private ownership, with approximately 80,869 acres belonging to the Eastern Shoshone and Northern Arapaho Tribes and 10,651 acres belonging to private owners. Since many of the surface landowners do not have mineral rights to their property (referred to as "split estate"), this issue is also addressed in the DEIS.

This DEIS has been prepared pursuant to the National Environmental Policy Act (NEPA) and addresses three action alternatives, the Proposed Action, Alternative A, and Alternative B, and a "No Action" alternative, as required by NEPA. The DEIS consists of the following six chapters:

Chapter 1, **Purpose and Need** of the proposed Wind River Gas Field Development Project, discusses the purpose and need for the proposed project, the environmental analysis process, the relationship of the project to existing policies, plans and programs, actions that authorize the proposed project, and identifies the issues raised during the scoping process.

Chapter 2 discusses the **Proposed Action and Alternatives**. It describes the alternative selection process, the three action alternatives and the No Action alternative, alternatives that were considered but eliminated from detailed study, the plan of operations, mitigation measures, and summarizes the environmental impacts of the Proposed Action and alternatives.

Chapter 3, **Affected Environment**, discusses the resource elements that would be affected by the Proposed Action and alternatives. The resources described include geological and mineral resources, paleontological resources, soil resources, climate and air quality, surface water and groundwater resources, vegetation and wetlands, wildlife, threatened and endangered species, recreational resources, cultural resources, and visual resources. This chapter also discusses land use, socioeconomics, environmental justice, transportation, health and safety, and noise.

Chapter 4 examines the potential **Environmental Consequences** (i.e., impacts) of the Proposed Action and alternatives on each of the resources mentioned above. This chapter discusses the direct and indirect impacts to the resources present within the WRPA resulting from the Proposed Action, Alternative A, Alternative B, and the No Action Alternative. It also discusses mitigation measures that may be considered in addition to those listed in Chapter 2 and residual (long-term) impacts from the proposed gas development project.

Chapter 5 discusses the **Cumulative Impacts** of the Proposed Action and alternatives on the human environment, which result from the incremental impact of current development, other past, present, and reasonably foreseeable future actions (RFFA) in the WRPA and the cumulative impact analysis area. The area evaluated for cumulative impacts varies with each resource, as discussed in Chapter 5.

Chapter 6 summarizes **Consultation and Coordination** with the public, including private landowners, Eastern Shoshone and Northern Arapaho Tribes, Bureau of Indian Affairs, and other federal, state, county, and local agencies potentially affected by the Proposed Action and alternatives. It also provides a listing of the parties that participated in the scoping process.

MANAGEMENT OF THE WRPA

Approximately 51 percent of the surface area of the WRPA is private, 32 percent is managed by the Bureau of Reclamation, 16 percent is tribal, and less than one percent is managed by the State of Wyoming. The land use plans applicable to the WRPA are the BIA Environmental Assessment on land management activities within the Wind River Indian Reservation (WRIR) "Environmental Assessment of the Land Management Activities Proposed by Land Operations, and Wind River Agency" (BIA 1984). The Eastern Shoshone and Northern Arapaho Tribes have prepared a zoning code, which covers the entire WRIR. The existing Fremont County Land Use Plan (1978) and draft Fremont County Land Use Plan (Fremont County 2001) were also reviewed for this EIS. The Tribes are in the process of completing a comprehensive land use plan, which is expected to be available within the next few months.

EXISTING DEVELOPMENT

Oil and natural gas exploration and production activities have been conducted within the WRPA since 1960. The WRPA currently contains 178 producing wells, with accompanying production related facilities, roads, and pipelines. Within the WRPA, total gas compression and treatment capacity is approximately 14,600 horsepower (hp). The residual disturbance from the existing wells is approximately 410.5 acres. This disturbance is approximately 0.45 percent of the WPRA and 0.79 percent of the three existing fields, Pavillion, Muddy Ridge, and Sand Mesa.

PROPOSED ACTION AND ALTERNATIVES

This DEIS addresses the Proposed Action and two additional action alternatives, and a No Action Alternative. These alternatives are summarized below and addressed in greater detail in the DEIS.

Proposed Action – 325 New Gas Wells

The Operators (Tom Brown, Inc., Samson Resources Company, and Saba Energy of Texas) have indicated that approximately 325 wells at up to 325 well locations, with a forecasted success rate of 81 percent (263 producing wells), may be drilled in the WRPA. This is in addition to 178 producing wells in the WRPA. The total number of wells and the timing of drilling operations are difficult to predict, due to the limited amount of natural gas exploration in the Sand Mesa, Sand Mesa South, and Coastal Extension development areas, and the geological complexities in the WRPA. Development in the WRPA is estimated to begin in late 2004 [subsequent to the publication of the Record of Decision (ROD)] and continue for approximately 20 years, with a life-of-project (LOP) of 20-40 years. Various associated facilities (e.g., roads, pipelines, water wells, disposal wells, evaporation ponds, and compressor stations) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from the Proposed Action would be approximately 1,982 acres (2.15 percent of the WRPA). A maximum of 1,164.1 acres of new surface disturbance would be from well pads and facilities, including on-site gathering, measurement, and dehydration facilities; 49 miles (183.8 acres) of surface disturbance from new roads or upgrades of existing roads; 140 miles (597.2 acres) of surface disturbance from new pipelines; and approximately 36.9 acres of new surface disturbance from ancillary facilities including disposal wells, treatment/separation facilities and five new compressor stations with a total capacity of 32,800 hp. New pipelines and processing facilities would be placed, where possible, adjacent to existing roads and outside of irrigated fields. While the short-term disturbance is a small percent of the total WRPA, these changes would be concentrated within the five development areas, increasing the percent of disturbed lands in those areas to 5.23 percent.

Although a total of 1,982 acres of short-term disturbance would result from the Proposed Action, a smaller area would be disturbed at any one time, since development will be phased (i.e., a specific number of wells would be drilled annually in each of the five fields). Directional drilling may be used under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) areas where drilling would result in a high potential for impact (e.g., “take”) to threatened, endangered and state-sensitive species and relocation of the well would not be feasible, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling).

Reclamation of the disturbed land would begin as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program, and well pads of dry holes would be plugged and abandoned and reclaimed. Pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use. Wells reaching ultimate recovery would be plugged and abandoned when production ceased. Thus, as new wells are drilled other areas are being reclaimed. During the LOP total surface disturbance would be reduced to 422.7 acres, assuming an 81 percent success rate. This disturbance is approximately 0.46 percent of the WRPA or 1.11 percent of the five development areas (see Table 2-3). Voluntary mitigation has been implemented by the Operators in the existing development areas and would be implemented under the Proposed Action to further reduce impacts.

Alternative A - 485 New Gas Wells

The demand for natural gas is projected to increase during the life of the proposed development project. If increases in gas prices occur, those areas in the WRPA that are currently considered marginal for exploration and development, from an economic standpoint, may become economically feasible to develop in the future. Implementation of this alternative would increase revenues to the tribes and private mineral owners, and to the tribal, federal, and state taxing entities in both magnitude and duration.

In order to accomplish this objective, the Operators have indicated that approximately 485 wells at up to 485 well locations, with a forecasted success rate of 76 percent (369 producing wells), may be drilled in the WRPA. This is in addition to 178 producing wells in the WRPA.

Development would begin within the WRPA in late 2004 [subsequent to the publication of the Record of Decision (ROD)] and continue for approximately 20 years, with a life-of-project (LOP) greater than 40 years. Various associated facilities (e.g., roads, pipelines, water wells, disposal wells, evaporation ponds, compressor stations, and gas processing facilities) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from the Alternative A would be 2,818.7 acres (approximately 3.06 percent of the WRPA or 7.43 percent of the five development areas). A maximum of 1813.3 acres of new surface disturbance would be from well locations (including on-site gathering, measurement, and dehydration facilities); 73 miles (278.3 acres) of new surface disturbance would be from new roads or upgrades of existing roads; 171 miles (673.6 acres) of surface disturbance would be from new pipelines; and approximately 53.5 acres of new surface disturbance would be from ancillary facilities, including disposal wells, treatment/separation plants, and five new compressor stations with a total capacity of 46,000hp. New pipelines and processing facilities would be placed, where possible, adjacent to existing roads and outside of the irrigated fields. Although, a total of 2,818.7 acres of short-term surface disturbance would result from the Alternative A, a smaller area would be disturbed at any one time, since development would be phased (i.e., a specific number of wells would be drilled annually in each of the five development areas). Directional drilling may be utilized in the WRPA under certain circumstances, as described for the Proposed Action.

Reclamation of the disturbed land would occur as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program and well pads of dry holes would be plugged and abandoned and reclaimed. Pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use. Wells reaching ultimate recovery would be plugged and abandoned when production ceased. Thus, as new wells are drilled, other areas are being reclaimed. Total residual disturbance for Alternative A would be 611.6 acres. This is approximately 0.67 percent of the WRPA or 1.61 percent of the five development areas. Detailed disturbance calculations for Alternative A are available in Appendix C. Voluntary mitigation has been implemented by the Operators in the existing development areas, and will be implemented under Alternative A to further reduce impacts.

Alternative B – 233 New Gas Wells at 233 Locations

Several respondents to the scoping notice expressed concern about potential environmental impacts resulting from the Proposed Action. Alternative B was developed in part to address those environmental concerns, including impacts on air quality, water quality, wildlife, threatened and endangered species, wetlands, and Wildlife Habitat Management Areas. The implementation of Alternative B would decrease the amount of proposed development and potential environmental impacts; however, royalty revenues to the Tribes, tribal members and private mineral owners, surface use payments, and taxes revenues would be reduced. In addition, mineral resource conservation would be jeopardized and may prevent ultimate development of recoverable reserves.

In order to accomplish this objective, the Operators have indicated that approximately 233 wells at 233 well locations, with a forecasted success rate of 78 percent (182 producing wells), may be drilled in the WRPA. This is in addition to 178 producing wells in the WRPA. Development would begin in late 2004 [subsequent to the publication of the Record of Decision (ROD)] within the WRPA and continue for approximately 20 years, with a life-of-project (LOP) of 20-40 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, compressor station) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from Alternative B would be 1,609.6 acres (approximately 1.75 percent of the WRPA or 4.24 percent of the five development areas). A maximum of 880 acres of new surface disturbance would result from 233 well locations (including on-site gathering, measurement, and dehydration facilities); 35 miles (137.9 acres) of surface disturbance would result from new roads or upgrades of existing roads, 123 miles (568.7 acres) of new surface disturbance would result from pipelines; and approximately 23 acres of new surface disturbance would be from ancillary facilities, including disposal wells, treatment/separation plants, and five new compressor stations with a total capacity of 22,700hp. Although, a total of 1,609.6 acres of short-term disturbance would result from Alternative B, a smaller area would be disturbed at any one time, since development will be phased (i.e., a specific number of wells would be drilled annually in each of the five fields). Directional drilling may be used in the WRPA under certain circumstances, as described under the Proposed Action.

Reclamation of the disturbed land would occur as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program, and well pads of dry holes would be plugged and abandoned and reclaimed. Pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use. Wells reaching ultimate recovery would also be plugged and abandoned when production ceased. Thus, as new wells are drilled, other areas are being reclaimed. Total surface disturbance would be reduced to 325.1 acres (assuming a 78 percent drilling success rate). This is approximately 0.35 percent of the WRPA or 0.86 percent of the five development areas. Voluntary mitigation has been implemented by the Operators in the existing development areas, and would be implemented under Alternative B to further reduce impacts.

Alternative C - No Action

NEPA and its implementing regulations require that a No Action Alternative be evaluated for comparison with the other alternatives analyzed. For this analysis, the No Action Alternative is denial of the drilling and development proposal, as submitted by the Operators. However, the Department of the Interior’s (DOI’s) authority to implement a No Action Alternative that denies a Tribe the right to develop its minerals or a tribal oil and gas lessee the right to drill is limited. The United States has trust obligations regarding development of the Tribes’ mineral resources. A typical tribal oil and gas lease “grants, leases, and lets exclusively unto Lessee for the purposes of investigating, exploring, prospecting, drilling, mining for, and producing Oil and Gas, including all associated hydrocarbons produced in liquid or gaseous form, laying pipe lines, building roads, tanks, power stations, telephone lines, and other structures thereon to produce, save, take care of, treat, transport, market, and own such products, and performing any required Reclamation Activities” subject to the terms of the lease (Tribal Standard Form Lease). Because the Secretary of the Interior has the authority and responsibility to protect the environment with tribal oil and gas leases, restrictions (e.g., No Surface Occupancy) may be imposed on the lessee. However, the DOI is not empowered to deny all drilling based on environmental concerns. Approval of an individual Application for Permit to Drill (APD) could be denied only when the activity would constitute a violation of laws or regulations (e.g. the Endangered Species Act). Otherwise, denial of all drilling could only result from congressional action authorizing exchange, condemnation, or buy-back of the subject lease.

The No-Action Alternative would allow wells to be developed on fee minerals [through individual Application for Permit to Drill (APDs) on a case-by-case basis], and on tribal minerals to offset potential drainage of tribal minerals. The Operators estimate that under a No Action Alternative 64 wells would be drilled in Pavillion on fee minerals and 36 wells in Pavillion on tribal minerals to offset drainage of tribal minerals, for a total of 100 new wells. Some sections within the Pavillion field are under a "Communitization Agreement," in which the tribes and private mineral owners share in the royalties, based on the percent of mineral holdings within that section. No development would occur in the Muddy Ridge, Sand Mesa, Sand Mesa South, or Coastal Extension fields under this alternative. Road and pipeline construction disturbance per well site associated with the No Action Alternative would be similar to the Proposed Action.

The No Action Alternative would result in approximately 316.6 acres of total new short-term surface disturbance in the Pavillion field from well locations, new roads or upgrades of existing roads, production facilities, new pipelines, and one additional compressor station with a capacity of 3,200 hp (see Appendix C for detailed disturbance calculations). A smaller area of disturbance would occur at any one time, since development would be phased.

Reclamation of the disturbed land in the Pavillion field would occur as soon as drilling and construction have been completed. Pipeline ROWs and access roads in irrigated fields would be completely reclaimed and dry holes would be plugged and abandoned and well pads reclaimed. Wells reaching the ultimate recovery would also be plugged and abandoned. Thus, as new wells are drilled, other areas are being reclaimed. The total surface disturbance would be reduced to 79.3 acres following reclamation. The disturbance would be approximately 0.09 percent of the WRPA or 0.67 percent of the Pavillion field. Voluntary mitigation has been implemented by the Operators under the existing development, and will be undertaken in the No-Action Alternative to further reduce short-term and residual impacts.

RESOURCE ELEMENTS ANALYZED

A total of 15 resource elements are analyzed in this DEIS. They include geological, mineral, and paleontological resources; soil resources; air quality; surface water and groundwater resources; vegetation and wetlands, land use; wildlife, threatened and endangered species; recreation; visual resources; cultural resources; socioeconomics; transportation; health and safety; and noise. The potential impacts of the Proposed Action, Alternative A, Alternative B, or Alternative C (No Action) are summarized below. The potential impacts from the Proposed Action and alternatives are summarized in Table ES-1 and discussed below for each resource element.

Geology/Mineral Resources/Paleontology

The Wind River Project Area (WRPA) lies within the central part of the Wind River Basin, a large trapezoidal-shaped structural and topographic basin that occupies about 8,500 square miles in central Wyoming (Keefer 1965, 1970). The basin is surrounded by a series of anticlinal structural uplifts including: (1) the Washakie Range to the northwest; (2) the Owl Creek Mountains to the north; (3) the southern Bighorn Mountains to the northeast; (4) the Casper Arch to the east; (5) the Rattlesnake Hills Anticline to the southeast; (6) the Sweetwater Arch to the south; and (7) the Wind River Range to the southwest. The Wind River Basin began forming in late Cretaceous Period with pronounced downwarping of the basin trough and broad doming of parts of the surrounding areas (Keefer 1970). The formation of the basin continued through the Paleocene Epoch and culminated in the early Eocene Epoch as high mountains were uplifted along reverse faults surrounding the basin. Sediments eroded from the flanks of the rising mountains filled the basin and formed the Lance, Fort Union, and Wind River Formations. The Wind River Formation underlies much of the WRPA. Beneath the Wind River Formation are geological formations consisting of pre-Eocene sedimentary rocks. Within the

WRPA, gas is currently produced from the Wind River, Fort Union, Lance, Meeteetse, Mesaverde, Cody, and Frontier formations.

Impacts to geological resources would include increased surface runoff; increased surface erosion; collapse, piping and gullying; and initiation of mass movements. These impacts would generally be minor and short term for the Proposed Action, Alternative B, and Alternative C, and moderate and short term for Alternative A.

Impacts to mineral resources could range from negligible to major. Depletion of petroleum reserves would result in major and permanent impacts from all alternatives. However, the impacts of the Proposed Action, Alternative A, Alternative B, and Alternative C on development of non-petroleum resources (e.g., gravel mining) would be negligible.

Impacts to paleontological resources would be both beneficial and adverse. Adverse impacts would include damage to fossils, increased vandalism, and increased illegal collection. The impacts for Alternatives A, B, and C would be minor and short or long term. On the other hand, disturbance from construction activities could result in the discovery of new fossils. The benefits of fossil discoveries would be minor and long term for the Proposed Action, Alternative B, and Alternative C; they would be moderate and long term for Alternative A (see Table ES-1).

Soils

Construction and drilling operations under the Proposed Action would disturb approximately 1,982 acres of soil, which would comprise 2.15 percent of the WRPA. Combined with the existing disturbance of 410.5 acres the total disturbance would be approximately 2,392.5 acres or 2.60 percent of the WRPA. Over the life of the project the disturbance from the Proposed Action would be reduced to 422.7 acres or 0.46 percent of the WRPA. This residual disturbance, when combined with the 410.5 acres of disturbance from existing development, would be 833.2 acres or 0.91 percent of the WRPA.

Under Alternative A, a total of 2,818.7 acres or 3.06 percent of soil in the WRPA would be disturbed. When combined with the existing disturbance the total disturbance to the soil would be 3,229.2 acres of 3.51 percent of the WRPA. Over the life of Alternative A, impacts to soil would be reduced to 611.9 acres or 0.67 percent. When combined with the existing disturbance the total residual disturbance would be 1,022.4 acres or 1.11 percent of the WRPA.

Under Alternative B, a total of 1,609.6 acres or 1.75 percent of soil in the WRPA would be disturbed. When combined with the existing disturbance, the total disturbance would be 2,020.1 acres or 2.20 percent. After reclamation, the residual disturbance would be 325.1 acres or 0.35 percent. When combined with the existing disturbance, the total residual impact would be 735.6 acres or 0.80 percent of the WRPA.

Alternative C, the No Action Alternative, would result in soil disturbance of 316.6 acres or 0.34 percent. When combined with the existing soil disturbance the total impact would be 727.1 acres or 0.79 percent. Residual disturbance from Alternative C to soil would be 79.3 acres. The total residual disturbance, when combined with the existing disturbance, would increase to 489.8 acres or 0.53 percent of the WRPA.

The impacts to soil resulting from construction of access roads, facilities, pipeline ROWs, and well pads and drilling and completion operations, could include soil exposure from vegetation removal; compaction and decreased permeability; collapse, piping and gullying; and increased susceptibility of soil to wind and water erosion. Under the Proposed Action, Alternative B, and Alternative C, these impacts would be minor and short term. Under Alternative A, impacts from exposure of soil from vegetation removal and increased susceptibility of soil to wind and water erosion would be moderate and short term.

Air Quality

Comprehensive air quality monitoring has not been conducted within the WRPA, however air quality in and surrounding the area is relatively good. Background pollutant concentrations recorded in the region are less than the National and Wyoming ambient air quality standards.

As an unavoidable result of various project-related activities, additional pollutants would be emitted to the atmosphere. Potential sources of emissions would include fugitive dust and vehicle exhaust from construction activities, exhaust from drill rig engines, and exhaust emissions related to well operations and gas compression. These project-related emissions have the potential to affect air quality on both a local and a regional scale. The magnitude of the potential impacts would vary proportionally with the number of wells ultimately developed under each alternative and the rate of development. The greatest impacts would occur with the implementation of Alternative A. Proportionally lower impacts would occur with the implementation of the Proposed Action or Alternative B. Air quality impacts would be minimized with the implementation of Alternative C. Increases in pollutant concentrations are not predicted to exceed the ambient air quality standards or PSD increments.

With the implementation of the Proposed Action or Alternatives A or B, minor long-term increases in terrestrial nitrogen deposition are predicted to occur. The nitrogen impacts would exceed the incremental Depositional Analysis Thresholds (DAT) in two areas of special concern; Wind River Canyon and the Owl Creek Range. However, total nitrogen deposition rates would remain between 43% and 45% of the “Green Line” level of concern (LOC), indicating that total nitrogen deposition would remain within acceptable ranges. Nitrogen deposition impacts that may occur upon implementation of Alternative C would be negligible, as predicted impacts are substantially less than the DAT. No substantial sulfur deposition impacts are predicted to occur as a result of the implementation of the Proposed Action or Alternatives. The atmospheric deposition of nitrogen and sulfur compounds upon aquatic water bodies is not predicted to impact the acid neutralizing (ANC) capacity of special concern lakes. Predicted ANC impacts are substantially less than the levels of concern.

Implementation of the Proposed Action or Alternatives would cause incremental increases in hazardous air pollutant concentrations. The increased concentrations would be long term, lasting the life of the project. For all project alternatives, the acute and chronic non-cancerous health effects would be negligible. With the implementation of the Proposed Action or Alternative A, minor increases in cancer risk are predicted to occur. The predicted incremental cancer risks would range from 1 to 2 incidents per million exposures. However, the predicted incremental cancer risks would occur only within relatively small areas. Should Alternatives B or C be implemented, the incremental cancer risk would be negligible.

Moderate visibility impacts are predicted to occur at the Wind River Canyon and the Owl Creek Range with the implementation of the Proposed Action or Alternative A, These impacts would be short term, existing for the duration of the project construction activities. Upon the completion of the construction phase of the project, visibility impacts at Wind River Canyon and Owl Creek Range would be reduced to minor levels. Minor short-term visibility impacts are predicted to occur at Wind River Canyon and the Owl Creek range upon implementation of

Alternative B. No discernable visibility impacts would occur with the implementation of Alternative C.

Water Resources

The major surface water drainages within the WRPA include Fivemile Creek, Muddy Creek, Cottonwood Drain, and Cottonwood Creek. These waterways discharge into Boysen Reservoir, which is located on the Wind River. A large portion of the WRPA lies within the Riverton Reclamation Withdrawal Area, which consists of numerous irrigation canals, laterals, and drains. Other surface water bodies within the WRPA include Middle Depression Reservoir, Upper Depression Reservoir, and a small portion of Boysen Reservoir.

Impacts to surface water resulting from the Proposed Action and alternatives, could include disruption of surface drainage systems, increased runoff and erosion, change in surface water networks, increase in suspended solids (turbidity), reduction in peak flows, increased sedimentation in lakes and reservoirs, and change in water quality. Disruption of surface drainage systems, increased runoff and erosion, change in surface water networks, and increased turbidity under the Proposed Action and Alternative A would result in moderate, short-term impacts. Reduction in peak flows would result in minor long-term impacts to water quality. Under Alternatives B or C the impacts to surface water would be negligible.

Groundwater beneath the WRPA is contained primarily within unconsolidated Quaternary deposits of sand and gravel. Groundwater also occurs within the deeper Mesozoic, Paleozoic, and Precambrian rocks. Impacts to groundwater from implementation of either the Proposed Action or alternatives could result in decrease in water levels, change in water quality and change in hydraulic properties. These impacts would be negligible under all alternatives.

Vegetation and Wetlands

Native mixed-grass prairie, greasewood and saltbush fans and flats, and riparian shrub, interspersed with larger expanses big Wyoming sagebrush and desert-shrub vegetation occur throughout the WRPA. Fragmentation of this native vegetation has occurred from conversion to crops, roads, and overgrazing by livestock. Irrigation diversions, storage, structures, and drains within the WRPA have affected upland habitats. These past vegetative disturbances have encouraged the spread of invasive grasses and noxious weeds throughout the area.

Impacts to upland vegetation from the Proposed Action and Alternatives A, B, and C would include vegetation removal resulting from construction and drilling activity, reduction in species diversity, and increase in noxious weeds and nuisance species. Loss of vegetation would be minor and short term under the Proposed Action, Alternative B and Alternative C. Alternative A would result in moderate impacts. Reduction in species diversity, increase in bare ground, and increase in noxious weeds and nuisance species would be minor and long term under the Proposed Action and Alternative B and C, while Alternative A would result in moderate impacts.

The Proposed Action and Alternatives A, B, and C would result in minor, long-term loss of wetlands and reduction in wetland species diversity. The loss of riparian areas would be negligible and long term. Exposure to contaminants from accidental spills would result in minor, short-term impacts.

Land Use

Land use plans that cover the WRPA include the "Environmental Assessment of Land Management Activities Proposed by Land Operations" (BIA 1984). The Shoshone and Arapaho Tribes have prepared a zoning code, which covers the entire Reservation. The Tribes are in the process of completing a comprehensive land use plan. Fremont County has an existing Land Use Plan (Fremont County 1978) and recently prepared a new draft land use plan (Fremont County 2001). These plans were reviewed as a part of the EIS process.

The land uses in the WRPA include agriculture, grazing, residential development, recreation, and oil and gas development. The impacts to agricultural lands and residential areas would be moderate and long term under the Proposed Action and Alternative A, and minor and long term under Alternative B. Impacts to agricultural lands under Alternative C would be considered minor and short term, since the disturbance from well-pad construction is reduced to 8x8 feet after well completion. Impacts to range resources would be minor and short term under the Proposed Action and Alternatives A and B, and negligible under Alternative C. Under all alternatives impacts from the proposed development on other resource extraction (e.g., gravel mining) would be negligible. Impacts to recreational areas from the Proposed Action, Alternative A, and Alternative B would be minor and long term, whereas, they would be negligible under Alternative C.

Wildlife

The WRPA provides wildlife habitat for big game, birds, fish, reptiles, and amphibians. A total of 365 species of wildlife are known to be present or have the potential to occur within the WRPA. Important wildlife resources that occur within the WRPA include large game, such as the pronghorn antelope, mule deer, and elk; raptors (e.g., ferruginous hawk and golden eagle); small game birds, such as greater sage-grouse, gray partridge, mourning dove and numerous species of waterfowl; and sport fish.

Wildlife habitats that could be affected by the proposed development include areas that would be physically disturbed by the drilling and construction of well pads, access roads, pipelines, and production facilities, as well as zones of influence around activity areas. Zones of potential influence are areas surrounding, or adjacent to, project activities where impacts to a given species could occur. The shape and extent of such zones vary considerably with the species.

Impacts to wildlife include loss of wildlife habitat, wildlife displacement, increased mortality, habitat fragmentation, exposure to contaminants, increased predation, and reduction of prey species. Loss of habitat, wildlife displacement, increased predation, and increased mortality are minor short-term impacts under the Proposed Action, Alternative A and Alternative B. Habitat fragmentation, exposure to contaminants, and reduction in prey species are negligible, short-term impacts for all alternatives, except Alternative A, which would cause minor impacts.

Threatened and Endangered Species

The threatened and endangered species that may be present in the WRPA include the bald eagle (threatened), black-footed ferret (endangered/experimental population), Canada lynx (threatened/ experimental population), grizzly bear (threatened), and gray wolf (threatened/ experimental population). The mountain plover was proposed as a threatened species in 1999, but was removed from the list of proposed species in September 2003. However, it remains a species of special concern to the US Fish and Wildlife Service and the State of Wyoming. The sage grouse is also discussed in the chapter on threatened, endangered, and state-sensitive species, since it is a species of a high level of concern to the USFWS and the State of Wyoming.

The impacts to these species are mainly associated with loss of habitat. The potential loss of bald eagle nesting, roosting and foraging habitat from all the alternatives is determined to be minor and short term. The potential loss of mountain plover habitat is minor and short term from the proposed Action and Alternatives A and B and negligible from Alternative C. The potential loss of black-footed ferret habitat, gray wolf habitat, and grizzly bear habitat is considered to be negligible. The increase in bare ground is a beneficial impact for the mountain plover, which has a preference for bare ground. Loss of greater sage-grouse habitat is considered to be minor and long term, since the sage grouse often does not return to nesting areas or leks that have been disturbed. Increased mortality to threatened and endangered species resulting from the Proposed Action and Alternatives A and B is considered to be minor and short term, but negligible from Alternative C. Since the WRPA does not contain habitat or the primary prey species (i.e., snowshoe hare) of the Canada lynx, no impacts are attributed to this species from the Proposed Action or alternatives.

Based on the information obtained on threatened and endangered species, it was determined that the Proposed Action and Alternatives A, B, and C “may affect, but are not likely to adversely affect” the bald eagle, black-footed ferret, gray wolf, and grizzly bear. The Proposed Action and alternatives would have “no effect” on the Canada lynx, since no habitat or prey species are present within the WRPA.

Recreation

Recreational activities within and adjacent to the WRPA include hunting of large game, upland game birds and waterfowl, fishing in Middle or Upper Depression Reservoirs, ORV use, wildlife viewing, and picnicking and camping (mainly Boysen State Park and Ocean Lake Wildlife Habitat Management Area). In general, impacts to recreation would be higher during the construction and drilling phase and decrease after reclamation has been completed. The impacts to recreational activities from the Proposed Action and alternatives would include loss of federal and trust lands available for recreation, reduction in hunting and fishing opportunities, reduction in other recreational opportunities. These impacts would be minor and short term.

Visual Resources

Visual impacts are caused by contrasts in the line, form, color, and texture between the characteristic landscape and the proposed facilities. Since the BIA, as managing agency for the proposed development project, has not developed a system of identifying and measuring visual quality, the BLM Visual Resource Management System (VRM) was used to evaluate potential impacts on visual resources. The BLM VRM classes were determined by evaluating scenic quality, viewer sensitivity level, and the viewing distance of an area. Using the BLM VRM system, more than 99 percent of the WRPA was determined to be equivalent to Visual Resource Inventory (VRI) Class IV, which permits major modifications of the existing character of the landscape. The areas classified as VRI Class III include Middle Depression Reservoir and the Sand Mesa Wildlife Habitat Management Area.

Impacts to visual resources identified, using the BLM VRM system, include alteration of landscape character, reduction in scenic quality, reduction in night sky quality, and impact to VRI Class III areas. The impacts from alteration of landscape character and reduction in scenic quality from the Proposed Action and Alternative A would be moderate and long term; impacts from Alternative B and Alternative C would be minor and long term. Reduction in night sky quality from lighting during construction and drilling under the Proposed Action, Alternative A and Alternative B would be categorized as moderate and short term; the impacts from Alternative C would be minor and short term. Impacts to VRI Class III areas would be minor under the Proposed Action, and moderate under Alternative A (see Table ES-1).

Cultural Resources

Approximately 20 percent of the WRPA has been inventoried for cultural resources, and a total of 150 cultural resource properties have been recorded within the WRPA. The majority of the recorded properties are small prehistoric lithic scatters, but other prehistoric sites include camps, lithic procurement sources, stone alignments, a rock shelter, and rock art. Five cultural resource properties have been determined to be eligible for nomination to the National Register of Historic Places, and include three rock art sites, a prehistoric campsite, and the Wyoming Canal.

Impacts to cultural and spiritual resources from the Proposed Action and alternatives could include increased vandalism, increased unauthorized collection of cultural artifacts, construction damage to cultural and spiritual sites, and disturbance to Native American traditional uses. The disturbances to Native American traditional uses, from the Proposed Action and alternatives, would be minor and short term. Increased vandalism, unauthorized collection, and construction damage to cultural sites would be minor and long term.

Socioeconomics

Economic impacts from the proposed development would be both beneficial and adverse. The beneficial impacts would include increased personal income and increased royalty income for Tribal members, fee mineral owners, and some area business owners. Tribal, federal, state and local governments in Fremont County would benefit from increased tax revenues. These benefits would range from minor under Alternative C to major under the Proposed Action and Alternative A. The adverse impacts from the proposed development would include split estate conflicts, reductions in net income from agricultural activities and change in the rural character in the five gas development areas. These impacts could be moderate and long term. It is likely that reductions in net income could be avoided and compensated by surface use agreement payments from the Operators.

Increases in local population and housing demand and decreases in Midvale Irrigation District revenues would result in negligible long-term impacts. Potential increases in demand for law enforcement and emergency response services would be characterized as minor and long-term impacts.

Effects of the Proposed Action and alternatives would encompass not only the direct activity in the WRPA, but also the indirect impacts to the region's finance, retail trade, services and other industries that would potentially capture a range of expenditures spun off by direct activity in the gas industry. Total economic effects over the 28-year analysis period would total an estimated 22,205 job-years (the equivalent of that number of full time jobs), $1.1 billion in total personal income and $5 billion in total regional economic output for the Proposed Action, and would range from a high of 34,872 job-years, $1.7 billion in total personal income and $7.9 billion in total regional economic output, for Alternative A, to a low of 4,071 in total job-years, $225 million in total personal income and $1 billion in total regional economic output for Alternative C - No Action. The fiscal impacts of gas development would also be positive. Severance taxes, royalties and *ad valorem* taxes all would generate substantial revenues to a number of local and state government entities and those representing tribal interests.

Under all alternatives, the private owners of lands that overlay minerals held in trust for the Eastern Shoshone and Northern Arapaho Tribes or owned by other private interests (split estate lands) could experience economic loss associated with the removal of land from agricultural production, disruption of agricultural activity, damage to fields and crops and interference with farming practices, such as cultivation patterns and the operation of mechanized irrigation systems. In recent years the Operators have instituted practices and measures to avoid and mitigate such losses. The Operators also make initial and annual surface damage payments to private owners and make additional payments when they must re-enter previously reclaimed fields. The mitigation measures and damage payments are intended to reduce and compensate private surface owners for economic loss associated with decreases in agricultural revenue.

The additional gas development associated with each alternative would further change the character of lands within the WRPA, from rural agricultural toward mixed agriculture and natural resource extraction, the latter being a type of low density industrial land use. The potential change in rural character varies from field to field for each alternative, but, in general, could be expected to increase with the amount of development expected from each alternative.

Population effects of all alternatives are anticipated to be minor. The well-developed regional oil and gas service industry and the local labor pool would provide most of the contractors and employees needed for gas development activities. Indirect jobs stimulated secondarily by gas development within the WRPA would also be filled from the local labor pool or by local employees who remain employed instead of losing their jobs, as economic activity from the Proposed Action offsets anticipated declines in existing production in the WRPA or other oil and gas fields.

Housing demand associated with all alternatives would be minor. Most housing demand would be for temporary housing accommodations to serve non-local contract employees during their work week. The duration of development under some alternatives may encourage non-local contract employees to seek longer term housing in Fremont County, but existing resources would likely accommodate this demand.

Law enforcement and emergency response (emergency medical/ambulance and fire suppression) are two of a limited range of local government facilities and services that would be subject to impact. Potential effects also would occur to county road and bridge services, discussed in the Transportation section. Increased demand could result in the need for increased training and specialized equipment in the case of emergency response services and for an equipped law enforcement officer to be located within or near the WRPA during the development phase. The substantial production-related taxes that would accrue to local governments under all alternatives would offset the cost of potential increases in these services.

Environmental Justice

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. The area of analysis for Environmental Justice concerns for the Wind River Natural Gas Development project is the Wind River Indian Reservation; the WRPA does not contain a high concentration of either minority or low-income populations. Human health effects are identified by executive order as a specific concern for environmental justice. Health and safety effects of the Proposed Action and alternatives, as a whole, would be negligible to minor, except for a moderate impact to the risk of worker-related accidents.

Health and safety impacts generally relate to the proximity of persons to drilling, field development and production activities that would occur within the WRPA. Since concentrations of minority and low-income persons on the WRIR are located in the areas of Ethete, Arapaho and Ft. Washakie, communities that are some distance from the WRPA, persons in these areas would not experience any greater impacts to health and safety (impacts that would be negligible to minor, in any case) than the population as a whole.

In terms of risk of worker-related accidents, Tribal Employment Rights Ordinances (TERO) require at least 50 percent of gas development and operations employees to be members of the Eastern Shoshone and Northern Arapaho Tribes. Impacts to the risk of worker-related accidents (which would be moderate) would therefore disproportionately affect tribal members, most of whom would likely be residents of the WRIR. However, the increased risk could be offset by several factors. First, the tribal preference law was enacted to address the major unemployment among tribal members and the desire to have tribal members benefit from economic activity on the WRIR. Second, taking a job created by the Proposed Action or alternatives would be a matter of individual choice, with individuals presumably considering whether the higher risk disclosed here is adequately compensated for by other terms of employment. Finally, the workplace for natural gas drilling, development and operations is governed by a variety of federal and state regulations that promote worker health and safety.

Air and water quality are also areas of potential environmental impact that could affect populations on the WRIR. The analyses conducted for this assessment indicate that potential impacts to air and water quality would be negligible to minor for all alternatives, with the exception of increased surface water runoff and erosion which would be moderate under Alternative A. Because surface water within the WRPA does not drain toward the areas of the WRIR mentioned above, where concentrations of minority and low-income persons reside, minority and low-income groups would not be disproportionately, or even directly, affected by moderate impacts from water runoff and erosion.

Transportation

Access to the WRPA is by a network of federal and state highways and county roads. Within the WRPA, county roads, Midvale Irrigation District canal roads, and operator-maintained roads provide access to leases, wells and ancillary facilities. Federal and state highways providing access to the WRPA include US 26/789, WYO 133, WYO 134. Transportation issues related to the proposed project include use of roads by trucks and heavy equipment and higher levels of traffic resulting in increased road and bridge wear and maintenance costs, traffic safety, and traffic related dust, emissions, and noise.

The Proposed Action and alternatives would result in increased traffic and maintenance demands on state and federal highways, county roads, and private and operator-maintained roads. Increased traffic and maintenance demands on state and federal highways would be minor and long term, under the Proposed Action and Alternatives A and B, except for WYO 134, where impacts would be moderate.

The largest concentrations of project-related traffic would occur on Fremont County roads providing access to and within the five gas development areas within the WRPA. Peak periods of traffic would occur during drilling and field development, resulting in localized increases in traffic and demand for maintenance on roads near and within development areas. Certain paved roads and a number of bridges maintained by the Fremont County Transportation Department are in poor condition; concentrated use of these roads and bridges by trucks and heavy equipment would accelerate deterioration and increase road and bridge maintenance costs.

Project-related traffic levels would be lower during field operations. During these periods ongoing maintenance demands would result primarily from trucks hauling water and oil, and from trucks and heavy equipment associated with infrequent well workovers and downhole maintenance activities.

Although periodic road maintenance impacts could be substantial on certain county roads, they would range from minor to moderate (as those terms have been defined for this assessment) and long term, under the Proposed Action and Alternatives A and B, varying over time and across the WRPA. Formation of a transportation planning committee would allow annual identification of intended transportation routes, proactive maintenance of affected roads and bridges and identification of alternative routes to avoid roads and bridges in poor condition.

Impacts of traffic on private and operator-maintained roads would be minor and long term under all alternatives, whereas impacts under Alternative A would be moderate.

Health and Safety

Health and safety concerns associated with natural gas exploration and production in the WRPA include occupational hazards associated with construction, drilling, and maintenance activities at natural gas well pads and associated facilities. Other health and safety issues include traffic-related accidents, potential natural gas and hydrogen sulfide leaks, accidental spills or releases of hazardous substances, and man-made wildfires.

Federal regulations related to health and safety requirements for oil and gas operations are specified under 43 CFR Ch. II, subpart 3162.5 (environmental obligations). These regulations require the prior approval of a drilling and operations plan by the BLM that addresses the procedures to be employed for protection of environmental quality, including safety precautions, control and removal of waste, spill prevention, and fire prevention and fighting procedures.

Health and safety impacts from the Proposed Action and alternatives would include increased work-related accidents, increased vehicle traffic and accidents, increased pipeline fire and explosion hazards, and increased likelihood of wildfires. The impacts associated with increased work-related accidents, increased vehicle traffic and accidents, increased pipeline fire and explosion hazard would be minor and long term for the Proposed Action, and Alternatives A and B, and negligible for Alternative C.

Noise

Ambient noise levels can be defined as the cumulative effect from all noise-generating sources in an area and constitutes the normal or existing level of environmental noise at a given location. The decibel (dB) is the unit of measure commonly used to describe sound levels. The US EPA has established an average 55 dB noise level as a guideline for acceptable environmental noise. This noise level is directed at sensitive receptors (residences, schools, medical facilities, and certain recreational areas) where people would be exposed to a specified noise level over a period of time (e.g., 24hrs.). For example, the noise level for construction equipment at 50 feet is 80 dB. Since the Tribes have not established regulatory noise standards, the 55 dB noise level is used as a reasonable level of noise that would not result in adverse effects.

Noise would result from well pad and access road construction, drilling operations, venting operations, traffic on access roads, increased vehicle-related noise, and compressor stations. The impacts from construction, drilling, and venting operations would be moderate and short term. The noise from increased number of vehicles and road maintenance operations would result in minor impacts (see Table ES-1).

CUMULATIVE EFFECTS

"Cumulative impacts" is defined in Section 1508.7 of the Council of Environmental Quality (CEQ) regulations (40 CFR 1508.7) as *"the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."* Cumulative impacts may result from the Proposed Action and alternatives, when combined with past, present, and reasonably foreseeable future activities (RFFAs).

The cumulative impacts of the Wind River gas development project within the WRPA and adjacent areas are assessed for geological, mineral, and paleontological resources; soil resources; air quality; surface- and groundwater; vegetation and wetlands; land use; wildlife; threatened and endangered species; recreation; visual resources; and cultural resources. The impacts to human health and safety are assessed, and the impacts from noise and transportation increases are also evaluated.

The Boysen Reservoir watershed is used as the basis for determining cumulative impacts to soil, vegetation and wetlands, wildlife, threatened and endangered species, and water. Cumulative socioeconomic impacts of the proposed development are assessed in Fremont County. The northwestern portion of the State of Wyoming is modeled for potential far-field air quality impacts. Past, present, and reasonably foreseeable future activities within and near the WRPA include oil and gas development, sand and gravel mining, agriculture, timber harvesting, residential development, and livestock grazing. Total residual disturbance from the Proposed Action is 422.7 acres or 0.46 percent of the WRPA. When combined with the residual disturbance from the existing development of 410.5 acres, the total residual disturbance is 833.2 acres or 0.91 percent. Quantitative data on cumulative disturbances from other past, present and reasonably foreseeable future activities are not available.

Geology/Minerals/Paleontology

Residential and commercial development, as well as additional oil and gas development, would result in removal of topsoil and vegetation, thus increasing runoff and erosion of surficial materials. Increased erosion would be a temporary impact for projects involving residential development and pipeline construction, since these areas would be revegetated after construction. Oil and gas development would potentially result in minor, long-term increases in erosion. Clear-cutting of timber would lead to increases in runoff from the affected areas. This increased runoff could lead to more erosion along waterways and the migration of the gulleys of small streams in an upstream direction. Application of Best Management Practices during construction of future projects would mitigate these cumulative impacts.

Soil

Gas development and residential and commercial development result in increased soil compaction at the sites underlain by the project facilities. Future projects and development would lead to additional areas of soil being lost. However, cumulative impacts to soil would be offset by the beneficial effects of the future projects.

Soil that is excavated loses its structure and therefore, some productivity. Stockpiling of topsoil during construction of future projects would lead to some loss of productivity of the soils that are reapplied to affected areas as reclamation material. This loss of productivity is a temporary effect that decreases as the soil receives moisture and is cultivated with plants.

Air Quality

As an unavoidable result of project-related activities, additional pollutants would be emitted to the atmosphere. Emissions generated from project activities would act in concert with emissions generated from other cumulative sources, both existing and future. Predicted impacts would not exceed the ambient standards or PSD Class I increments. However, moderate impacts upon NO_2 and PM_{10} concentrations are predicted. The duration of the PM_{10} impacts would be short-term, occurring predominately during the development phase of the project. Following the completion of construction activities, PM_{10} impacts would be reduced to minor levels. The moderate NO_2 impacts would be long-term, existing for the duration of the project.

Total terrestrial deposition rates resulting from cumulative and project sources would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable. Total sulfur deposition impacts would be negligible. Predicted impacts to lake ANC resulting from cumulative and project sources are predicted to occur at two lakes located in Cloud Peak Wilderness. Moderate long-term impacts are predicted to occur at Florence Lake, where changes in ANC are predicted to exceed the level of acceptable change. Minor long-term impacts are predicted to occur at Emerald Lake where changes in ANC levels would be detectable. The contribution of project sources upon these cumulative impacts would be negligible. Impacts to ANC at the remaining lakes of special concern would be negligible.

Moderate long-term visibility impacts are predicted to occur at Cloud Peak Wilderness as a result of cumulative sources. However, the contribution from project sources to the Cloud Peak impacts would be negligible. Moderate short-term visibility impacts are predicted to occur at Wind River Canyon and the Owl Creek Range, which includes Phlox Mountain. However, impacts at these areas would be reduced to minor levels following the completion of project construction activities. Minor long-term visibility impacts would also occur at Bridger Wilderness, Popo Agie Wilderness, and the Wind River Roadless Area.

Water

The Fivemile Creek, Muddy Creek, and Cottonwood Creek watersheds have a total area of 915 mi^2. Within the affected watersheds, there is a potential of cumulative impacts from other activities occurring upstream from the WRPA. Evaluation of the Wyoming Department of Environmental Quality (2003) database for National Pollution Discharge Elimination System

(NPDES) permits indicate that six permits have been issued for the Fivemile Creek drainage basin, with only one permit being current. There are no NPDES permits issued for Muddy Creek or Cottonwood Creek. As development occurs upstream from the WRPA additional discharges into theses streams may occur. Because produced water from each of the Alternatives will not be discharged into surface water, no NPDES permit would be required for the proposed operations. Thus, there would only be cumulative impacts to the streams from produced water, if accidental spills occurred.

Based on a report by the USGS (1994), it is estimated that 243 tons of sediment are generated per square mile of the watersheds in the Wind River Basin or 222,300 tons/year for the combined basins of Fivemile, Muddy, and Cottonwood Creeks. The sediment increase from the Proposed Action is 47 tons/yr, Alternative A is 71 tons/yr, and Alternative B is 47 tons/yr. These are 0.02%, 0.04%, and 0.02% of the total sediment loading in these basins, respectively. These changes in sediment loading would not be measurable and are considered negligible in terms of potential cumulative impacts.

In the upper portions of the watershed, as with the WRPA, there have been no serious groundwater pollution problems. By complying with federal and applicable tribal and state law, using state-of-the-art drilling methods, lining pits, and implementing SPCC plans, the Proposed Action and alternatives would not impact the groundwater systems. Because up-gradient groundwater systems discharge into streams prior to reaching the WRPA, no cumulative impacts would be expected to the groundwater system.

Vegetation

Long-term vegetation disturbances are 422.7 acres under the Proposed Action, 611.9 acres under Alternative A, 325.1 acres under Alternative B, and 79.3 acres under Alternative C. Even when these effects are combined with the incremental effects resulting from vegetation removal associated with gravel and sand mining, future transportation improvements, and other residential and commercial development, the cumulative impacts would be minor.

Of more importance are the incremental effects of ecological changes in native Wyoming big sagebrush vegetation associated with proportionately higher growth of non-native grasses and loss of shrub cover. Past introduction of invasive grasses has changed the habitat and contributed to the decline in native species. Invasive grasses have changed the sagebrush habitat's physical structure, hydrology and salinity, productivity, energy flow, and fire cycle. Dominance of cheatgrass, and the shortening of fire return intervals, has modified ecosystem relationships. Declines in species diversity through competition, disruption of the food web, and genetic hybridization of sagebrush species is evident. These sagebrush habitat modifications and species modifications could create an irreversible shift in the ecosystem, creating a long-term altered, but stable state. With more sagebrush vegetation burned, there are fewer roots to hold the soil, resulting in increased erosion. Erosion increases sediment in the streams and reduces vegetative cover along riparian areas. Erosion from oil/gas development would be short-term during the construction period. Overall, the cumulative effects to vegetation from oil and gas operations and other past, present, and RFFAs would be minor.

Land Use

In addition to the gas development within the WRPA, it is reasonable to foresee future oil and gas development occurring on other lands within the WRIR. The cumulative impact of further gas development in the region may influence land-use within the WRPA as a result of the gradual industrialization of the area. The land-use type that would most likely reflect this change would be residential development. As the WRPA becomes more industrial in character, landowners in the area may find it more difficult to develop their property for residential use.

Agriculture and ranching within the WRPA may be also be affected by cumulative long-term disturbances. If gas development interferes with normal farm or ranching operations, farmers and ranchers may cease operations on those portions of land that are most affected. Gravel/sand mining operations within the WRPA on tribal and/or BOR lands may displace some rangeland uses, but it is likely that cattle grazing would continue on lands immediately adjacent to the gravel/sand mine. Therefore, the cumulative impacts of oil and gas development, residential development, gravel mining and other reasonably foreseeable future activities would be minor.

Wildlife

Cumulative impacts to wildlife would occur from oil and gas construction and drilling; increased traffic, hunting, and noise; residential development; and habitat displacement and habitat fragmentation from existing, proposed and reasonably foreseeable future activities. The extent of the impact would be related to the amount development at any one time. The phased drilling program, to be implemented by the Operators, proposed monitoring program, and implementation of the mitigation measures described in Chapter 2, would further reduce the extent of cumulative effects in the WRPA, WRIR, and Muddy, Fivemile, and Cottonwood Creek sub-basins. As a result of these measures, cumulative impacts are expected to be minor.

Threatened and Endangered Species

Oil/gas development under the Proposed Action or alternatives would be a negligible contributor to the cumulative impacts of federally listed, or state-sensitive species and their habitats within the WRPA. Even when these effects are combined with the incremental effects resulting from future residential and commercial development, gravel and sand mining, and increased motorized vehicles; the cumulative impacts would be minor. Reclamation and mitigation actions would further reduce cumulative impacts.

Recreation

The effect of residual disturbance from the proposed gas development project would be concentrated within the five development areas, increasing the percentage of disturbed lands in those areas. Increased recreational access to lakes, streams and related facilities from new roads constructed for the gas development project could increase use of Boysen State Park, Sand Mesa WHMA, and Ocean Lake WHMA. Recreation opportunities are greater today because of water development and irrigated agriculture, which have jointly had a beneficial impact on recreation in the WRPA. Residential development can impact recreation resources by absorbing or fragmenting habitat, changing game populations and distribution, and increasing demand for recreation. However, impacts to recreation, to date, from residential development in and near the WRPA have been minimal. The nearest residential area to the WRPA is the Town of Pavillion, one mile west of the WRPA. Most of the residences in and near the WRPA are isolated homes that are part of larger agricultural areas. Tribal land in and near the WRPA has no residential development. These tribal lands are devoted to rangeland and resource extraction, and most are in more remote areas of the WRIR that are not served by Federal or State highways. These characteristics suggest that reasonably foreseeable future activities are unlikely to include more than limited residential development on private land and on tribal land. Given that scenario, residential development in the future would make a minor contribution to cumulative impacts to recreation resources in and near the WRPA. Therefore, past, present and reasonably foreseeable future activities in and near the WRPA would have minimal cumulative impact on recreational activities.

Visual Resources

The Proposed Action and Alternatives A, B and C (No Action) would add to the existing impact to visual resources associated with natural gas development in the WRPA. Impacts to visual resources within the WRPA under the Proposed Action and Alternatives A and B would shift the character of the landscape in some areas from farming and ranching to a more industrial nature. Alternative C (No Action) would result in similar cumulative impacts over a smaller geographic area, as development would be limited to the Pavillion field. However, because the Pavillion field is located within the most densely populated area of the WRPA, the limited geographic influence on cumulative impacts has the potential to affect a larger number of people, when compared to the entire population within the WRPA. Reasonably foreseeable future development of one or multiple gravel/sand extraction operations within the WRPA would contribute to the change in landscape character by creating additional contrasts in the line, color, form and texture with the surrounding landscape.

The cumulative effects of these visual impacts would modify the landscape and alter the visual experience for those traveling through or residing in the WRPA. Visitation to recreation areas within and adjacent to the WRPA may also be affected by this change in landscape character and visual experience.

Cultural Resources

Available cultural resources records and literature sources have not indicated that outstanding cultural resources exist within and near the WRPA that might be affected by natural gas development and other past, present and reasonably foreseeable future activities. Elders of the Eastern Shoshone and Northern Arapaho Tribes have indicated that potential Traditional Cultural Properties do not exist within the WRPA. Execution of the proposed natural gas development in conjunction with other reasonably foreseeable future activity in the WRIR is, therefore, unlikely to have substantial cumulative impacts to cultural resources under the Proposed Action or Alternatives A, B, and C.

Socioeconomics

The Northern Arapaho Tribe has announced plans to build a casino on the WRIR south of Riverton, Wyoming. Current plans are to begin construction in the spring of 2004. Under the most optimistic schedule, it is likely to be several years before the casino would be operational. While the casino could require some non-local employees, most of the workforce is anticipated to come from the WRIR and Fremont County. The small non-local workforce would not appreciably add to county population or housing demand in the early years of operation. Depending on the scale and success of the casino, the effects on indirect employment in retail, wholesale, service and other sectors of the local economy could be substantial. However, many of these jobs would also be filled from the local labor pool. Therefore, population increases associated with the casino would be anticipated to be negligible to minor.

The Town of Riverton has recently decided to pursue location of a Wyoming Department of Corrections prison facility in the Riverton area. The site selection process is in the early stages;

therefore, it is not yet known if Riverton will be successful in its efforts (Riverton Ranger 2003b, Thorsen 2004). Consequently the potential prison facility was not considered in this cumulative assessment.

There are considerable oil and gas reserves in Fremont County. In 2001, Fremont County produced six percent of all oil produced in Wyoming and nine percent of all gas. Exploration and production of oil and gas resources is driven in large part by price. Substantial increases in the price of oil and gas could accelerate oil and gas exploration and development in the county and elsewhere in the state, resulting in increases in employment and potentially population. As described in Section 4.13, the regional oil and gas service industry could accommodate a substantial increase in activity with existing capacity and by hiring or in some cases re-hiring currently unemployed or underemployed workers in the region. Moreover, community infrastructure in Riverton has capacity to accommodate population levels that are higher than currently exist. Consequently, moderate increases in oil and gas exploration and development could be accommodated by the existing oil and gas service industry, local labor pool and community infrastructure.

Currently, there are 178 producing wells in the WRPA, including 100 in the Pavillion field, 75 in the Muddy Ridge field and 3 in the Sand Mesa field. These wells, ancillary facilities and the associated development and production activity have affected socioeconomic conditions in the WRPA. The existing WRPA wells are in the production stage, and generate lower levels of activity than during development. But, when combined with the development associated with the Proposed Action and alternatives, the existing development would contribute to cumulative impacts on certain elements of the socioeconomic environment. Cumulative economic, employment and fiscal effects would be positive. Cumulative effects on split estates and the rural character of certain areas within the WRPA would be negative.

Most cumulative socioeconomic effects would occur in the Pavillion and Muddy Ridge fields; the Sand Mesa field has only three producing wells; there has been no development in the Sand Mesa South field and no recent development in the Coastal Extension field. Under Alternative C – No Action, cumulative socioeconomic effects would occur only in the Pavillion field.

For recently developed wells on irrigated lands, where well heads have been reclaimed to 8x8 feet, the total amount of residual disturbance would be less than six acres, which would result in losses of $90.00/year to the MID, if the BOR reclassified the land. The amount of existing residual disturbance associated with older wells and facilities on all lands is 410.5 acres, and some portion of those wells and facilities are located on irrigated lands. The proportion of older wells and facilities on irrigated land has not been identified for this assessment; however, it is substantially less than 100 acres. If all 100 acres were reclassified by the BOR, the MID would lose $1,500/year in assessment revenues, which, when added to the potential lost revenue amounts associated with existing new wells on irrigated lands and proposed wells on irrigated lands, the total lost revenue would be less than $2,000 a year under any alternative.

Cumulative gas field activities would increase demand for law enforcement and emergency response services under all alternatives, but the increment of demand associated with current production activities is minor. Although the potential for conflict on split-estate lands is diminished during the production phase, conflict still could occur, particularly during reentry on surface lands for re-completion and other well maintenance activities.

Although natural gas development has been ongoing in the Pavillion field for over 40 years, the recent acceleration in the pace of development has changed the rural character of the area for some residents and the gas field development associated with any of the alternatives would further change the rural character of the Pavillion field and the other development areas.

Potential future commercial and industrial activities, which may affect socioeconomic conditions in the WRPA include sand and gravel mining on tribal lands within the WRPA and sand and gravel mining, oil and gas exploration and development, and timber harvesting on the WRIR lands north and west of the WRPA. At present, the location, timing, size and other characteristics of these activities are unspecified, so the cumulative effects of these activities on socioeconomic conditions within the WRPA cannot be assessed.

Transportation

Baseline average annual daily traffic (AADT), associated with existing gas production operations, would decline over time as existing wells cease production and are plugged and abandoned, but compression and production facilities AADT would remain relatively constant as new production replaces production from existing wells. Cumulative gas operations AADT would peak at an estimated 158 in the third year of the Proposed Action and decline to about 58 after the development phase of the Proposed Action is completed. Cumulative gas production AADT would continue to decline over time as wells are plugged and abandoned.

In addition to the natural gas-related activities discussed above, existing traffic within the WRPA is generated by residential, agricultural and recreational land uses, and by the activities of the MID. Residential land uses in the WRPA may increase in the near term as larger parcels of farm land are subdivided, sold and developed into low-density residential housing. This trend is currently occurring in parts of the WRPA, but at current levels would not increase traffic appreciably across the entire WRPA over the next several decades. Agricultural activities and related traffic are anticipated to remain relatively constant. Recreational use within the WRPA may also increase over time increasing traffic in the area. Recreational use data for Boysen Reservoir, Bass Lake and Ocean Lake all show generally flat or slightly upward trends, with seasonal variations and changes in use in response to fluctuations in reservoir levels.

The MID has an ongoing program of maintenance of water distribution and drainage systems within the WRPA and elsewhere in the district, which generates fluctuating volumes of truck and heavy equipment traffic on a short-term basis. In addition, the MID is emphasizing conversion from open conduits to pipelines and sprinklers. Conversion of water distribution and delivery systems may generate additional construction traffic, but this traffic would be short-term in nature.

Potential future commercial and industrial activities, which may affect traffic conditions, include sand and gravel mining on tribal lands within the WRPA and sand and gravel mining, oil and gas exploration and development, and timber harvesting on the WRIR lands north and west of the WRPA. At present, the location, timing, size and other characteristics of these activities are unspecified, so the cumulative effects of these activities on highways and roads providing access to and within the WRPA cannot be assessed.

The Northern Arapaho Tribe is planning to build a casino on Tribal land located south of Riverton. This development would likely increase thru-traffic on US 26 north and west of Riverton, but the cumulative effect of casino and WRPA traffic is likely to be a relatively small when compared to peak summer-time traffic volumes that already occur on this highway. Development of the casino would be unlikely to have a measurable affect on other highways and roads providing access to and within the WRPA.

The Riverton City Council has decided to actively pursue the construction and operations of a new medium security state prison in Riverton (Riverton Ranger 2003b). At present, it is not known when or whether the State of Wyoming will decide to locate a prison in the Riverton area, so the effects of the prison on area highways cannot be assessed.

The AADT increased on every affected segment between 1991 and 2001. Increases ranged from 8 percent at the west corporate limits of Shoshoni (or less than one percent per year) to 59 percent at the junction of US 26 and WYO 134 (almost 6 percent per year). In contrast, truck traffic decreased on most segments, with the notable exception on WYO 134, which had a 47 percent increase at the junction with US 26, a 20 percent increase at Midvale, and a 20 percent increase at the junction of WYO 133 and US 26. Although the percentage increase in truck traffic at these locations was substantial, the numerical increase was modest, ranging from 35 more trucks per day at the junction of WYO 134 and US 26, to 15 more trucks per day at both WYO 134 at Midvale and the junction of WYO 133 and US 26.

WYDOT has not prepared forecasts of future traffic conditions on the highways which provide access to the WRPA, but the agency generally assumes that traffic increases on highways across the state will average from 3 to 5 percent annually (Steele 2003), which is consistent with average annual increases on most of the affected segments between 1991 and 2001. If this assumption holds in the future, traffic on the affected segments would double in 15 to 25 years. As traffic on affected highway segments increases, traffic associated with the Proposed Action and alternatives would become a smaller portion of total traffic on these highways, and the contribution of the Proposed Action or other alternatives to cumulative impacts of natural gas activities within the WRPA would be negligible to minor on most segments, except where gas traffic converges on WYO 134 in the Midvale area, where impacts and particularly truck impacts could be minor to moderate.

Traffic associated with agricultural activities is anticipated to remain relatively stable and traffic associated with the MID may show short term increases during facility construction and reconstruction. Traffic associated with existing natural gas operations would decline over time. Although there may be some traffic associated with other natural resource extraction activities within the WRPA (sand and gravel mining) and outside the WRPA to the north and west (sand and gravel mining, oil and gas exploration and development, timber harvesting) schedules and locations for these activities have not been specified and have not been considered for this assessment. Therefore, the only activities which would have a substantial impact on county roads within the WRPA would be the Proposed Action and alternatives.

Health and Safety

The Proposed Action and alternatives, when considered with other past, present, and reasonably foreseeable future projects, would result in a slight increase in occupational accidents in the region above those identified for the Proposed Action alone, resulting in a minor impact. Human health and safety effects to the residents of properties adjacent to the major access roads within the WRPA would be minor. These minor risks would result from generation of increased traffic, noise, air emissions, and fugitive dust from project-related vehicles associated with any of the alternatives. Truck trips and related hazards to public safety associated with increased accident risks, dust, and noise emissions from the multiple activities would be slightly greater than described for the Proposed Action or alternatives alone. The cumulative impact associated with traffic increases would be experienced over a broader geographic area than just in and around the WRPA. Given the broad geographic area affected and the rural charter of the region, the cumulative impacts to health and safety would be minor.

Pipeline ruptures could potentially occur anywhere in the region where pipelines would be located. Given the relatively infrequent incidence of pipeline accidents, the rural character of the region, and modest level of overall construction and utility installation activity, the low potential for pipeline–related ruptures and accidents would result in minor cumulative impacts to health and safety. Other projects and construction activities in the region that would utilize, store or transport hazardous materials, and/or generate hazardous wastes would be subject to regulations that would minimize the potential for accidental spills or releases into the environment. Assuming that the Proposed Action or Alternatives and all other protects comply with applicable regulations, the cumulative human health and safety impacts within and near are rated as negligible.

Noise

Sources of noise within the WRPA would result from construction, drilling, and completion of wells, compressor stations, and project-related traffic along access roads. However, cumulative noise effects within the WRPA would be minor, since no additional noise sources other than natural gas development are anticipated within or adjacent to the WRPA, and there would be sufficient distance between project construction sites, facilities, and compressor stations, and residences within the WRPA and WRIR.

Under all alternatives, there would be minor increases in the cumulative noise resulting from increases in AADT along roads leading into the WRPA. The noise would be greatest during the development phase (well pad construction, drilling, and completion) of the Wind River Gas Development Project. Additionally, the traffic noise would generally be the greatest during morning and evening when workers and equipment would be arriving and departing the construction sites. After all the wells are operational, traffic noise would decrease. Cumulative noise increases would be the highest along Gables Road and Eight Mile Road because approximately 70 percent of project traffic would use these routes to enter the WRPA from U.S. Highway 134. The other 30 percent would use Wyoming Highways 133 and 134 from U.S. Highway 26, resulting in a smaller increase of traffic noise along these roads. These minor increases would be similar for each alternative. However, the length of the construction phase of each alternative would vary, so that the cumulative noise effects would last the longest time under Alternative A, followed by the Proposed Action, then Alternative B, and Alternative C.

CONSULTATION AND COORDINATION

The purpose of the scoping process, as stipulated by 40 CFR, parts 1500-1508, is to identify important issues, concerns, and potential impacts that require analysis in this EIS and to eliminate insignificant issues from detailed analysis. Consultation with and participation by the public have taken place during the EIS process through scoping notices and public meetings.

A scoping notice was submitted to the public on September 22, 2002 and public meetings were held in the towns of Pavillion and Fort Washakie, Wyoming on October 22, 2002 and October 23, 2002, respectively. The federal, state, and local agencies, government officials, Native American governmental organizations, landowners, local media, companies, organizations that attended the public meetings and/or responded to the scoping notice are provided in Chapter 6. The list of preparers of this EIS is also provided in this chapter.

During the preparation of this DEIS, the BIA and its contractors met periodically with the Cooperating Agencies (BLM, Eastern Shoshone and Northern Arapaho tribal agencies, and Fremont County), as specified in a Memorandum of Understanding (MOU), signed on August 12, 2003. The Preliminary DEIS was submitted to the Cooperating Agencies for review and comments. The contractors for the BIA also met individually with representatives from tribal, state, federal, and local agencies, to obtain data relevant to the preparation of this DEIS.

AGENCY-PREFERRED ALTERNATIVE

(will be included here after submission of the Record of Decision by the BIA)

Table ES-1. Summary of Impact Determinations for the Proposed Action, Alternative A, Alternative B, and Alternative C.[1,2,3]

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
GEOLOGY				
Increased surface runoff	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Increased surface erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Collapse/piping/gullying	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Initiate mass movements	Negligible	Negligible	Negligible	Negligible
MINERALS				
Deplete petroleum reserves	Major, permanent	Major, permanent	Major, permanent	Major, permanent
Impede development of non petroleum resources	Negligible	Negligible	Negligible	Negligible
PALEONTOLOGY				
Damage to fossils	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Uncover new fossils and localities **(beneficial)**	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increased vandalism	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Increased illegal collection	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
SOIL				
Exposure of soil from vegetation removal	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Compaction/decreased permeability	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Collapse/piping/gullying	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Increased susceptibility of soil to wind and water erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
AIR QUALITY				
Increases in Local Pollutant Concentrations	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term
Increases in Regional Pollutant Concentrations	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	All Pollutants: Negligible, Long Term
Hazardous Air Pollutant Non-Cancerous Health Effects	Negligible, Long Term	Negligible, Long Term	Negligible, Long Term	Negligible, Long Term
Hazardous Air Pollutant Cancerous Health Effects	Minor, Long Term	Minor, Long Term	Negligible, Long Term	Negligible, Long Term
Increases in Terrestrial Acid Deposition	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Negligible, Long Term; Sulfur Deposition: No Impacts
Increases in Aquatic Acid Deposition (Decreased Lake ANC)	No Impacts	No Impacts	No Impacts	No Impacts
Reductions in Visibility (Regional Haze)	Moderate, Short Term; Minor, Long Term	Moderate, Short Term; Minor, Long Term	Minor, Short Term	No Impacts
SURFACE WATER				
Disruption of surface drainage systems	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Negligible, Long
Increased runoff and erosion	Moderate, Short term; Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Reduction in peak flows	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Increased sedimentation in lakes and reservoirs	Minor, Short term; Negligible, Long term	Moderate, Short term; Minor, Long term	Negligible, Long term	Negligible, Long term
Change in surface water networks	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Minor, Long term
Increase in suspended solids (turbidity)	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Minor, Long term
Change in water quality	Minor, Short term; Negligible, Long term	Minor, Short term; Negligible, Long term	Negligible, Long term	Negligible, Long term
GROUNDWATER				
Decrease in water levels	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Change in water quality	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Change in hydraulic properties	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
VEGETATION				
Increased erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Placement of riprap	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Loss of vegetation	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Reduction in species diversity	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increase in bare ground	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increase in noxious weeds and nuisance species	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
WETLANDS				
Loss of wetlands	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Reduction in wetland species diversity	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Exposure to contaminants	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Loss of riparian areas	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
LAND USE				
Impact to agricultural lands	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Short term[4]
Impact to range resources	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Impact to residential areas	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Impact to recreational areas/ WHMAs	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Impact to resource extraction	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Impact to Land Use Plans	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
WILDLIFE				
Impacts to game species, birds, mammals, and fish	Negligible to Minor, Short term	Negligible to Minor, Short term	Negligible to Minor, Short term	Negligible to Minor, Short term
Loss of habitat	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Wildlife displacement	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Increased mortality	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Habitat fragmentation	Negligible, Long term	Minor, Long term	Negligible, Long term	Negligible, Long term
Potential exposure to contaminants	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Reduction in prey species	Negligible, Short term	Minor, Short term	Negligible, Short term	Negligible, Short term
Increased predation	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
THREATENED/ ENDANGERED/ STATE SENSITIVE SPECIES				
Loss of Canada lynx habitat	No habitat	No habitat	No habitat	No habitat
Loss of bald eagle nesting, roosting, foraging habitat	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Loss of black-footed ferret habitat	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Loss of gray wolf habitat	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Loss of grizzly bear habitat	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Loss of mountain plover habitat	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Increase in bare ground **(beneficial for mountain plover)**	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Loss of sage-grouse habitat	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Increased mortality of T/E or State-sensitive species	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Potential exposure to contaminants	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
RECREATION				
Loss of federal and trust lands available for recreation	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Reduction in hunting and fishing opportunities	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Reduction in other recreation opportunities – wildlife viewing and ORV recreation	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Decreased enjoyment from recreational experience	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
VISUAL RESOURCES				
Alteration of landscape character	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Reduction in scenic quality	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Reduction in night sky quality	Moderate, Short term	Moderate, Short term	Moderate, Short term	Minor, Short term
Impact to VRI Class IV areas	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Impact to VRI Class III areas	Minor, Long term	Moderate, Long term	Negligible, Long term	Negligible, Long term
CULTURAL RESOURCES				
Increased vandalism	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Increased unauthorized collection	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Construction damage to sites	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Disturbance of Native American traditional uses	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
SOCIOECONOMICS				
Regional economic output **(beneficial)**	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Employment **(beneficial)**	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Personal income **(beneficial)**	Major, Long term	Major, Long term	Major, Long term	Minor, Long term
Revenues to the Eastern Shoshone and Northern Arapaho Tribes **(beneficial)**	Major, Long term	Major, Long term	Moderate, Long term	Minor, Long term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Revenues to Fremont County taxing entities **(beneficial)**	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increased local population	Negligible to minor, Long term	Minor, Long term	Negligible to minor, Long term	Negligible, Long term
Housing demand	Negligible, Long term	Negligible to minor, Long term	Negligible, Long term	Negligible, Long term
Law enforcement and emergency response	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Midvale Irrigation District revenues and operations	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Split estate conflicts	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
Change in rural character	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
TRANSPORTATION				
Increased traffic and maintenance demands on state and federal Highways	Minor (except for WYO 134, which would be moderate), Long term	Minor (except for WYO 134, which would be moderate), Long term	Minor (except for WYO 134, which would be moderate), Long term	Negligible (except for WYO 134, which would be minor), Long term
Increased traffic and maintenance demand on county roads.	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term
Traffic on private and operator-maintained roads	Minor, Long term	Moderate, Short term, Minor, Long term	Minor, Long term	Minor, Long term
Highway and road safety	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
HEALTH AND SAFETY				
Increased work-related accidents	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Increased vehicle traffic and accidents	Minor, Long term	Minor, Long-Term	Minor, Long term	Minor, Long term
Increased likelihood of wildfires	Negligible, Short term	Negligible, Short term	Negligible, Short	Negligible, Short

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
			term	term
Pipeline Fire and Explosion Hazards	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Hazardous Materials and Waste – spills and releases	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Use of magnesium chloride for dust control	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
NOISE				
Well pad and access road construction	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Drilling operations	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Venting operations	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Access roads	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Compressor stations	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
Increased vehicle-related noise	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Changes in wildlife behavior due to presence of humans and noise	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term

[1]**Definitions:**
Negligible impacts – Changes in resource condition are lightly above level of detection.
Minor Impacts – Changes is resource condition are measurable, but small and localized.
Moderate Impacts – Changes in resource condition are measurable and result in consequences that are relatively localized.
Major Impacts – Changes in resource condition are measurable and have substantial consequences at a regional level.
Short-term Impacts – Effects of short duration, that would occur during construction, drilling, completion and reclamation of a well.
Long-term Impacts – Effects of long duration, that would persist beyond the construction, drilling and reclamation phases, or continue for the life of the project.
[2]See Chapter 4 for detailed discussion of impacts.
[3]All impacts are adverse unless identified as “beneficial.”
[4]Impacts from gas development in the Pavillion field are considered Short term, since disturbance from well pads will be reduced to 8’x8’ in agricultural areas.

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List of Figures

A	A soil horizon
AADT	Annual Average Daily Traffic
ACEC	Areas of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ADT	Average Daily Traffic
ANC	Acid Neutralization Capacity
APD	Applications for Permit to Drill
AQRV	Air Quality Related Value
ARS	Air Resource Specialist, Inc.
ASTM	Association of Standard and Testing Methods
AUM	Animal Unit Month
BA	Biological Assessment
bbls	Barrels
BCF	Billion Cubic Feet
BEB	Birdsley-Effington-Boysen
BG	Big Game
BG	Background Distance Zone
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practices
BOR	Bureau of Reclamation
BP	Before Present
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
Btk	B soil horizon with accumulated silicate clay
Bw	B soil horizon with little or no illuvial accumulation
C	C soil horizon lacking properties of A or B horizons
CAA	Clean Air Act
$CaCO_3$	Calcium Carbonate
CASTNet	Clean Air Status and Trends Network
CCD	
CDP	Census Designated Place
CDW	Colorado Division of Wildlife
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CIA	Cumulative Impacts Analysis
CIG	Colorado Interstate Gas
COE	United States Army Corps of Engineers
CREG	Consensus Revenue Estimating Group
CWA	Clean Water Act
DAT	Deposition Analysis Threshold
dB	Decibel
dBA	A-weighted Decibel
DDT	Dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality

DFPA	Desolation Flats Project Area
DOE	U.S. Department of Energy
DOI	Department Of the Interior
DPS	District Population Segment
DR	Decision Record
dv	Deciview
EA	Environmental Assessment
EDA	Economic Development Agency
EIS	Environmental Impact Statement
EMT	Emergency Medical Technician
EO	Executive Order
EPA	Environmental Protection Agency
EPT	Ephemerotera, Plecoptera, and Trichoptera
ESA	Endangered Species Act
EUR	Estimated Ultimate Recoverable Oil
F	Species Taken for Falconry
FA	Wind River Formation Fossil Locality A
FB	Furbearer or Wind River Formation Fossil Locality B
FCEMA	Fremont County Emergency Management Agency
FCR	
FD	Wind River Formation Fossil Locality D
FE	Wind River Formation Fossil Locality E
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FF	Wind River Formation Fossil Locality F
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
FM	Foreground/Middleground Distance Zone
FONSI	Finding Of No Significant Impact
FWS	Fish and Wildlife Service
FR	Federal Registered
FY	Fiscal Year
GPM	Gallons Per Minute
GPS	Global Positioning System
HAP	Hazardous Air Pollutant
IDT	Interdisciplinary Team
IMPROVE	Interagency Monitoring of Protected Visual Environments
JBC	Joint Business Council
KOP	Key Observation Point
LAC	Level of Acceptable Change
LEPC	Local Emergency Planning Committee
LFO	Lander Field Office

LOP	Life Of Project
LOS	Level of Service
M1	First Upper Molar
M2	Second Upper Molar
MACT	Maximum Achievable Control Technology
MCF	Million Cubic Feet
Meq/L	Milliequivalents per Liter
mg/L	Milligrams per Liter
μG/L	Micrograms per liter
MID	Midvale Irrigation District
mm	Millimeter
MMBTU	Thousands British Thermal Units
MMS	Minerals Management Service
MSDS	Material Safety Data Sheet
MY	Million Years
N/A	Not Applicable or Not Available
NAAQS	National Ambient Air Quality Standards
$NaCO_3$	Sodium Carbonate
NADP	National Atmospheric Deposition Program
NCDC	National Climate Data Center
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NG	Nongame Species
NGPC	
NHPA	National Historic Preservation Act
NOS	Notice Of Staking
NPC	National Petroleum Council
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSI	No Significant Impacts
NTMB	Neotropical Migratory Bird
NWS	National Weather Service
OCMU	Owl Creek Mountains Unit
OHWM	Ordinary High Water Mark
ORV	Off-road Vehicles
OSHA	Occupational Safety and Health Administration
PCI	Pavement Condition Index
PD	Predator
PEM	Palustrine Emergency
PLS	Pure Live Soil
POD	Plan Of Development
ppm	Parts Per Million
PPP	Pollution Prevention Plan

PSD	Prevention of Significant Deterioration
PSS	Palustrine Shrub Scrub
PSU	Palustrine Unconsolidated Shore
RCRA	Resource Conservation and Recovery Act
RI	Riverine Intermittent
RMP	Resource Management Plan
RMU	Resource Management Unit
ROD	Record of Decision
ROW	Right Of Ways
RP	Riverine Perennial
RTH	Red-tailed Hawk
RUSLE2	Revised Universal Soil Loss Equation 2nd Iteration
SAR	Sodium-Adsorption Ratio
SARA	Superfund Amendments and Reauthorization Act
SEO	State Engineer's Office
SG	Small Game
SGU	Small Game Unit
SH	Wyoming State Highway
SHPO	State Historic Preservation Office
SI	Significant Impacts
SIP	State Implementation Plan
SLR	Sensitivity Level Rating
SLRU	Sensitivity Level Rating Units
SMA	Surface Management Agency
SPCC	Spill Prevention, Control, and Countermeasure Plan
SQRU	Scenic Quality Rating Unit
SS	Seldom Seen Distance Zone
SSC1	1996 Nongame Bird and Mammal Plan Species of Special Concern 1
SSC2	1996 Nongame Bird and Mammal Plan Species of Special Concern 2
SSC3	1996 Nongame Bird and Mammal Plan Species of Special Concern 3
TBI	Tom Brown Incorporated
TCF	Trillion Cubic Foot
TCP	Traditional Cultural Properties
TDS	Total Dissolved Solids
TG	Trophy Game
TPQ	Threshold Planning Quantity
TSP	Total Suspended Particulates
T&E	Threatened and Endangered
UAD	Unquantified Additional Development
UNKI	Unknown Impact Until Site-Specific Location is Proposed and Surveys are Completed
UPRC	Union Pacific Resources Company
US	United States Highway
USDA	United States Department of Agriculture

USDC	United States Department of Commerce
USDI	United States Department of the Interior
USDOE	United States Department of Energy
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator Coordinates
UW	University of Wyoming
VOC	Volatile Organic Compound
VR	Visual Range
VRM	Visual Resource Management
VRI	Visual Resource Inventory
WAAQS	Wyoming Ambient Air Quality Standards
WCIC	Wyoming Central Irrigation Company
WDEQ	Wyoming Department of Environmental Quality
WDAI	Wyoming Department of Administration and Information
WDR	Wyoming Department of Revue
WEMA	Wyoming Emergency Management Agency
WFU	Water Fowl Unit
WGFD	Wyoming Game and Fish Department
WGS	Wyoming Geological Survey
WHMA	Wildlife Habitat Management Area
WINDS	
WOGCC	Wyoming Oil and Gas Conservation Commission
WR	Wind River
WRCC	Western Regional Climate Center
WRIR	Wind River Indian Reservation
WRPA	Wind River Project Area
WSP	Wyoming State Parks and Historic Sites
WTA	Wyoming Taxpayers Association
WYDOT	Wyoming Department of Transportation
WYNDD	Wyoming Natural Diversity Database
WYO	Wyoming State Highway

1.0 PURPOSE AND NEED

1.1 PROJECT DESCRIPTION AND LOCATION

1.1.1 Description

The Wind River Project Area (WRPA) natural gas producing operators, including Tom Brown, Inc., Samson Resources Company and Saba Energy of Texas, hereafter referred to as "the Operators", have notified the Wind River Agency of the Bureau of Indian Affairs (BIA) and the Lander Field Office of the USDI Bureau of Land Management (BLM) that the Operators intend to drill and develop natural gas wells in the WRPA in central Wyoming (Figure 1-1). The proposed exploration and development wells, access roads, pipelines, and other ancillary facilities are located on tribal and private lands, including split estate. Split estate in the WRPA refers to areas with private or federal surface ownership and tribal mineral ownership. Facilities located on federal or tribal surface estate and Tribal minerals would be permitted by BIA and BLM. Facilities located on privately owned surface and privately owned minerals would be permitted with the Wyoming Oil and Gas Conservation Commission (WOGCC).

1.1.2 Location

The WRPA is located in Townships 3 through 4 North and Ranges 2 through 5 East in Fremont County, Wyoming as shown in Figure 1-1. The WRPA is located approximately 21 miles northwest of Riverton, Wyoming and is bounded on the east by Boysen Reservoir. The WRPA consists of five development areas: Pavillion, Sand Mesa, Muddy Ridge, Sand Mesa South, and Coastal Extension (Figure 1-2). Main accesses to the various development areas within the WRPA are also shown in Figure 1-2. From the town of Pavillion, the Pavillion Field is accessed by Wyoming Highway 133 and Pavillion East Road and the Muddy Ridge Field is accessed out of Pavillion along Tunnel Hill Road. From the city of Riverton, access to the Pavillion and Muddy Ridge fields is by Burma Road (County Road 320) to Missouri Valley Road (Wyoming Highway 134) and north on Tunnel Hill Road (CR 427). The Coastal Extension Field may be accessed via North Portal Road and North Muddy Road. Sand Mesa and Sand Mesa South may be accessed from North Portal Road to Sand Mesa Road or from US Highway 26/Wyoming Highway 789 to Bass Lake Road.

The existing network of roads within the WRPA includes secondary roads (paved two-lane highways, which are mainly state highways), light-duty roads (gravel surface roads that are maintained), and unimproved roads (dirt and gravel roads and tracks that are generally not maintained). Within the WRPA, there are a total of 45.6 miles of secondary roads, 104.2 miles of light-duty roads, and 185.1 miles of unimproved roads (Figure 1-3).

The Operators anticipate that future development in the WRPA would likely be concentrated within and near existing development areas rather than in outlying areas where development currently does not exist, with the exception of the exploratory and potential development wells proposed for the Sand Mesa, Coastal Extension, and Sand Mesa South.

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Figure 1-1. Location of the Wind River Gas Development Project Area in Central Wyoming.

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Figure 1-2. Road Access to the WRPA.

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Figure 1-3. Existing Secondary, light duty, and unimproved roads within the WRPA

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1.1.3 Project Background

Drilling and natural gas production activities have been conducted within the WRPA by the present Operators and their predecessors since 1960. There are currently 178 producing gas wells in the WRPA, along with 100.7 miles of existing pipeline and 14,540 horsepower (HP) of existing compression.

The WRPA consists of five natural gas development areas. The names and status of drilling activity within the development areas are summarized in Table 1-1. Figures 1-4, 1-5, and 1-6 illustrate that existing natural gas development is concentrated in the Pavillion and Muddy Ridge Fields.

Table 1-1. Natural Gas Fields within the WRPA.

Field Name	Producing Wells	Abandoned Wells	Dry Holes	Total Wells
Pavillion	99	10	4	113
Muddy Ridge	70	6	5	81
Sand Mesa	3	4	3	10
Sand Mesa South	0	0	0	0
Coastal Extension	0	0	1	1
Other	6	8	24	38
TOTAL	**178**	**28**	**37**	**243**

The well density in the five development areas ranges from 16 to 32 wells per 640-acre section, based on the BLM and WOGCC spacing orders. Prior to development, the Operators submit a request for spacing of the wells to the BLM for tribal minerals and to the WOGCC for private minerals. The spacing order, prepared by the BLM and WOGCC in response to the Operators' request, specifies the formations where drilling will occur, the density of wells allowed in each formation within a section, and the spacing of the wells within the section. In those areas where specific spacing was not requested by the Operators, the spacing requirement in the Notice to Lessees (BLM 1997), is used. Table 1-2 summarizes the well density and spacing specified in the spacing orders. Figure 1-7 illustrates the well density in the Muddy Ridge and Pavillion fields, based on the spacing orders.

Table 1-2. Spacing Orders for the Wind River Gas Field Development Areas[1].

FIELD	DATE OF ORDER	WOGCC/ BLM	TOWNSHIP/ RANGE/	SECTION	FORMATIONS/ DENSITY (ac)	COMMENTS
Pavillion	11/16/2000	WOGCC	T3N, R2E	1: Tract 1	Wind River (16/640 ac) and Fort Union (16/ 640ac)	Located anywhere within 640-ac section
			T3N, R2E	3: N1/2NW1/4, SW1/4, SW1/4SE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	9: W1/2NE1/4, SE1/4NE1/4, N1/2SE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	10: NW1/4SW1/4, NE1/4NW1/4, N1/2NE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	11: W1/2NW1/4, SE1/4NW1/4, NW1/4SW1/4, E1/2	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	12: S1/2	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	13: N1/2N1/2, SE1/4NE1/4, N1/2SE1/4, SE1/4SE1/4, NE1/4SW1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	15: N1/2SW1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R3E	6: Tracts 2 and 4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
Pavillion	11/15/2000	BLM	T3N, R2E	1: Tracts 2, 3, 4, 5, 6, 7, 8, 9, and 10, Lots 2, 3, and 4, SW1/4NE1/4, S1/2NW1/4, NE1/4SW1/4, N1/2SE1/4	Wind River (16/640 ac); Fort Union (16/ 640ac)	Located anywhere within 640-ac section
			T3N, R2E	2: Tracts 1, 2, 4, 6, 8, 9, 10, 11, 12, 13	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	3: Tracts 1, 2, 3, 6, 8, 9, 10, 11, 12 15, 16, 17, 18, 19, 20, 21	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	9: NE1/4NE1/4, S1/2SE1/4	Wind River (8/320ac) and Fort Union (8/320 ac)	“
			T3N, R2E	10: S1/2N1/2, NW1/4NW1/4, NE1/4SE1/4, S1/2SW1/4, SE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	11: NE1/4NW1/4, NE1/4SW1/4, S1/2SW1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	12: N1/2	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	13: SW1/4NE1/4, S1/2NW1/4, W1/2, SW1/4, SE1/4SW1/4, SW1/4SE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	14: All	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
			T3N, R2E	15: N1/2, S1/2SW1/4, SE1/4	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“

FIELD	DATE OF ORDER	WOGCC/ BLM	TOWNSHIP/ RANGE/	SECTION	FORMATIONS/ DENSITY (ac)	COMMENTS
			T3N, R3E	6: Tracts 1, 3, 5, 6, 7, 8, 9, 10, 11	Wind River (16/640 ac) and Fort Union (16/ 640ac)	“
Pavillion	8/17/2001	BLM	T3N, R3E	5: Lots 1,2,3,4,S1/2N1/2, S1/2	Wind River (16/640 ac)	Located anywhere within 640-ac section
			T3N, R3E	7: SW1/4SE1/4, Tracts 1,2,3,5,6,8,11,12,14,16,17,18,20,21,22,23 ,24,25,26,27,28, 29,30	Wind River (16/640 ac)	“
			T3N, R3E	18: Lots 3,5,6, SE1/4SW1/4, S1/2SE1/4	Wind River (16/640 ac)	“
Pavillion	10/19/2001	WOGCC	T3N, R3E	7: S1/2SW1/4	Wind River (16/640ac)	Located anywhere within 640-ac section
			T3N, R3E	18: Lots 1, 2, E1/2NM1/4, NE1/4, NE1/4SW1/4, N1/2SE1/4	Wind River (16/640ac)	“
Pavillion	3/11/2002	WOGCC	T3N, R2E	4: All private minerals	Wind River (8/320 ac and Fort Union (8/320 ac)	Located no closer than 920 ft to any other well producing from same formations
Pavillion	5/7/2002	BLM	T3N, R2E	4: All tribal minerals	Wind River (8/320 ac) and Fort Union (8/320 ac)	Located anywhere within 640-ac section
			T3N, R2E	E ½ 4: Tracks 3,4, and 5 (approximately the NW1/4NE1/4)	Wind River (8/320 ac) and Fort Union (8/320 ac)	“
			T3N, R2E	W ½ 4: Tracts 1 and 2 (approximately the NW1/4NW1/4) and the SW1/4NW1/4	Wind River (8/320 ac) and Fort Union (8/320 ac)	“
Pavillion	9/19/2002	BLM	T3N, R2E	10: S/2N/2, NW/4NW/4, NE/4SW/4, S/2SW/4, SE/4	Wind River and Fort Union (32 wells/640 ac)	Commingled or otherwise
			T3N, R2E	11: NE/4NW/4, NE/4SW/4, S/2SW/4	Wind River and Fort Union (32 wells/640 ac)	“
Pavillion	9/28/2002	WOGCC	T3N, R2E	10: N1/2NE1/4, NE1/4NW1/4, NW1/4SW1/4	Wind River and Fort Union (32 wells/640 ac)	Commingled or otherwise
			T3N, R2E	11: E1/2, W1/2NW1/4, SE1/4NW1/4, NW1/4SW1/4	Wind River and Fort Union (32 wells/640 ac)	
Muddy Ridge	12/30/2002	BLM	T4N, R2E	24: NE1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	Located anywhere within 160-ac quarter section
			T4N, R2E	24: SE1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	“
			T4N, R2E	25: NE1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	“
			T4N, R2E	25: SE1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	“

FIELD	DATE OF ORDER	WOGCC/ BLM	TOWNSHIP/ RANGE/	SECTION	FORMATIONS/ DENSITY (ac)	COMMENTS
			T4N, R2E	36: Tract 1 (31.67), NE1/4NE1/4 and that part of the Tracts 4,5 & 8 comprising the remainder of the equivalent NW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	"
			T4N, R3E	19: Lots 1 (35.45) & 2 (35.59), E1/2NW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	"
			T4N, R3E	19: Lots 3 (35.73) & 4 (35.87), E1/2SW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	"
			T4N, R3E	30: Lots 1 (35.94) & 2 (35.95), E1/2NW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	""
			T4N, R3E	30: Lots 3 (35.95) & 4 (35.96), E1/2SW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	"
			T4N, R3E	31: Tracts 3 (50.57) & 4 (39.42) and that part of Tracts 10 & 11 comprising the remainder of the equivalent NW1/4	Mesaverde (8/160 ac) and Meeteetse (8/160 ac	"
All other fields	5/30/97 NTL	BLM	Not specified	Not specified	1 well/40 ac	Located in center of 40-ac quarter-quarter section

[1]BLM 1997; BLM 2000a; BLM 2001a; BLM 2002a; BLM 2002b; BLM 2002c; WOGCC 2000; WOGCC 2001; WOGCC 2002al WOGCC 2002c.

Figure 1-4. Producing, Abandoned, and Dry Gas Wells in the Pavillion Field, WRPA.

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Figure 1-5. Producing, Abandoned, and Dry Gas Wells in the Muddy Ridge Field, WRPA.

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Figure 1-6. Producing, Abandoned, and Dry Gas Wells in and near the Coastal Extension, Sand Mesa, and Sand Mesa South Fields, WRPA.

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Figure 1-7. Density of Wells in the Wind River Gas Development Areas, based on BLM and WOGCC Spacing Orders.

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1.1.4 Land Status

The WRPA encompasses approximately 91,520 acres of mixed tribal, federal, state and private lands. Surface ownership within the WRPA is summarized by category in Table 1-3. Mineral ownership of the WRPA is 80,869 acres of tribal minerals, and 10,651 acres of private minerals. Mineral ownership is summarized in Table 1-4. The location of surface and mineral ownership in the WRPA is shown in Figures 1-8 and 1-9, respectively. For analysis purposes the total WRPA will be rounded out to 92,000 acres.

Table 1-3. Surface Ownership in the WRPA[1]

Surface Ownership	Acres	Percent
Private	47,066	51.4
Bureau of Reclamation (Riverton Withdrawal Area)	29,489	32.2
Tribal	14,409	15.7
State (WGFD, Boysen State Park)	546	0.6
Open Water (federal, tribal)	10	<0.1
Total	**91,520**	**100**

[1]Areas were calculated using a project area boundary digitized by Buys & Associates from a map provided by Tom Brown, Inc. (2002). All areas were calculated using a GIS. Error is estimated to be less than 1%.

Table 1-4. Mineral Ownership in the WRPA[1].

Mineral Ownership	Acres	Percent
Tribal	80,869	88.4
Private	10,651	11.6
Total	**91,520**	**100**

[1]Areas were calculated using a project area boundary digitized by Buys & Associates from a map provided by Tom Brown, Inc. (2002). All areas were calculated using a GIS. Error is estimated to be less than 1%.

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Figure 1-8. Surface Ownership within the WRPA.

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Figure 1-9. Mineral Ownership within the WRPA.

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1.2 PURPOSE OF AND NEED FOR ACTION

1.2.1 Bureau of Land Management

Exploration and development of tribal oil and gas leases by private industry is an integral part of oil and gas program of the Bureau of Land Management under the authority of the Indian Mineral Development Act of 1982 (25 U.S.C. § 2101 et seq.); the Indian Mineral Leasing Act of 1938 (25 U.S.C. §§ 396a to 396g); the Act of August 21,1916 (39 Stat. 519); and the Federal Oil and Gas Royalty Management Act of 1982 96 Stat. 2447).

The BLM oil and gas program encourages environmentally sound development of tribal oil and gas reserves. Natural gas is an integral part of the United States' and the Tribes' energy future due to its availability and presence of existing market delivery infrastructure. By further developing domestic reserves of clean burning natural gas, the U.S. would reduce dependence on foreign energy. The environmental advantages of burning natural gas rather than oil or coal were emphasized by the U.S. Congress and the President when the Clean Air Act Amendments of 1990 were signed into law.

1.2.2 Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) has the responsibility to act as trustee for the Tribes and individual Indians in the development and protection of Indian resources of all types. The agency assists the Tribes (Shoshone and Arapaho within the WRIR) and individual Indian mineral owners in the development of their mineral resources as a source of income and employment. The BIA also encourages the Tribes to enter into mineral leases for the development of their trust lands with the goal of maximizing their best economic interest and minimizing any adverse environmental or cultural impacts from the development and sale of their resources (25 CFR part 211).

The statutes and regulations that the BIA follows for leasing on tribal lands include the 1916 Act, the Indian Mineral Leasing Act of 1938, and the Indian Mineral Development Act of 1982. Additional information on these acts is provided in Section 1.5.2.

As with federal and state government, tax and royalty revenues from mineral resources, particularly natural gas, are important sources of income for Tribal government. These revenues help fund a variety of Tribal services including infrastructure construction and improvements, housing, law enforcement, road maintenance, environmental programs, educational assistance, economic development, planning and social services such as programs for children and the elderly. Per capita distributions of royalty revenue also comprise a substantial portion of total income for some individual members of the Eastern Shoshone and Northern Arapaho Tribes. Revenues from natural gas are the largest single source of revenues for the Tribes, and represent a significant portion of total income of the tribal members.

1.2.3 Need for Gas Development

In December 1999, the National Petroleum Council, formed in 1946 to advise, inform and make recommendations to the Secretary of Energy on any matter requested by the Secretary relating to oil and natural gas and the oil and natural gas industries, issued a report titled *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand (*NPC 1999). The report projects that U.S. natural gas consumption would increase by 32 percent between 1998 and 2010. This would constitute a seven trillion cubic foot (TCF) increase, from the 1998 level of 22 TCF to 29 TCF in 2010. Much of the incremental demand is projected for use in the generation of electricity.

To meet this growing demand, the report projects that U.S. domestic gas production would increase from the 1998 level of 19 TCF to 25 TCF in 2010. The remaining demand would be met by imports of foreign natural gas, primarily from Canada. About 14 percent of this increase in domestic supply is anticipated to come from the Rocky Mountain region. Production from the WRPA would help meet this demand.

1.2.4 The Operators

The Operators (Tom Brown, Inc.; Saba Energy of Texas; and Samson Resources) propose to further develop the natural gas resources within the project area by increasing the total number of wells and ancillary facilities where economically feasible. This proposal would extend recovery of natural gas from the WRPA, thus allowing the Operators to continue providing natural gas to companies distributing to consumers. The proposed exploration and development would benefit consumers by extending natural gas supplies.

The proposed natural gas development would allow the leaseholders to exercise their rights within the WRPA to drill for, extract, remove, and market natural gas products. The Wind River area leaseholders also have the right to build and maintain necessary improvements, subject to renewal or extension of the lease or leases in accordance with the appropriate government authority.

1.3 ENVIRONMENTAL ANALYSIS PROCESS

Drilling for gas within the WRPA has been successful for more than 40 years. This success has resulted in a request by the Operators to the BIA, the lead agency for National Environmental Policy Act (NEPA) analyses conducted on Tribal land, for an extension of drilling and production activity within the WRPA. The BIA advised the Operators that an EIS would be required in view of the Operators' plans to drill additional exploratory and in-fill locations and construct ancillary facilities at levels not analyzed in previous environmental analyses. The purpose of this EIS is to provide decision-makers with the information needed to make a final decision that is fully informed and based on facts relevant to the Proposed Action and alternatives. It analyzes the effects of the construction, operation, and the reclamation of well pad locations, access roads, production facilities, pipelines, and other associated facilities on natural resources and land use within the WRPA. It also documents analyses conducted on the Proposed Action and three alternatives in order to identify and disclose the environmental impacts and mitigation measures necessary to address issues raised during the scoping process. The EIS also provides a vehicle for public review and comment on the Proposed Action and alternatives, the environmental analysis, and the conclusions about the relevant issues.

The BIA, as directed by the Council on Environmental Quality (CEQ) and the NEPA regulations (40 CFR, Parts 1500-1508), analyzes its actions on tribal and federal lands as to their impact on the human environment. The analysis is to determine whether approval of the action would result in unnecessary or undue degradation of the environment. The analysis uses a process dictated by NEPA and the CEQ regulations for evaluating and disclosing the potential environmental consequences of the Proposed Action and alternatives.

The evaluation of the Proposed Action and the alternatives was developed through interdisciplinary field review with representatives from the Operators, the BIA, the cooperating agencies (i.e., Joint Business Council (JBC) of the Shoshone and Arapaho Tribes; the BLM; Fremont County); and the project contractor (Buys & Associates, Inc.).

Factors considered during the environmental analysis process regarding the Proposed Action and the alternatives include the following:

- The location of environmentally suitable well pad locations, access roads, pipelines, and other production and ancillary facilities that best meet other resource requirements and minimize surface impacts yet honor the lease rights within the WRPA.
- A determination of impacts resulting from the Proposed Action and alternatives on the human environment, when conducted in accordance with applicable regulations and lease stipulations, and the development of mitigation measures necessary to avoid or minimize these impacts.

The EIS is *not* a decision document. The decision regarding the project will be documented in a Record of Decision (ROD) signed by the Regional Director, Rocky Mountain Region, Bureau of Indian Affairs. The BIA's decision will relate primarily to trust lands administered by the BIA. The BLM, JBC, and Fremont County, as cooperating agencies, will have input into the decision-making process. Other jurisdictions to issue approvals related to this proposal may be aided by the disclosure of impacts available in this analysis.

This EIS will guide the implementation of a selected alternative and will facilitate preparation of additional environmental analyses within the WRPA and adjacent lands. Prior to surface disturbance at drill sites and associated roads, pipelines, and ancillary facilities located on federal, private, and tribal surface, or federal and tribal minerals, additional site-specific analyses may be required.

1.4 RELATIONSHIP TO POLICIES, PLANS, AND PROGRAMS

The WRPA is located within the administrative boundaries of the Wind River Agency, Bureau of Indian Affairs and the Bureau of Reclamation (BOR) (see Figure 1-2). The documents that direct management of federal and tribal lands within the WRPA are summarized in the following sections.

1.4.1 Environmental Assessment of Land Management Activities

The document that directs management of Tribal lands within the WRPA located within the BIA administrative area is the FONSI/DR (Finding of No Significant Impact/Decision Record) and approved Environmental Assessment (EA) of the Land Management Activities proposed by Land Operations, Wind River Agency (BIA 1984).

1.4.1.1 Management Objectives

The management objective in the EA of land management (BLM 1984) applicable to the Proposed Action and alternatives within the BIA administrative area is to provide guidance and stewardship for programs and activities affecting natural resources on the Wind River Indian Reservation (WRIR) in the following areas: exploration, production, and marketing of oil, natural gas, and gravel.

1.4.1.2 Management Actions

Management actions applicable to the Proposed Action and alternatives within the BIA administrative area are to ensure a level of production in each area that:

- Maximized the best economic interest of the Tribes (25 CFR Part 211)
- Protects long term uses, and
- Protects the land base.
- Prudent development and conservation of tribal minerals.

1.4.1.3 Conformance with EA of Land Management

The EA of Land Management Activities proposed by Land Operations, Wind River Agency is a general document covering forest management, range management, oil and natural gas, irrigation, and soil conservation/crop production issues for the Wind River Indian Reservation land and its resources. General guidance with specific stipulations for endangered species, and geophysical, and irrigation actions are included in the document.

The Wind River Natural Gas Field Development Project is in conformance with management objectives provided in the EA for Land Management subject to the implementation of the prescribed mitigation measures proposed by the Operators and BIA identified in Chapter 2 of this EIS, and additional mitigation measures derived through the analysis of impacts in Chapter 4, Environmental Consequences.

1.4.2 Relationship to Other Plans and Documents

1.4.2.1 Draft Wind River Land Use Development Plan

The Eastern Shoshone and Northern Arapaho Tribes zoning ordinance has encompassed the WRPA area since the 1970s. A land use plan to coordinate development on the Wind River Indian Reservation (WRIR) for the next 20 years is under development by the Eastern Shoshone Tribe with input from the New'e Development Corporation Board, Eastern Shoshone Tribal Council and the Northern Arapaho Tribal Council. The overall goal "is to develop long-range planning, policies, ordinances and management documents that will further the tribe's ability to provide a self-sufficient community and economy" (Cottenoir 2003). The preparation of the plan is expected to take two years.

The overall land use goals of the draft plan are:

- Residential
  – Provide suitable housing areas that contain a cost-effective infrastructure.
  – Provide tribal members with a development process.
- Agriculture
  –.Protect and preserve agricultural lands.
- Commercial
  –.Designate commercial land use for large and small businesses.

- Industrial
  –.Provide land for industrial opportunities for both tribes and surrounding municipalities.

- Public Use
  –.Improve public and recreational areas on the reservation.

- Economic Development
  –.Provide opportunities for employment on the reservation.

Strategic plan goals in the draft plan are:

- Environmental and Natural Resource
  –.Provide a plan to conserve and preserve future resources.

- Transportation
  –.Support regional transportation planning and decision-making.

- Zoning
  –Modify current tribal zoning laws, as necessary, to further protect property and encourage orderly development.

1.4.2.2 Fremont County Land Use Plan

The Fremont County Land Use Plan (Fremont County 1978) includes objectives and goals for public land coordination and management, economic development, growth management, environmental quality, and natural resources. Fremont County has no countywide zoning regulations (Price, R., Fremont County, personal communication, August 5, 2003). Individual towns and cities have zoning requirements, but the Proposed Action has no facilities in an incorporated town or city. County permits may be required for the crossing of county roads by roads, pipelines, and Rights-of-Way (ROW). Fremont County has also prepared a draft land use plan (Fremont County 2001). This plan will also be considered, as

NEPA requires consideration of local land use plans in the preparation of environmental analyses. The Proposed Action and alternatives to the Proposed Action for the Wind River Natural Gas Development Project would occur entirely within Fremont County.

Based on the foregoing, the Wind River Natural Gas Field Development Project will be in conformance with applicable land use plans and tribal law.

1.4.2.3 Lander Resource Management Plan

The Final Resource Management Plan/EIS for the Lander Resource Area, Lander, Wyoming (BLM 1986) addresses the areas east, south, and west of the WRIR. Therefore, its goals and objectives are not evaluated for compliance with the Proposed Action and alternatives.

1.4.3 Wyoming BLM Guidelines for Surface-Disturbing and Disruptive Activities

The Wyoming BLM guidelines for Surface-Disturbing and Disruptive Activities may be incorporated into the oil and gas leases within the WRPA, at the discretion of the BIA. The purposes of these guidelines are: (1) to reserve, for the BLM, the right to modify the operations of surface and other activities resulting in disturbance of the land for the purposes of protecting the environment, and (2) to inform a potential lessee of the requirements that must be met when using BLM-administered public lands. The BLM Standard Mitigation Guidelines may be used by the BIA for the proposed natural gas production operations within the WRPA and are presented in Appendix B.

1.4.4 Bureau of Reclamation Riverton Withdrawal Area

The Riverton project was authorized for construction by the Secretary of the Interior on June 19, 1918, under the terms of the Indian Appropriation Act for fiscal year 1919. By the Act of June 5, 1920, the project was placed under the jurisdiction of the Bureau of Reclamation (BOR). Irrigators from the First and Second Divisions formed the Midvale Irrigation District (MID) in January 1921. In 1925, water was first made available for irrigation for 1,600 acres west of Pilot Butte Reservoir. On March 3, 1926, 20 units of public lands, ranging from 35 to 108 acres were opened under the authority of the BOR. By 1939, all 260 units opened on the First and Second Divisions had been filled. The Third Division was authorized under the Flood Control Act (58 Stat. 887) of 1944. On September 25, 1970, Public Law 91-409 reauthorized the project as the Riverton Unit of the Pick-Sloan Missouri Basin Program.

1.5 MEMORANDA OF UNDERSTANDING

BIA/BLM/MMS Memorandum of Understanding

In 1991 a memorandum of understanding was established among the BIA, BLM, and Minerals Management Service (MMS) (BLM MOU WO 600-9111, September 6, 1991). This MOU outlines the roles and responsibilities of each of these agencies with respect to minerals management on tribal lands.

BIA/BLM/Shoshone-Arapaho Tribes/Fremont County MOU

The BIA, BLM, Fremont County and the Shoshone and Arapaho Tribes Joint Business Council signed a MOU on August 12, 2003 that addresses agency and tribal cooperation on the Wind River Gas Development EIS. The MOU specifies that these agencies will serve as cooperating agencies for this EIS and outlines the roles and responsibilities of each agency. It states that these agencies were appointed as cooperating agencies because each has specific areas of expertise that will benefit the preparation of this EIS.

The role of the BIA, as lead agency, is to coordinate with and consult with the JBC, BLM and Fremont County throughout the preparation of the EIS, particularly during scoping and the development of the Draft EIS.

1.6 AUTHORIZING ACTIONS

The federal, state, county, and local actions required to implement the Wind River Natural Gas Development Project are listed in Table 1-5.

Table 1-5. Authorizing Actions of Federal, Tribal, State, and Local Governments

AGENCY	NATURE OF ACTION
DEPARTMENT OF THE INTERIOR (DOI)	
Bureau of Indian Affairs (Wind River Agency)	• Grants Right-of-Ways (ROWs) to Operators for natural gas field development actions on tribal surface outside of federal lease or unit boundaries, and to third party applicants (i.e., non-unit operator or non-lease holder), both within and outside of the unit boundary. • Reviews impacts on federally listed, or proposed for listing, threatened or endangered species of fish, wildlife, and plants, and consults with U.S. Fish and Wildlife Service. • Reviews inventories of, and impacts to cultural resources affected by the Proposed Action, and consults with Wyoming State Historic Preservation Office (SHPO), Tribes, and Advisory Council on Historic Preservation (ACHP). • Approves leases on tribal land within the Wind River Indian Reservation.
Bureau of Land Management (Lander Field Office) Wyoming State Office, Reservoir Management Group	• Approves Applications for Permit to Drill (APDs), with the concurrence of the Surface Management Agency (SMA), Sundry Notices and reports on wells, production facilities, disposal of produced water, gas venting or flaring, and well plugging and abandonment for federal and Indian wells as part of the agency's trust responsibilities. • Administers the approval and subsequent actions of federal and Indian oil/gas agreements, including unit and communitization agreements. • Approves spacing applications for Indian minerals. • Assures that producing Indian oil and gas leases are diligently developed in accordance with lease terms and regulations. • Administers drainage protection and protection of correlative rights on federal and Indian mineral estate.

Bureau of Reclamation	• Administers approximately 101,000 acres of surface land in the Riverton Unit, which were withdrawn from public trust, as well as 3,300 acres of acquired lands. • Reclamation lands within the Riverton Unit lie entirely within the historic boundary of the WRIR.
Midvale Irrigation District	• Manages approximately 72,000 acres in the riverton Unit for irrigated agriculture. • Operates and maintains federally constructed irrigation-related facilities in the Riverton Unit, under Contract 14-06-600-444A, dated December 17, 1971. • Is authorized to sublease BOR lands in the First and Second Divisions of the Riverton Unit for grazing and agricultural purposes under Contract 14-06-600-4192, dated November 22, 1960.
U.S. Fish and Wildlife Service	• Reviews impacts on federally listed, or proposed for listing, threatened or endangered species of fish, wildlife, and plants for the BIA.

ENVIRONMENTAL PROTECTION AGENCY (EPA)	
Office of Air and Radiation	• Oversees the air and radiation protection activities of the Agency including national programs, technical policies, and regulations. Administers the Clean Air Act on Federal and Indian Lands.
American Indian Environmental Office	• Coordinates the Agency-wide effort to strengthen public health and environmental protection in Indian Country, with a special emphasis on building Tribal capacity to administer their own environmental programs.
Office of Environmental Justice	• Serves as a focal point for implementation of Executive Order 12898, which ensures that communities comprised predominately of minority or low-income populations receive protection under environmental laws.
Office of Solid Waste and Emergency Response	• Provides policy, guidance, and direction for the land disposal of hazardous wastes, underground storage tanks, solid waste management, encouragement of innovative technologies, source reduction of wastes and the Superfund Program.
Office of Water	• Responsible for the Agency's water quality activities including development of national programs, technical policies, and regulations relating to drinking water, water quality, ground water, pollution source standards, and the protection of wetlands, marine, and estuarine areas.
DEPARTMENT OF THE ARMY	
U.S. Army Corps of Engineers	• Issues permit(s) (Section 404 of the Clean Water Act) for placement of dredged or fill material in waters of the U.S. and their adjacent wetlands.
SHOSHONE AND ARAPAHO TRIBES	

Wind River Environmental Quality Commission	• In conjunction with the Environmental Protection Agency (EPA), Wind River Environmental Quality Commission is responsible for ensuring the adherence environmental policies and regulations. The agency also assists the EPA in administering the Clean Air Act and Clean Water Act on the WRIR.
Tribal Water Engineer's Office	• The Tribal Water Engineers Office is responsible for direct oversight and administration of the Wind River Water Code. The agency works in conjunction with the Water Resources Control Board and the Shoshone-Arapaho Tribes Joint Business Council.
Tribal Game and Fish Department	• The Tribal Fish and Game Department is responsible for the administration of the fish and game program, which includes the issuing of hunting and fishing licenses and the enforcement of regulations, according to the Reservation Fish and Game Code.
Tribal Cultural Representatives	• The Tribal Cultural Representatives are responsible for conducting cultural resource inventories on and off the WRIR in coordination with the Joint Business Council and the respective Tribes.
Tribal Joint Business Council	• The Joint Business Council is responsible for the review and approval of all actions as they relate to Tribal Trust Land. The JBC is the main authority for the administration of all joint programs and makes decisions regarding Real Property and Natural Resource Management on the WRIR. The JBC is responsible for approving any zoning changes.
WYOMING STATE HISTORIC PRESERVATION OFFICE (SHPO)	
SHPO	• Provides consultation concerning inventory of, impacts to, and mitigation measures for cultural resources, if applicable.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY (WDEQ)[1]	
Water Quality Division	• Administers Storm Water Pollution Prevention Plans, if applicable. • Approves wastewater and sewage disposal, if applicable. • Administers Clean Water Act, if applicable.
Air Quality Division	• Administers Clean Air Act, if applicable. [1]The jurisdictional boundaries for water and air quality responsibilities between the EPA and WDEQ are not clear.
WYOMING STATE ENGINEER'S OFFICE	
State Engineer	• Issues permits for state ground water and surface use water rights. • Issues temporary water rights for construction permits to utilize state surface water rights.
WYOMING OIL AND GAS CONSERVATION COMMISSION (WOGCC)	

WOGCC	• Serves as primary authority for drilling on privately held mineral resources. • Has authority to allow or prohibit flaring or venting of gas on privately owned minerals. • Regulates drilling and plugging of wells on privately owned minerals. • Approves directional drilling of wells on privately owned minerals. • Administers rules and regulations governing drilling units of wells on privately owned minerals. • Grants gas injection well permits of wells on privately owned minerals. • Administers drainage protection and protection of correlative rights on private mineral estate.

FREMONT COUNTY	
Fremont County	• Grants small wastewater system permits, where applicable. • Issues driveway access permits where new roads intersect with county roads. • Prepares road use agreements and/or oversize trip permits when traffic on county road(s) exceeds established size and weight or where the potential for excessive road damage exists.

1.5.1 Regulatory Jurisdiction

Since the WRPA consists of BOR surface, Indian private surface, tribal minerals, and non-Indian private surface (split estate), and non-Indian private surface and minerals; federal, tribal, state, and local authorities may have jurisdiction over different portions of the WRPA. Thus, the question of jurisdiction over Indian lands is a complex issue.

This section summarizes several areas of law that could affect the Proposed Action, and considers which regulatory authorities would have jurisdiction. These areas, which include Federal environmental statutes, transportation, oil and gas leasing, well spacing, and fish and wildlife, are the major areas considered, but do not represent all of the laws that could potentially affect the Proposed Action. Table 1-5 summarizes the jurisdictional issues present with respect to the Proposed Action. Additional issues not discussed here may arise as the Wind River Gas Field Development Project develops.

Table 1-6. Regulatory Jurisdiction within the WRPA.

	Tribal Surface/ Tribal Minerals	Federal Surface/ Tribal Minerals	Private Surface/ Tribal Minerals	Private Surface/ Private Minerals
Environmental Statutes	EPA, with extensive tribal participation.	EPA and the State.	EPA and other applicable authorities.	EPA. The State's authority here is not clear.
Transportation	BIA and the tribes for tribal roads or easements. The State for rights-of-way granted to the State by the Secretary of the Interior.	The BOR for easements. The State for rights-of-way granted to the State by the Secretary of the Interior.	The State for rights-of-way, granted to the State by the Secretary of the Interior. The County for private ways of necessity.	The State for rights-of-way granted to the State by the Secretary of the Interior. The County for private ways of necessity.
Oil and Gas Leasing	BIA	BIA and BLM	BIA and BLM	Private landowner
Well Spacing	BLM	BLM	BLM	WOGCC, in conjunction with the BLM.
Fish and Wildlife	The tribes for fish and game. USFWS for threatened and endangered species.	The USFWS for threatened and endangered species. WGFD for game and non-game species.	USFWS for threatened and endangered species.	USFWS for threatened and endangered species.

1.5.2 Oil and Gas Leasing

The BIA is responsible for assisting the Tribes and individual Indian mineral owners in the development of their mineral resources as a source of income and employment. Mineral agreements on the Indian lands may be governed by three different laws and associated regulations:

- Act of August 21, 1916 (1916 Act), and attendant regulations on leasing of ceded land in the Wind River Indian Reservation, Wyoming for oil and gas mining (25 CFR 227).
- Indian Mineral Leasing Act of 1938 (IMLA) and attendant regulations dealing with leasing of tribal lands for mineral development (25 CFR 211) and 25 CFR 212 addressing leasing of allotted lands for mineral development.
- Indian Mineral Development Act of 1982 (IMDA) and attendant regulations (25 CFR 225), which govern minerals agreements for the development of Indian-owned minerals.

Note that 25 CFR 211.1 (e) states that the regulations do not apply to leasing and development governed by 25 CFR 227 (Wind River Indian Reservation). Mineral leases may be governed by either of the remaining two acts, which are regulated by the attendant regulations. Selected provisions of the acts are detailed in Table 1-6.

Table 1-7. Provisions of Acts Governing Mineral Leases on Indian Lands.

Provision	1916 Act and 25 CFR 227	1982 IMDA and 25 CFR 225	1938 IDMA and 25 CFR 211, 212	1920 MLA, 30 USC 181-287
Lease Form	Standard BIA	Flexible with 20 point checklist	Standard DOI	Standard DOI
Royalty	Minimum 12.5% of value less that used for production.	No minimum set. Cost of production recognized by regulations.	Minimum 16 2/3%	5% primary acreage, 12 ½% Secondary Acreage (“preference right to lease for the remainder of the land in his prospecting permit”)
Rent	$1.25 per acre	Flexible	$2.00 per acre	$1.00 per acre
Lease term	20 years	Flexible	10 years	20 years
Aggregate per lease acreage	10,240	No maximum	640	246,080 other than Alaska, which is 300,000 each in northern and southern leasing districts
Inspection by Tribe or BIA	Developer required to allow	Developer required to allow	Developer required to allow	Inspection not addressed
Operations and financial	In accordance with DOI regulations. Diligence and prevention of waste specified.	Economic Assessment required prior to approval of agreement.	Diligence, protect lease from drainage, prevention of waste specified	Prevent waste and entrance of water into oil-bearing strata specified.

Source: Schumacher, 1994

The lease(s) on Tribal land analyzed in this EIS have been negotiated under the 1916, IMLA, and IMDA. Full text versions of the applicable regulations are available for review at http://www.access.gpo.gov/nara/cfr/.

The BIA encourages the Indian tribes and individuals to enter into mineral leases for the development of their trust lands with the goal of maximizing their best economic interest and minimizing any adverse environmental or cultural impacts for the development and sale of their resources. The leasing of tribal minerals is governed by the following objectives:

- Orderly and timely resource development
- Environmental protection
- Minimal cultural impacts associated with development.

These objectives are accomplished through proper planning and oversight of development operations by agencies of the Department of the Interior, including BIA, BLM, and Minerals Management Service (for collection of royalties). The principal objective of these agencies is to ensure that there are no detrimental effects from the development of mineral resources from Indian lands (Aguilar 1994). In addition, the United States, through legislation, court decisions, and executive orders, has established the scope of the federal trust on Indian lands. Government officials managing Indian assets are held to the highest responsibility and trust and the most exacting fiduciary standards to discharge their trust in good faith and fairness. As such, the BIA has the responsibility to act as trustee for the Indian tribes and individuals in the development and protection of Indian resources of all types.

1.6 ISSUE IDENTIFICATION AND ISSUE STATEMENTS

The BIA reviewed and analyzed the comments they received during the scoping process. Public response to the notices and meetings included 42 letters. In addition, numerous people attended one or both of the public scoping meetings held in Pavillion, Wyoming on October 22, 2002 and in Fort Washakie, Wyoming on October 23, 2002, respectively. Oral comments on the Proposed Action were received during the public meetings. Additional information on the public meetings is provided in Chapter 6 (Consultation and Coordination).

The process for identifying issues to be addressed in this EIS involved two steps. First, specific comments were arranged into groups of common concerns. Second, a primary issue statement was prepared for each group of comments. These issues were used to define the scope of this NEPA analysis. These key issues were used to analyze environmental effects, prescribe mitigation measures, or both. Other issues were raised, but were not included in the following list because they involved standard parts of a NEPA analysis (e.g., the analysis must consider an adequate range of alternatives, discussion of the roles of federal, state, and local agencies in authorizing and/or permitting the project, description of surface and mineral ownership and split estate lands). The thirteen key issues that comprised the overall scope of the NEPA analysis are:

Issue 1: The effects of the proposed development of gas resources on the extraction of other mineral resources and on geologic hazards present in the project area.

Comments expressed concerns about the effects the Proposed Action may have on the extraction of other minerals in the project area, such as aggregates. Areas prone to landslides and increased erosion need to be considered.

Issue 2: The effects of the proposed development of gas resources on soils in the project area.

Comments expressed concerns about the Proposed Action increasing the loss of topsoil through erosion (via water and wind). Other concerns include the Proposed Action's potential for increasing the compaction and contamination of soils, and adversely affecting its structure and fertility.

Issue 3a: The effects of the proposed development of gas resources on air quality within and near the WRPA (the near field).

Various public and agency comments expressed concerns about the effects of the proposed gas development on the area's air quality with respect to the National Ambient Air Quality Standards and PSD Class II increments from criteria pollutant emissions. These concerns included the cumulative impact from the Proposed Action plus other sources in the near-field region. Concerns were also expressed about the potential effects of hazardous air pollutants (HAP) from condensate tanks, flares, and gas processing equipment that may affect the health of humans at nearby residences, schools, and other sensitive receptors. A few comments requested a discussion of relevant permitting requirements at the federal and state level and applicable mitigation measures that may be required including BACT and monitoring. Concern was also expressed about venting of methane and other gasses and their potential effect to air quality.

Issue 3b: The effects of the proposed development of gas resources on air quality at Class I and sensitive Class II areas (the far field).

Public and agency comments expressed concern about the effects of the Proposed Action on Class I PSD increments and air quality related values (AQRV) - visibility and acid deposition - at distant Class I airsheds and wilderness areas in the region. Also, comments expressed concerns about the potential for lake acidification at sensitive alpine water bodies.

Issue 4: The effects of the proposed development of gas resources on surface water and groundwater in the project area.

Comments requested a discussion of water quality, water quantity, and sediment input impacts to Muddy Creek, Fivemile Creek, Ocean Lake and the drains that flow into it, Middle Depression Reservoir, Lake Cameahwait and tributaries, and Cottonwood Drain. Impacts identified for discussion related to surface disturbance (such as runoff from roads and well pads), spills of produced fluids and hazardous materials, and loss of containment from pits and tanks. Comments also expressed concerns about produced water and how it would be disposed of (surface discharge or injection). The comments also requested a presentation of baseline water quality for surface and groundwater in the project area. The source of water to be used to drill and develop the well development areas should also be presented. Comments expressed concerns about the effects on local aquifers of gas well completion, formation fracturing with chemicals, well operation, and injection of wastewater and other fluids into disposal wells.

Issue 5: The effects of the proposed development of gas resources on vegetation, riparian areas, and wetlands.

Comments requested a discussion of how project-related disturbance could increase the potential for the spread of noxious weeds and invasive plants, their potential to displace native plant communities, and their potential to increase fire hazards in the Project Area. A comment was also submitted calling for discussion of project-related impacts on riparian communities and wetlands.

Issue 6: The effects of the proposed development of gas resources on agricultural operations, rangeland resources, and general land use character in the WRPA.

Comments expressed concerns about potential conflicts between gas drilling and production activities with agricultural operations and grazing in the WRPA and mitigation measures that could address those impacts. In addition, comments requested a discussion of how the character of the lands in the WRPA may change due to the Proposed Action. Another comment expressed concerns about potential conflicts between the installation of gas pipelines related to the project and maintenance of local irrigation ditches.

Issue 7: The effects of the proposed development of gas resources on wildlife and wildlife habitat.

Comments expressed concerns that the proposed project would impact wildlife and their habitats. General groups of species for which they identified concerns include big game (mule deer and antelope), raptors, migratory birds, waterfowl, shorebirds, and the sage grouse, pheasant, and mountain plover specifically. The effects that were identified specifically included fragmentation of habitats, reduced patch size, elimination of migration pathways (primarily through the construction of roads, well pads, and fences), effects on herding patterns and migration, and reduced longevity of individuals. Within the WRPA, the use of Muddy Ridge by golden eagles and big game was highlighted. A request for a discussion of compliance with the Migratory Bird Treaty Act was included in the comments. Potential impacts to the Sand Mesa Wildlife Habitat Unit should also be discussed. Finally, a comment requested a discussion of the potential use of herbicides by the project to control weeds and how that herbicide use could impact terrestrial habitat and wildlife species.

Issue 8: The effects of the proposed development of gas resources on fisheries and aquatic habitats.

Comments requested a discussion of potential impacts of the project on aquatic species and habitats in Muddy Creek, Fivemile Creek, Ocean Lake and drains that discharge to it, Middle Depression Reservoir, Lake Cameahwait and its tributaries, and Cottonwood Drain. In addition, a comment requested that a discussion of the potential use of herbicides by the project to control weeds and how that herbicide use could impact aquatic habitat and species.

Issue 9: The effects of the proposed development of gas resources on special-concern species, including threatened, endangered, candidate, or sensitive species of plants and animals.

Comments requested a discussion of potential impacts to special-concern species, including species of plants and animals listed as threatened or endangered, proposed for or identified as candidates for listing as threatened or endangered, or identified as sensitive by the State of Wyoming. Some respondents noted the need for the analysis to comply with Section 7 of the Endangered Species Act (ESA) and disclose the results of Section 7 Consultation in the EIS.

Issue 10: The effects of the proposed development of gas resources on recreational opportunities and the recreational experience.

Respondents expressed concerns about the degree to which the proposed project would alter the existing recreational setting and experience at Boysen State Park, Ocean Lake, and the Sand Mesa Wildlife Habitat Unit for activities such as hunting, fishing, camping, bird watching and boating. Numerous visitors to Boysen State Park ride Off-Road Vehicles within and adjacent to the park and concerns were expressed about potential conflicts and safety hazards associated with project-related truck and vehicle traffic.

Issue 11: The effects of the proposed development of gas resources on the local economy.

Comments requested an analysis of the effects the proposed project would have on the local economy in terms of new employment, taxes, and royalties that would be generated.

Some comments expressed concerns about potential impacts to the rural lifestyle of the WRPA residents, while others were concerned about the effects of the proposed project on private property values on split-estate lands. A few comments requested a discussion of mitigation measures that would address these potentially adverse impacts. Finally, a comment was presented expressing concern about how reduction of agricultural acreage could adversely impact the revenue stream of the Midvale Irrigation District and its ratepayers.

Issue 12: The analysis of the proposed development of gas resources on traffic and transportation in the project area and neighboring communities.

Comments were provided that expressed concerns about the potential for project-related traffic on local roads to increase road and bridge damage and maintenance costs to the county and how those costs would be recovered. In addition comments were submitted expressing concerns about project-related traffic and potential increases in dust emissions, noise, and safety hazards. Another comment requested that the EIS include specific information on the number and sizes of vehicles that would be utilized by the project, their travel frequency, the number of trips anticipated, and the roads that would be used to access the project area. In addition, the comment requested that the EIS address the feasibility of adopting alternative travel routes and discuss traffic impacts expected in Pavillion, specifically. Finally, a comment requested that the EIS include an identification of roads that would be closed and reclaimed versus left open after completion of the project.

Issue 13: The EIS should adequately address the cumulative impacts of the Proposed Action plus other oil and gas development projects in the region.

Comments were provided that requested that cumulative impacts be addressed in the EIS for the proposed project plus other oil and gas exploration and production projects in the region. Other projects identified that could be part of the cumulative impacts assessment included the Jonah II, Continental Divide/Wamsutter II, Pinedale Anticline, South Baggs, and Atlantic Rim CBM projects. A map identifying all other oil and gas projects in the cumulative impacts assessment area was also suggested. Since the proposed project would have varying levels of geographic impacts depending on the resources in question (i.e. air quality impacts could affect a large geographic area, whereas soils and erosion impacts may be limited to the footprints of project facilities), comments suggested that each resource section should identify the cumulative impacts area specific to it (airshed, watershed, habitat ranges, etc). Finally, a comment suggested that the cumulative impacts assessment include reasonably foreseeable projects in the region.

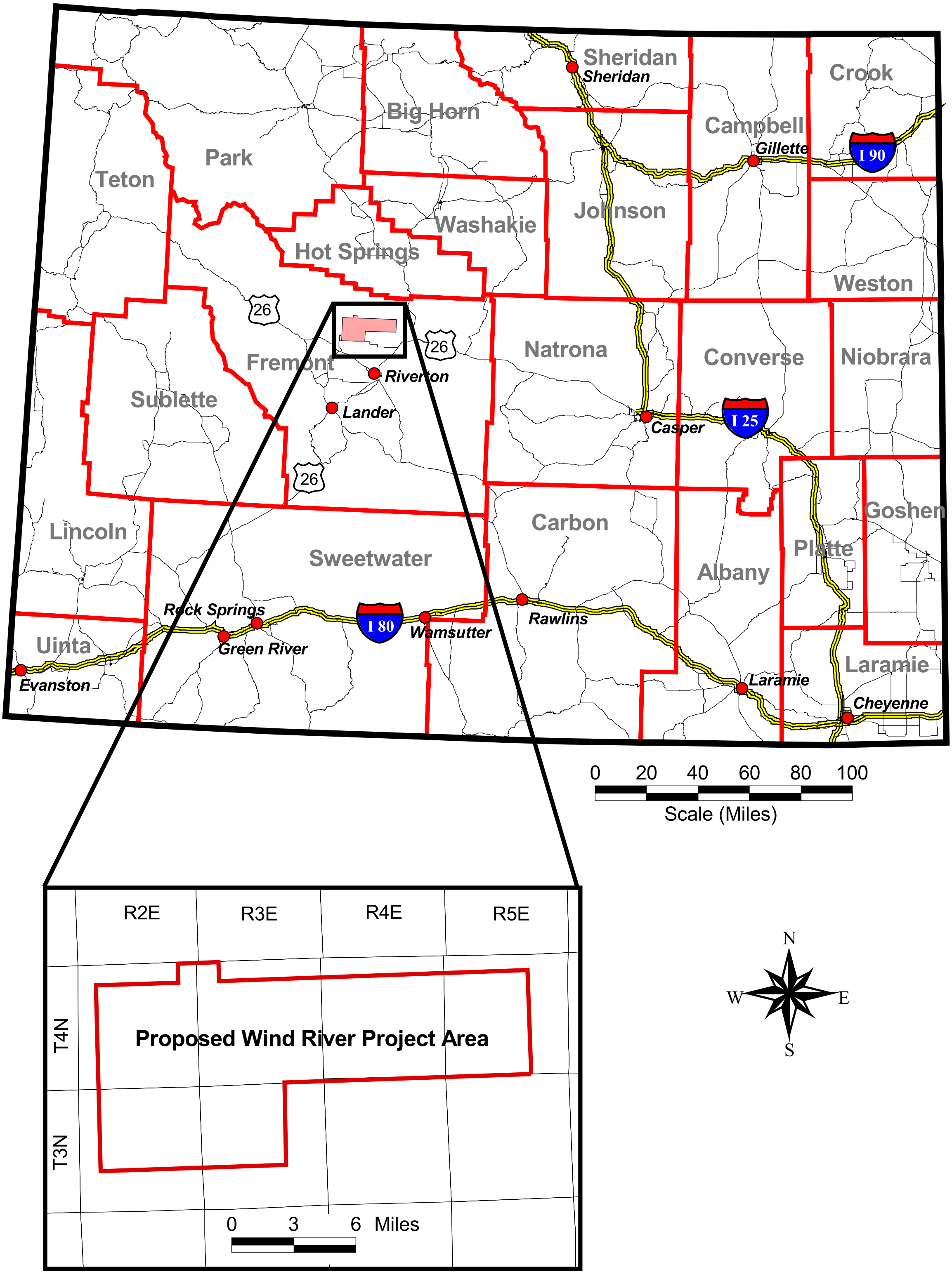

Figure 1-1. Location of Wind River Gas Development Project Area in Central Wyoming.

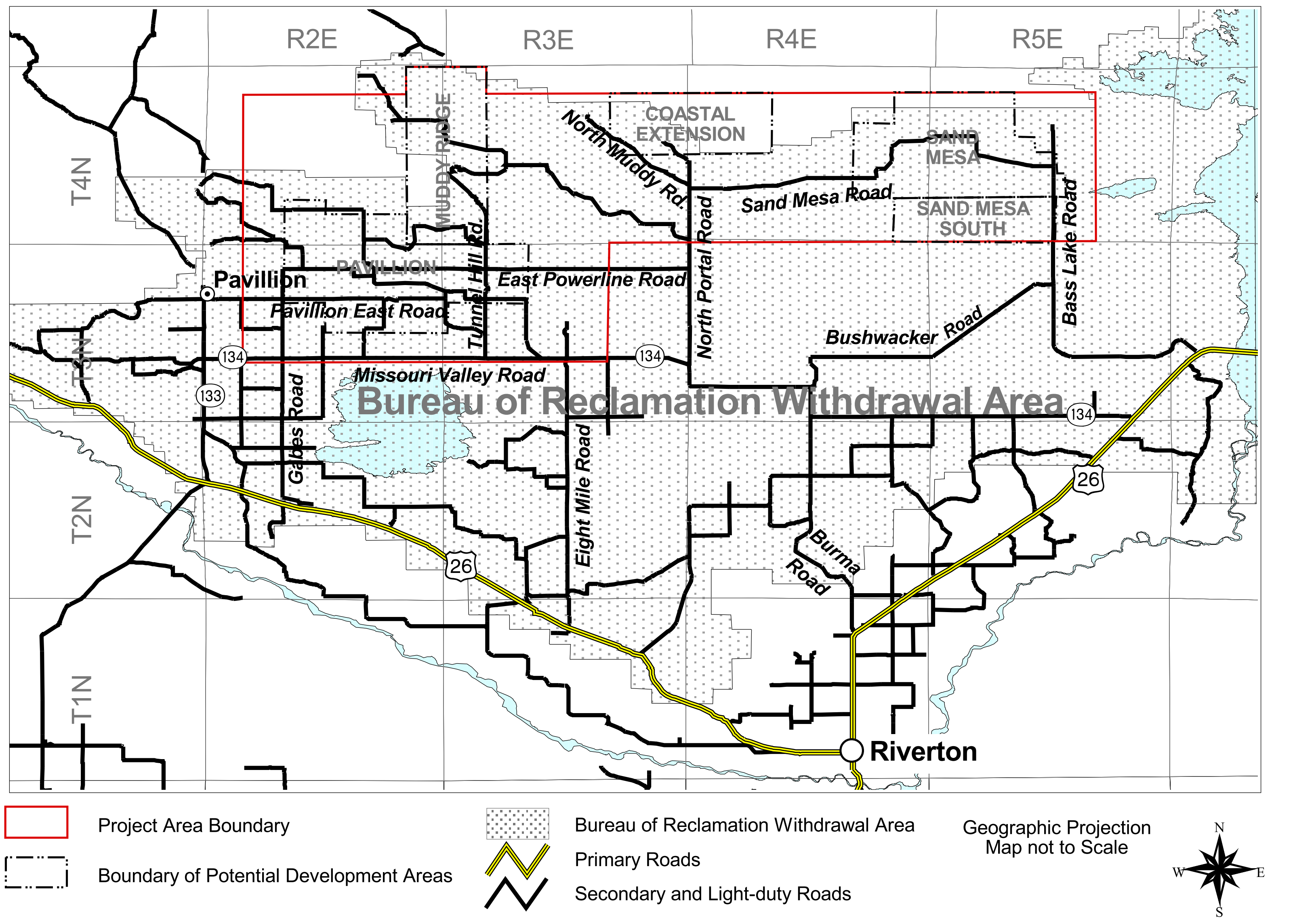

Figure 1-2. Road Access to the Wind River Project Area.

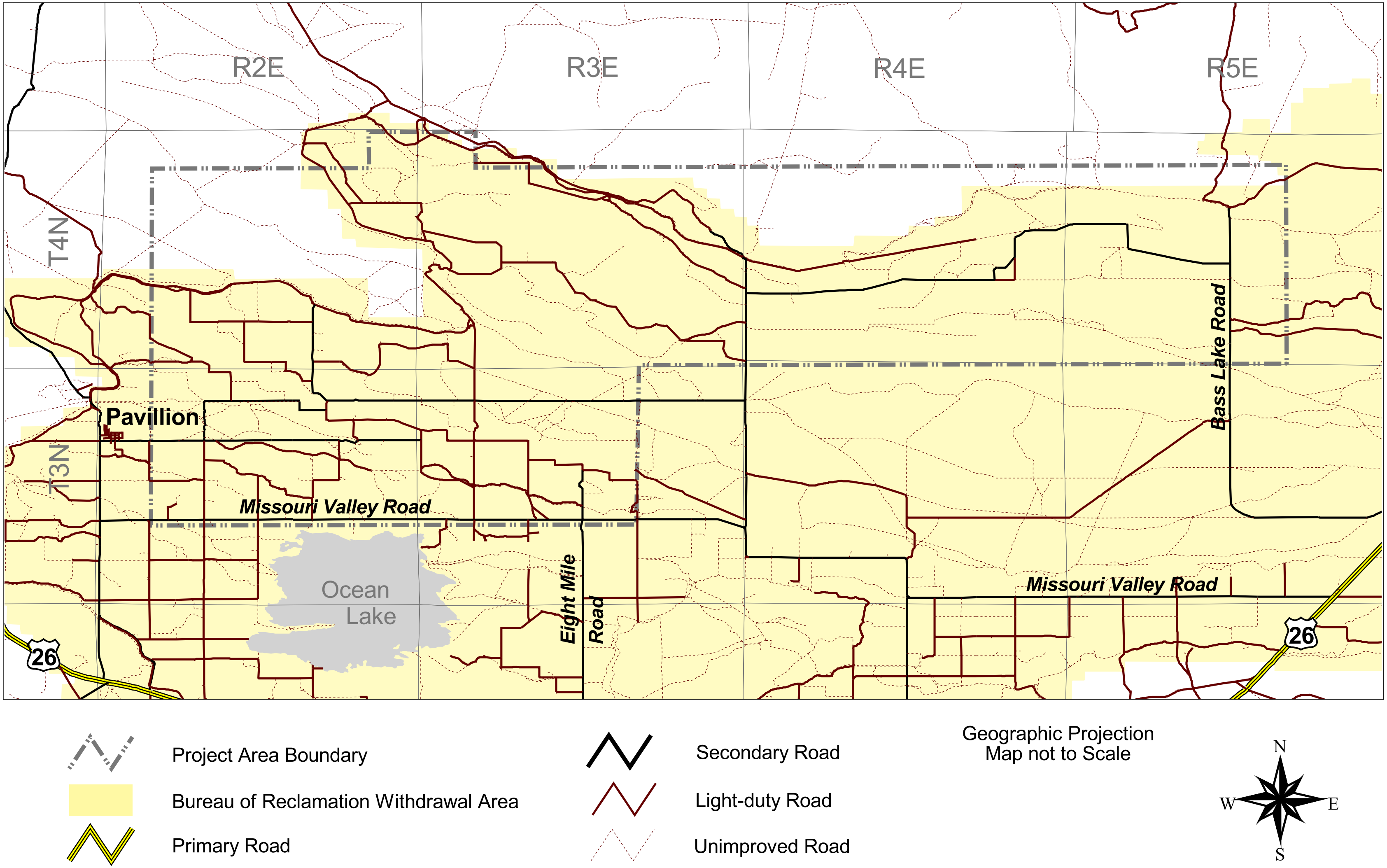

Figure 1-3. Existing Secondary, Light-duty and Unimproved Roads within the Wind River Project Area.

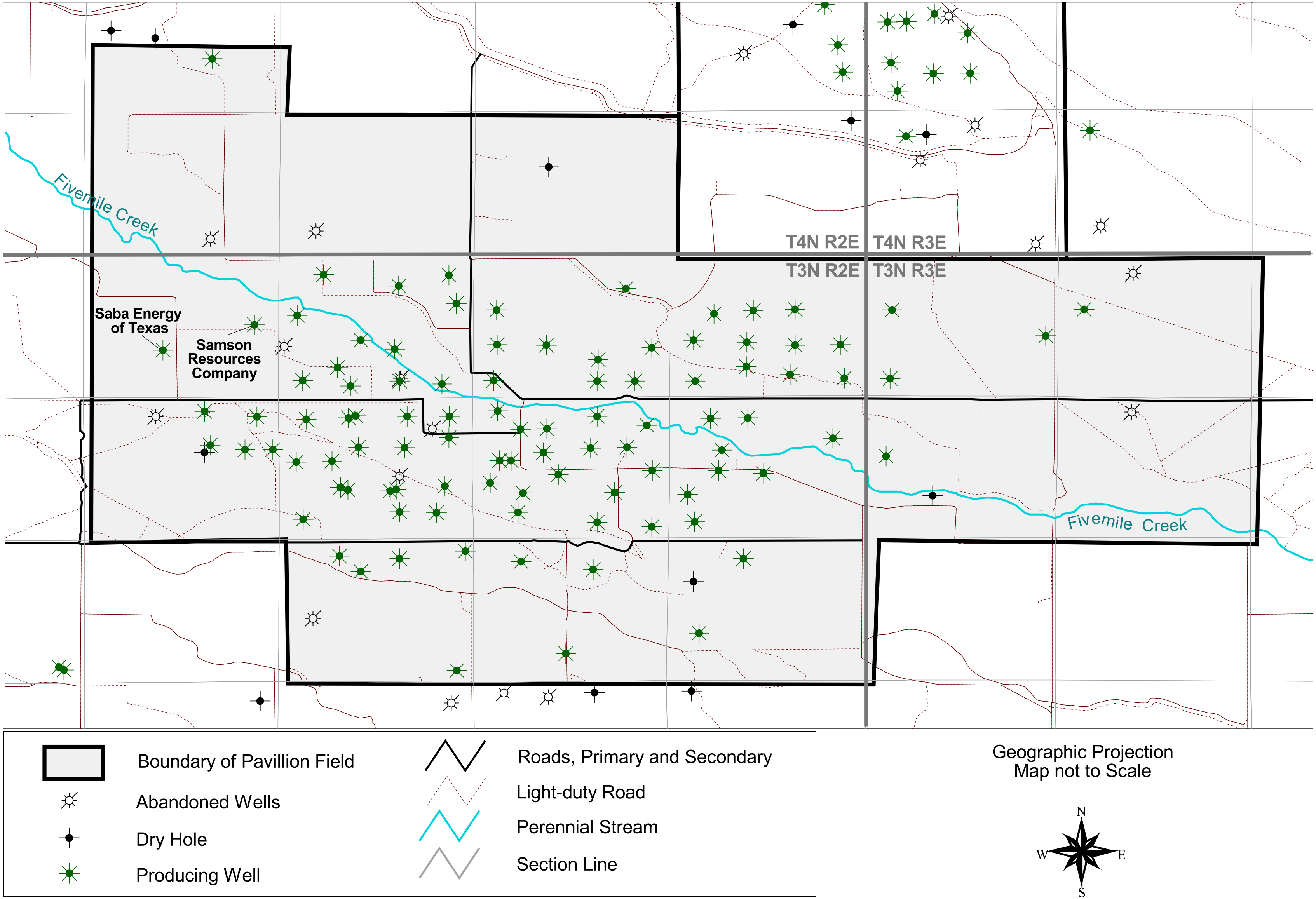

Figure 1-4. Producing, Abandoned and Dry Gas Wells in the Pavillion Field, WRPA.

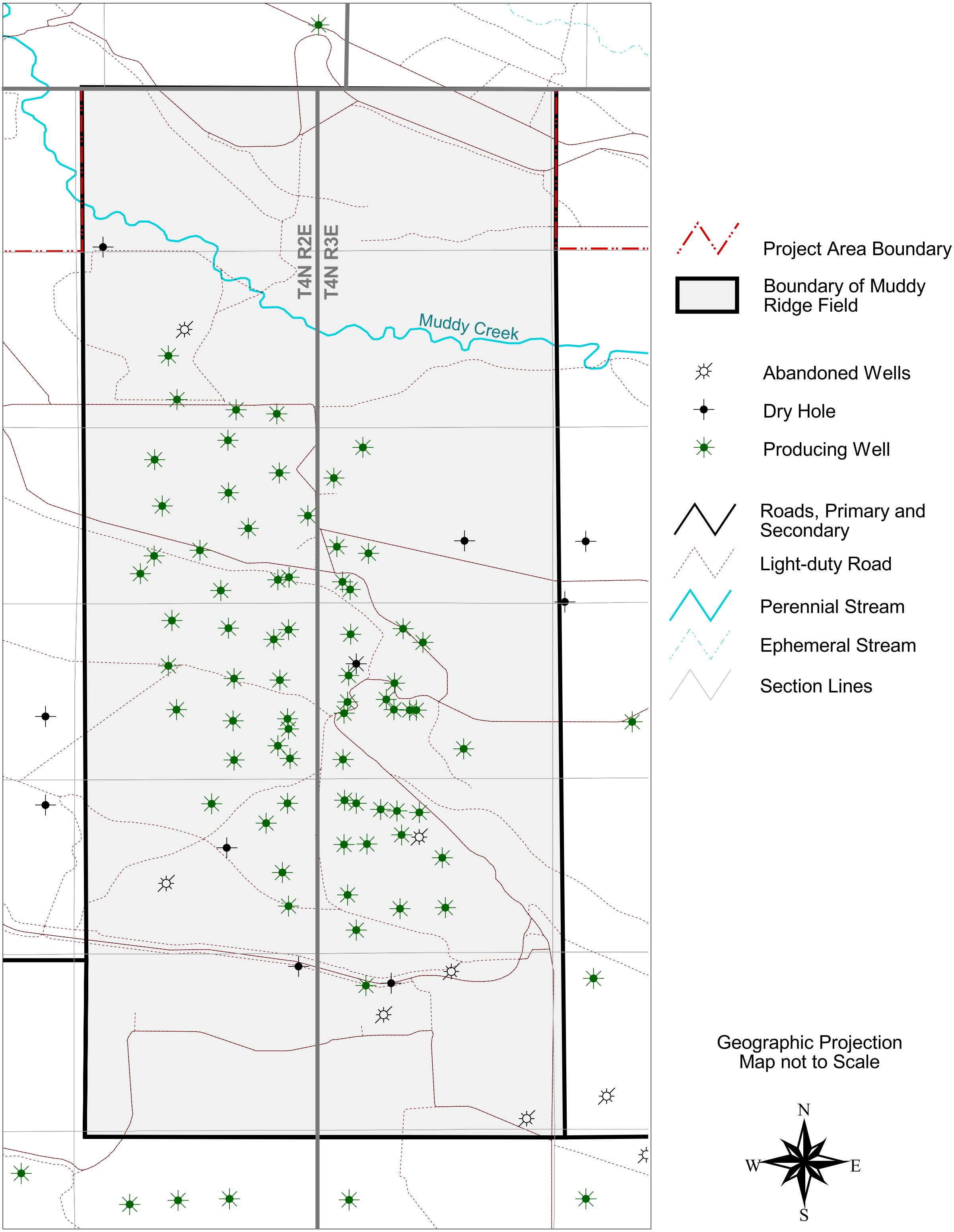

Figure 1-5. Producing, Abandoned and Dry Gas Wells in the Muddy Ridge, WRPA.

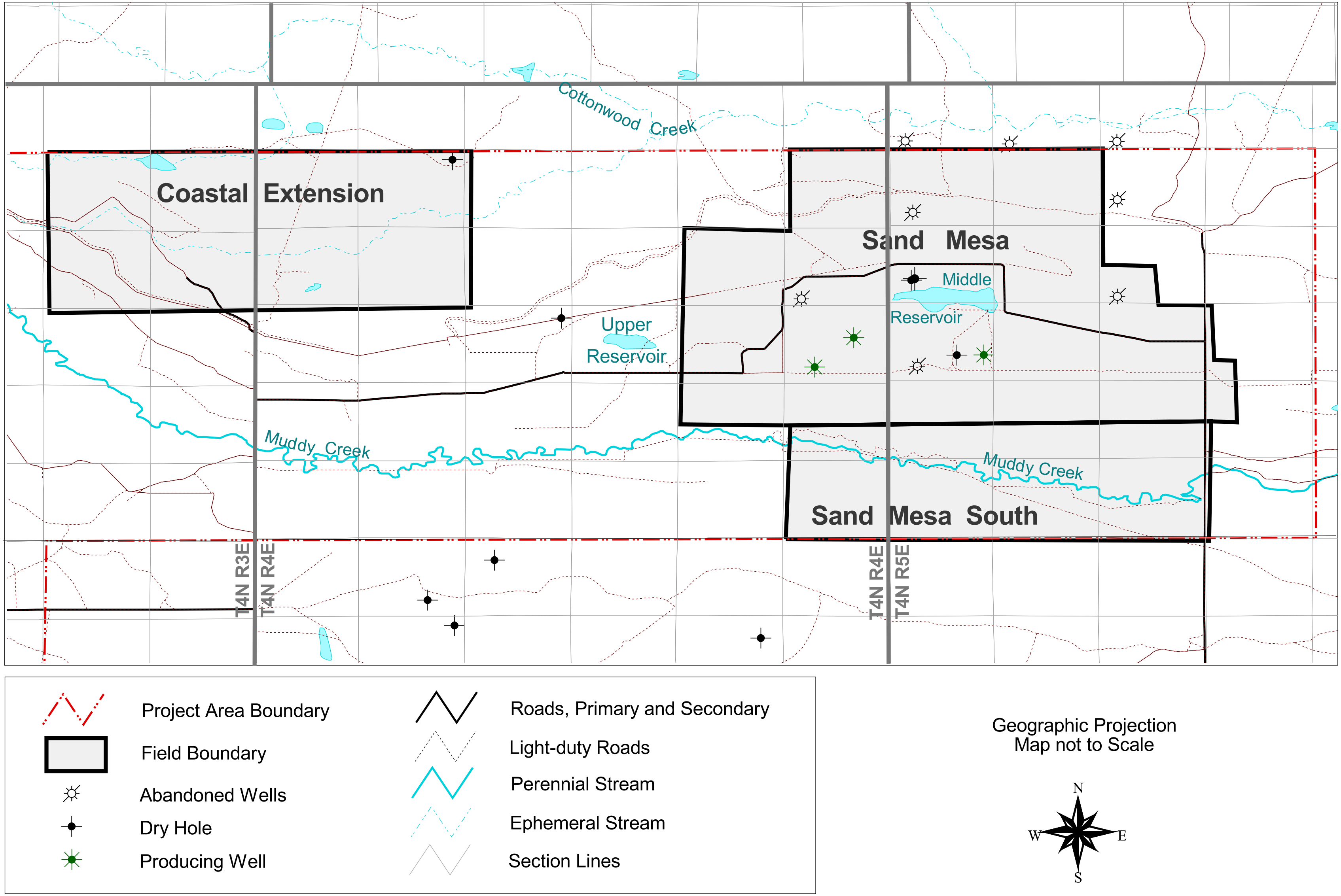

Figure 1-6. Producing, Abandoned and Dry Gas Wells in the Coastal Extension, Sand Mesa, and Sand Mesa South Fields, WRPA.

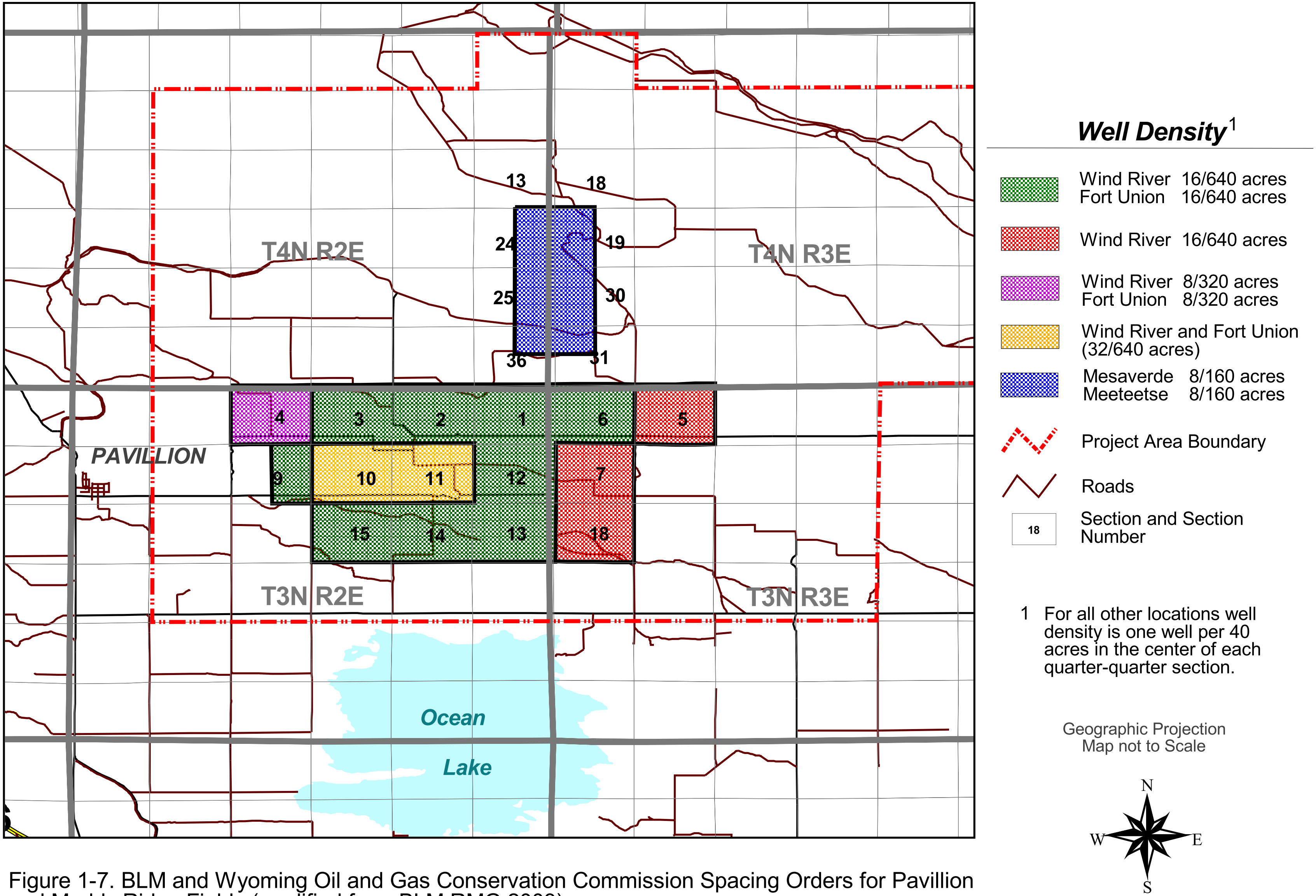

Figure 1-7. BLM and Wyoming Oil and Gas Conservation Commission Spacing Orders for Pavillion and Muddy Ridge Fields (modified from BLM RMG 2003)

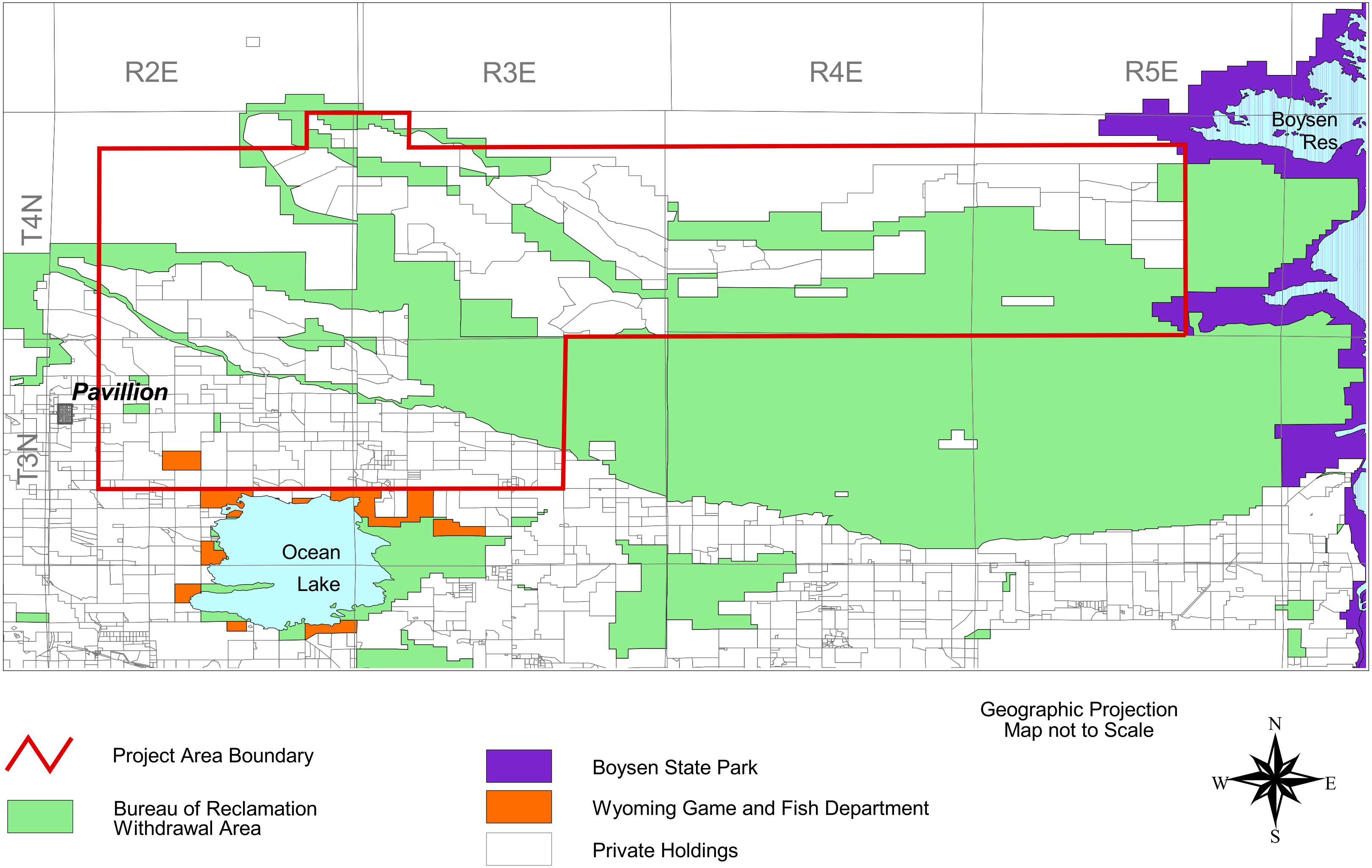

Figure 1-8. Surface Ownership within the Wind River Project Area.

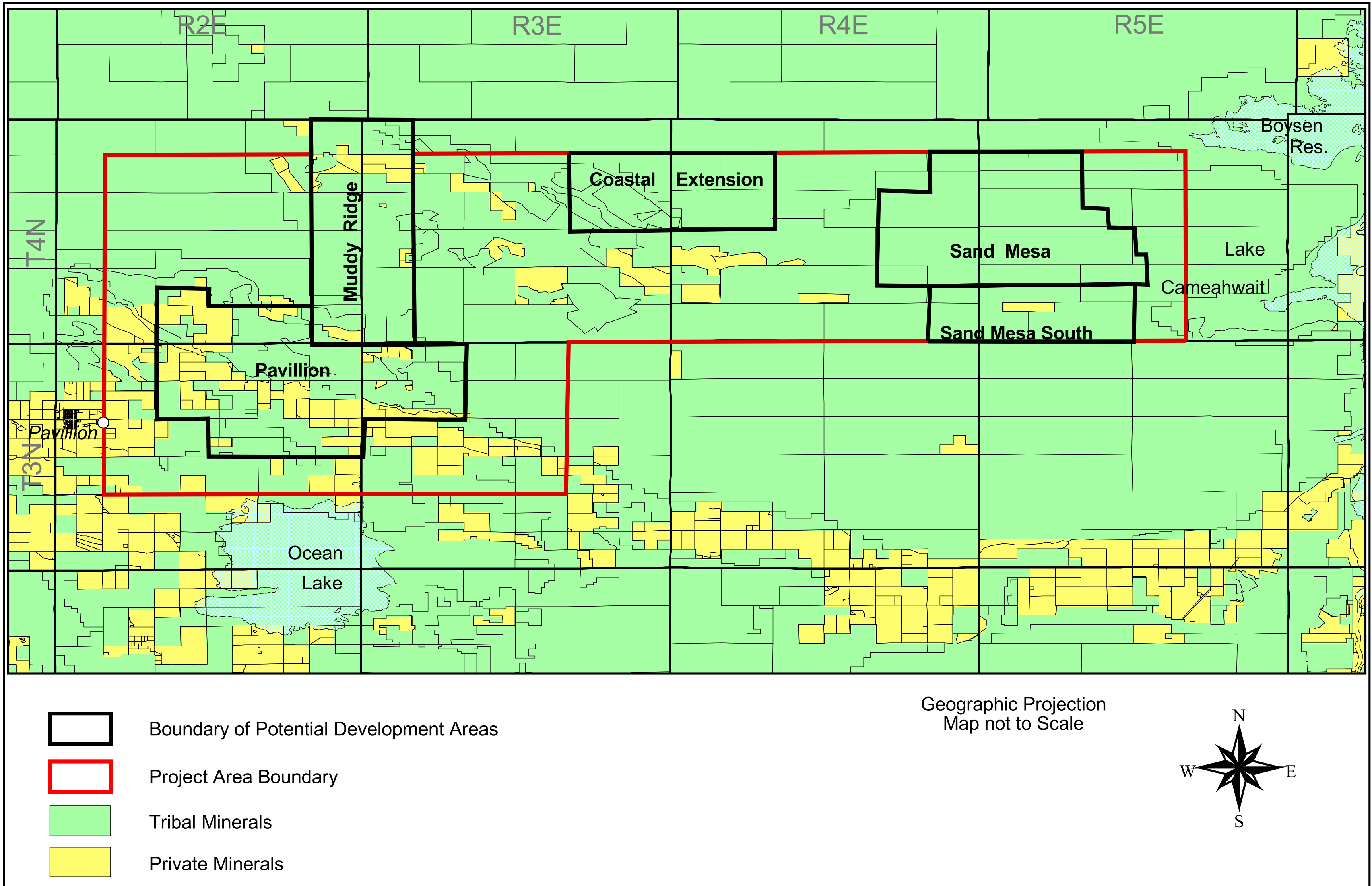

Figure 1-9. Mineral Ownership within the Wind River Project Area.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 SUMMARY

The Wind River Project Area (WRPA) currently contains 178 active producing wells, with accompanying production related facilities, roads, and pipelines. Within the WRPA, total gas compression and treatment capacity is approximately 14,600 horsepower (hp) and the residual disturbance for the existing wells and facilities is approximately 410.5 acres, or 0.45 percent of the approximately 92,000 acres comprising the WPRA.

The Operators have proposed to drill approximately 325 wells at up to 325 well locations in addition to the 178 producing wells in the WRPA. Some of these wells would be classified as exploration/delineation wells because natural gas production potential has not been totally defined due to geological complexities. Other wells, where production potential is better known, would be classified as in-fill or development wells. The precise number and location of the additional wells, and the timing of the drilling and development activities, would be determined by the success of development drilling, production technology, and economic considerations including development costs for leases with marginal profitability. Well density would range from 16 to 32 wells per 640-acre section, based on the BLM and WOGCC spacing orders (see Table 1-2 and Figure 1-7). Development would be phased in time and would not be uniformly spaced throughout the WRPA. The Operators anticipate that future development in the WRPA would be concentrated primarily within or near the existing Pavillion, Muddy Ridge, and Sand Mesa fields. However, some exploration and development is planned for the Coastal Extension and Sand Mesa South areas, which currently have no producing wells.

Based on the planning information provided by the Operators and alternatives identified through the scoping process, this EIS addresses the Operators' Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action). The alternative selection process is discussed in the following section.

2.2 ALTERNATIVE SELECTION PROCESS

2.2.1 Proposed Action

The Proposed Action involves drilling 325 natural gas wells at up to 325 well locations. Wells may be directionally drilled under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) areas where drilling would result in a high potential for impact (e.g., “take”) to threatened, endangered and state-sensitive species and relocation of the well would not be feasible, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling).

The forecasted success rate for the Proposed Action is 81 percent (i.e., 263 producing wells), which was determined by summarizing development plans projected by the Operators over the next twenty-year planning period. Development estimates were based on reasonably foreseeable drilling projections for areas within the WRPA where the planned activities would occur. Table 2-1 shows the potential success rates for each of the development areas within the WRPA under the Proposed Action. The Proposed Action is in addition to the existing 178 producing wells. Additional natural gas compression and treatment capacity required for the Proposed Action is estimated at 32,800 hp. Some of the additional compression capacity would be located outside of the WRPA.

Table 2-1. Potential Success Rates for the Natural Gas Development Areas within the WRPA.

PROPOSED ACTION.

FIELD	NUMBER OF WELLS	POTENTIAL SUCCESS RATE (%)	NUMBER OF PRODUCING WELLS
Pavillion	155	100	155
Muddy Ridge	50	100	50
Sand Mesa	100	50	50
Sand Mesa South	12	50	6
Coastal Extension	8	20	2
TOTALS	**325**	**81%**	**263**

ALTERNATIVE A.

FIELD	NUMBER OF WELLS	POTENTIAL SUCCESS RATE (%)	NUMBER OF PRODUCING WELLS
Pavillion	206	100	206
Muddy Ridge	66	100	66
Sand Mesa	133	50	67
Sand Mesa South	48	50	24
Coastal Extension	32	20	6
TOTALS	**485**	**76%**	**369**

ALTERNATIVE B.

FIELD	NUMBER OF WELLS	POTENTIAL SUCCESS RATE (%)	NUMBER OF PRODUCING WELLS
Pavillion	96	100	96
Muddy Ridge	40	100	40
Sand Mesa	80	50	40
Sand Mesa South	10	50	5
Coastal Extension	7	20	1
TOTALS	**233**	**78%**	**182**

ALTERNATIVE C.

FIELD	NUMBER OF WELLS	POTENTIAL SUCCESS RATE (%)	NUMBER OF PRODUCING WELLS
Pavillion	100	100	100
Muddy Ridge	0		0
Sand Mesa	0		0
Sand Mesa South	0		0
Coastal Extension	0		0
TOTALS	**100**	**100%**	**100**

During the construction phase, the Proposed Action would disturb 1982.0 acres or 2.15 percent of the WRPA. Disturbance areas within the WRPA would be reduced following reclamation of pipeline ROWs and portions of the well pads not required for production operations. Under the Proposed Action, reclamation would reduce surface disturbance to 422.7 acres or 0.46 percent of the WRPA.

2.2.2 Alternatives to the Proposed Action

Alternatives to the Proposed Action, as determined from the scoping process and BIA management concerns, include Alternative A, Alternative B, and the No Action Alternative (Alternative C). The alternatives to the Proposed Action are summarized as follows:

- **Alternative A - Increase the Number of New Wells Drilled in the WRPA to 485.** Alternative A would consist of an increased number and density of wells to 485 wells at up to 485 locations. Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) high potential for environmental impact (e.g., "take") to threatened, endangered, and state-sensitive species, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). An overall success rate of 76 percent (i.e., 369 new wells) is assumed (Table 2-1). Section 2.4 in this chapter provides a detailed description of Alternative A. During the construction phase, Alternative A would disturb up to 2818.7 acres or 3.06 percent of the WRPA. With implementation of reclamation under Alternative A, disturbance would be reduced to 611.9 acres, or about 0.67 percent of the WRPA (Table 2-2).

- **Alternative B – Decrease the Number of New Wells Drilled in the WRPA to 233.** Alternative B would consist of a decreased number and density of new wells to 233 wells at up to 233 locations. Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) high potential for environmental impact (e.g., "take") to threatened, endangered, and state-sensitive species, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). Section 2.5 of this EIS provides a detailed description of Alternative B. Assuming a success rate of 78 percent, the Operators anticipate that 182 of the 233 wells will be producing gas wells (Table 2-1). During the construction phase, Alternative B would result in surface disturbance of 1609.6 acres or 1.75 percent of the WRPA. With implementation of reclamation under Alternative B, impacts would be reduced to 325.1 acres, or about 0.35 percent of the WRPA (Table 2-2).

- **Alternative C - No Action.** This alternative would allow Applications for Permit to Drill (APDs) and rights-of-way on private lands within WRPA. Additional wells would be developed as needed to prevent drainage of tribal minerals. Under the No Action Alternative, a total of 100 new gas wells at 100 locations may be developed in the Pavillion field. Assuming a success rate of 100 percent, there would be 100 producing wells (Table 2-1). Section 2.6 provides a detailed description of Alternative C. With implementation of Alternative C, approximately 316.6acres of surface disturbance would result, or 0.34 percent of the WRPA. After reclamation, total disturbance would be reduced to 79.3 acres or 0.09 percent of the WRPA (Table 2-2).

Table 2-2. WRPA Disturbance Summary for Existing Production, the Proposed Action, and Alternatives A, B, and C[1].

Disturbance Type	Existing	Proposed Action		Alternative A		Alternative B		Alternative C (No Action)	
		New	LOP[2]	New	LOP	New	LOP	New	LOP
Well Pads (acres)	207.5	1164.1	263.3	1813.3	382.8	880	206.7	200.9	36.5
Roads (acres)	180.1	183.8	122.5	278.3	175.4	137.9	95.4	41.9	23.1
Pipelines (acres)	0	597.2	0	673.6	0	568.7	0	54.1	0
Ancillary Facilities[3]	22.9	36.9	36.9	53.5	53.5	23	23	19.7	19.7
Total disturbance (acres)	410.5	1982	422.7	2818.7	611.9	1609.6	325.1	316.6	79.3
Percent of WRPA	0.45	2.15	0.46	3.06	0.67	1.75	0.35	0.34	0.09
Gas Compression, Gas Treatment, and Electrical Generation (hp)	14,600	32,800		46,000		22,700		3,200	

[1] See Appendix C for detailed calculations.
[2] Life of Project (LOP)
[3] Ancillary facilities include production facilities in Pavillion irrigated fields; Pavillion Booster Station; and compressor stations.

The Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action) are discussed in detail in the following sections.

2.3 PROPOSED ACTION - 325 NEW GAS WELLS

The Operators (Tom Brown, Inc., Samson Resources Company, and Saba Energy of Texas) have indicated that 325 wells may be drilled at up to 325 well locations. Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) high potential for environmental impact (e.g., “take”) to threatened, endangered, and state-sensitive species, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). In the Pavillion field, it would not be mechanically feasible to directionally drill two wells from the same pad in the shallow Wind River and Fort Union formations, while achieving the maximum recovery of the resource, required by statutes and regulations (see Chapter 1). The feasibility of directional drilling at the exploratory Sand Mesa South and Coastal Extension fields has not yet been determined.

The forecasted success rate for the Proposed Action is estimated to be 81 percent (i.e., 263 producing wells). This is in addition to 178 producing wells in the WRPA. The total number of wells and the timing of drilling operations are difficult to predict, due to the limited amount of natural gas exploration in the Sand Mesa, Sand Mesa South, and Coastal Extension fields, and the geological complexities in the WRPA.

Development in the WRPA would begin in late 2004 [subsequent to the publication of the Record of Decision (ROD)] and continue for approximately 20 years, with a life-of-project (LOP) of 20-40 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, and compressor stations) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from the Proposed Action would be 1982.0 acres (approximately 2.15 percent of the WRPA). A maximum of 1164.1 acres of new surface disturbance would be from well pads and facilities, including on-site gathering, measurement, and dehydration facilities; 49 miles (183.8 acres) of surface disturbance from new roads or upgrades of existing roads; 140 miles (597.2 acres) of surface disturbance from new pipelines; and approximately 36.9 acres of new surface disturbance from ancillary facilities including disposal wells, treatment/separation facilities and five new compressor stations with a total capacity of 32,800 hp. New pipelines would be placed, where possible, adjacent to access roads. In addition, pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use, unless otherwise specified by the landowner. While the short-term disturbance is a small percent of the total WRPA, these changes would be concentrated within the five development areas, increasing the percent of disturbed lands in those areas. Table 2-3 shows the percent of disturbance within each field and the total disturbance in the five development areas.

Table 2-3. Surface Disturbance within each Field for the Proposed Action and Alternatives.

Field	Proposed Action		Alternative A		Alternative B		No Action[1]	
	Initial (ac)	Residual (ac)	Initial (ac)	Residual (ac)	Initial (ac)	Residual (ac)	Initial (ac)	Residual (ac)
Pavillion (11,774 ac)	472.1 4.01%	159.4 1.35%	619.8 5.26%	215.5 1.83%	307.2 2.61%	113.7 0.97%	316.6 2.69%	79.3 0.67%
Muddy Ridge (7,550 ac)	411.2 5.45%	119.4 1.58%	506.8 6.71%	158.4 2.10%	352.8 4.67%	96.3 1.28%	0	0
Sand Mesa (9,572 ac)	764.9 7.99%	121.5 1.27%	974.4 10.18%	159.6 1.67%	635.9 6.64%	96.4 1.01%	0	0
Sand Mesa South (3,820 ac)	173.0 4.53%	16.7 0.44%	402.6 10.54%	59.4 1.56%	159.4 4.17%	13.5 0.35%	0	0
Coastal Extension (5,220 ac)	160.7 3.08%	5.7 0.11%	315.0 6.03%	18.7 0.36%	154.4 2.96%	5.2 0.10	0	0
TOTAL (37,936 ac)	**1982.0 5.23%**	**422.7 1.11%**	**2818.7 7.43%**	**611.9 1.61%**	**1609.6 4.24%**	**325.1 0.86%**	**316.6[1] 2.69%**	**79.3[1] 0.67%**

[1]Drilling in Pavillion field only.

Although a total of 1982.0 acres of short-term disturbance would result from the Proposed Action, a much smaller area would be disturbed at any one time, since development will be phased (i.e., a specific number of wells would be drilled annually in each of the five development areas). The number of wells to be drilled annually under the Proposed Action is shown in Table 2-4.

Table 2-4. Number of Wells to be Drilled Annually under the Proposed Action.

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	11	12	8		
2005	12	12	8		
2006	13	12	8	3	1
2007	12	12	8	3	1
2008	13	2	8	3	1
2009	17		8	3	1
2010	17		8		1
2011	18		8		1
2012	15		8		1
2013	17		8		1
2014	10		8		
2015			8		
2016			4		
TOTAL	**155**	**50**	**100**	**12**	**8**

Reclamation of the disturbed land would begin as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program, and well pads of dry holes would be plugged and abandoned and reclaimed. Wells reaching ultimate recovery would be plugged and abandoned when production ceased. Thus, as new wells are drilled other areas are being reclaimed.

During the LOP total surface disturbance would be reduced to 422.7 acres, assuming an 81 percent success rate, [263.3 acres associated with 263 wells, 122.5 acres of roads, and 36.9 acres of surface disturbance associated with ancillary facilities] or approximately 0.46 percent of the WRPA. While the short-term disturbance is a relatively small percentage of the total WRPA, these changes would be concentrated within the five development areas, increasing the percent of disturbed lands in those areas (see Table 2-3). Detailed disturbance calculations for the Proposed Action are available in Appendix C.

Voluntary mitigation actions have been implemented by the Operators in the existing development areas, and would be undertaken in the Proposed Action to further reduce short-term and long-term impacts. The types of mitigation actions that would be taken by the Operators, as appropriate, are listed below.

- On agricultural land in the Pavillion field, wells would only drilled in the winter months (November to April) to minimize the impact on the irrigated fields.

- On agricultural land in the Pavillion field, only the wellhead would be located in the crop field. The wellhead in agricultural areas would be reduced to 8x8 feet after construction and drilling have been completed.

- Production facilities would be centralized on dry ground or the edge of agricultural areas adjacent to the roads.

- Fill material, purchased from the landowner, would be used to pad the irrigated field during drilling operations to protect the crops and would be removed before the spring thaw.

- The Operators would accommodate the landowners, as much as possible, in the location of the well pads, while maintaining well spacing required in the spacing orders.
- Existing rights-of-way would be used for pipeline construction, where possible.
- Reserve pit spoil material would be relocated as soon as drilling is completed.
- Private water wells would be tested for the presence of contaminants before and after drilling operations, when requested by the landowner.
- Unpaved access roads would be watered on a frequent basis to minimize the release of dust into the air.
- Minor sources of air pollution would meet Best Available Control Technology (BACT) standards.
- The size of the reserve pit would be reduced in agricultural areas to minimize environmental impact.
- No drilling would occur within 500 feet of waterbodies (e.g., Muddy and Fivemile Creeks).
- New wells would be drilled on existing well pads, where possible.
- Speed limits would be reduced within the WRPA to reduce dust generation and noise levels.

Specific components of the Wind River Natural Gas Field Development program are discussed in Section 2.7. The components would be the same for each of the alternatives. Additional site-specific proposal and resource information would be contained in the individual well APDs and ROW applications submitted to the BIA and BLM.

2.4 ALTERNATIVE A - DRILL 485 NEW GAS WELLS

The demand for natural gas is projected to increase during the life of the proposed development project. If increases in gas prices occur, those areas in the WRPA that are currently considered marginal for exploration and development, from an economic standpoint, may become economically feasible to develop in the future. Implementation of this alternative could maximize revenues to the Tribes in both magnitude and duration.

In order to accomplish this objective, the Operators have indicated that approximately 485 wells at up to 485 well locations may be drilled. The forecasted success rate is estimated to be 76 percent (369 producing wells). This is in addition to 178 producing wells in the WRPA. Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) areas with high potential for environmental impact (e.g., “take”) to threatened, endangered, and state-sensitive species, and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). In the Pavillion field, it would not be mechanically feasible to directionally drill two wells from the same pad in the shallow Wind River and Fort Union formations, while achieving the maximum recovery of the resource required by statutes and regulations (see Section 2.9.2 for a discussion of directional drilling in the WRPA). The feasibility of directional drilling at the exploratory Sand Mesa South and Coastal Extension fields has not yet been determined.

Development would begin within the WRPA in late 2004 [subsequent to the publication of the Record of Decision (ROD)] and continue for approximately 20 years, with a life-of-project (LOP) greater than 40 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, compressor stations, and gas processing facilities) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from the Alternative A would be 2818.7 acres (approximately 3.06 percent of the WRPA). A maximum of 1813.3 acres of new surface disturbance would be from well locations (including on-site gathering, measurement, and dehydration facilities); 73 miles (278.3 acres) of new surface disturbance would be from new roads or upgrades of existing roads; 171 miles (673.6 acres) of surface disturbance would be from new pipelines; and approximately 53.5 acres of new surface disturbance would be from ancillary facilities, including disposal wells, treatment/separation plants, and five new compressor stations with a total capacity of 46,000hp. New pipelines would be placed, where possible, adjacent to access roads. In addition, pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use, unless otherwise specified by the landowner. While the short-term disturbance is a relatively small percentage of the total WRPA, these changes would be concentrated within the five development areas, intensifying the percentage of disturbed lands in those areas (see Table 2-3).

Although, a total of 2818.6 acres of short-term surface disturbance would result from Alternative A, a much smaller area would be disturbed at any one time, since development would be phased (i.e., a specific number of wells would be drilled annually in each of the five development areas). Table 2-5 shows the number of wells that would be drilled annually under Alternative A.

Table 2-5. The Number of Wells to be Drilled Annually under Alternative A.

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	14	12	8		
2005	14	12	8		
2006	14	12	8	3	2
2007	14	12	8	3	2
2008	14	12	8	3	2
2009	14	6	8	3	2
2010	14		8	3	2
2011	14		8	3	2
2012	14		8	3	2
2013	14		8	3	2
2014	14		8	3	2
2015	14		8	3	2
2016	14		8	3	2
2017	14		8	3	2
2018	10		8	3	2
2019			8	3	2
2020			5	3	2
2021				3	2
TOTAL	**206**	**66**	**133**	**48**	**32**

Reclamation of the disturbed land would occur as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program and well pads of dry holes would be plugged and abandoned and reclaimed. Wells reaching ultimate recovery would be plugged and abandoned when production ceased. Thus, as new wells are drilled, other areas are being reclaimed.

Total residual disturbance would be 611.6 acres [382.8 acres associated with 369 wells (this assumes a 76 percent drilling success rate), 175.4 acres of roads, and 53.5 acres of surface disturbance associated with ancillary facilities] or approximately 0.67 percent of the WRPA. Detailed disturbance calculations for Alternative A are available in Appendix C.

Voluntary mitigation has been implemented by the Operators in the existing development areas, and would be undertaken by the Operators under Alternative A to further reduce short-term and long-term impacts. The types of mitigation actions that would be taken by the Operators are discussed in Section 2.3, under the Proposed Action.

As with the Proposed Action, additional site-specific proposal and resource information would be contained in the individual well APDs and ROW applications when submitted to the BIA and BLM.

2.5 ALTERNATIVE B – 233 NEW GAS WELLS AT 233 LOCATIONS

Several respondents to the scoping notice expressed concern about potential environmental impacts resulting from the Proposed Action. Alternative B was developed in part to address those environmental concerns, including impacts on air quality, water quality, wildlife, threatened and endangered species, wetlands, and Wildlife Habitat Management Areas.

The implementation of Alternative B would decrease the amount of proposed development and potential environmental impacts; however, revenues to the Tribes would also be reduced.

In order to accomplish this objective, the Operators have indicated that approximately 233 wells at up to 233 well locations would be drilled. The success rate is estimated to be 78 percent (182 producing wells). This is in addition to 178 producing wells in the WRPA. Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) areas of high potential for environmental impact (e.g., threatened and endangered species), and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). In the Pavillion field, it would not be mechanically feasible to directionally drill two wells from the same pad in the shallow Wind River and Fort Union formations, while achieving the maximum recovery of the resource required by statutes and regulations (see Section 2.9.2 for a discussion of directional drilling in the WRPA). The feasibility of directional drilling at the exploratory Sand Mesa South and Coastal Extension fields has not yet been determined.

Development would begin in late 2004 [subsequent to the publication of the Record of Decision (ROD)] within the WRPA and continue for approximately 20 years, with a life-of-project (LOP) of 20-40 years. Various associated facilities (e.g., roads, pipelines, power lines, water wells, disposal wells, evaporation ponds, compressor station) would also be constructed throughout the WRPA.

The total new short-term surface disturbance resulting from Alternative B would be 1609.6 acres (approximately 1.75 percent of the WRPA). A maximum of 880 acres of new surface disturbance would result from 233 well locations (including on-site gathering, measurement, and dehydration facilities); 35 miles (137.9 acres) of surface disturbance would result from new roads or upgrades of existing roads, 123 miles (568.7 acres) of new surface disturbance would result from pipelines; and approximately 23 acres of new surface disturbance would be from ancillary facilities, including disposal wells, treatment/separation plants, and five new compressor stations with a total capacity of 22,700hp. While the short-term disturbance is a relatively small percentage of the total WRPA, these changes would be concentrated within the five development areas, intensifying the percentage of disturbed lands in those areas (see Table 2-3).

Although, a total of 1609.6 acres of short-term disturbance would result from Alternative B, a much smaller total area would be disturbed at any one time, since development will be phased (i.e., a specific number of wells would be drilled annually in each of the five fields). Table 2-6 shows the number of wells that would be drilled annually under Alternative B. New pipelines would be placed, where possible, adjacent to access roads. In addition, pipeline ROWs in irrigated fields would be completely reclaimed for agricultural use, unless otherwise specified by the landowner.

Table 2-6. The Number of Wells to be Drilled Annually under Alternative B.

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	14	12	8		
2005	14	12	8		
2006	14	12	8	3	1
2007	14	4	8	3	1
2008	14		8	3	1
2009	14		8	1	1
2010	12		8		1
2011			8		1
2012			8		1
2013			8		
TOTAL	**96**	**40**	**80**	**10**	**7**

Reclamation of the disturbed land would occur as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program and well pads of dry holes would be plugged and abandoned and reclaimed. Wells reaching ultimate recovery would also be plugged and abandoned when production ceased. Thus, as new wells are drilled, other areas are being reclaimed.

Total surface disturbance would be reduced to 325.1 acres (assuming a 78 percent drilling success rate), (206.7 acres associated with 182 wells, 95.4 acres of roads [with roads to unsuccessful wells being reclaimed], and 23 acres of surface disturbance associated with ancillary facilities) or approximately 0.35 percent of the WRPA.

Voluntary mitigation by the Operators has been implemented in the existing development areas, and would be undertaken in Alternative B to further reduce short-term and residual impacts. The types of mitigation actions that would be implemented by the Operators are presented in Section 2.3 under the Proposed Action.

As with the Proposed Action and Alternative A, additional site-specific proposal and resource information would be contained in the individual well APDs and ROW applications submitted to the BIA and BLM. The BIA or BLM would prepare environmental assessments, as needed.

2.6 ALTERNATIVE C - NO ACTION

The National Environmental Policy Act and its implementing regulations require that a No Action Alternative be evaluated for comparison with the other alternatives analyzed. For this analysis, the No Action Alternative is denial of the drilling and development proposal, as submitted by the Operators. However, the Department of Interior's (DOI's) authority to implement a No Action Alternative that denies a Tribe the right to develop its minerals or a tribal oil and gas lessee the right to drill is limited. The United States has trust obligations regarding development of the Tribes' mineral resources. A typical tribal oil and gas lease "grants, leases, and lets exclusively unto Lessee for the purpose of investigating, exploring, producing oil and gas, including all associated hydrocarbons produced in liquid or gaseous form, laying pipe lines, building roads, tanks, power stations, telephone lines, and other structures thereon to produce, save, take care of, treat, transport, market and own such products, and performing any required Reclamation Activities" subject to terms of the lease

(Tribal Standard Form Lease). Because the Secretary of the Interior has the authority and responsibility to protect the environment with tribal oil and gas leases, restrictions (e.g., No Surface Occupancy) may be imposed on the lessee. However, the DOI is not empowered to deny all drilling based on environmental concerns. Approval of an individual Application for Permit to Drill (APD) could be denied only when the activity would constitute a violation of laws or regulations (e.g. the Endangered Species Act). Otherwise, denial of all drilling could only result from Congressional action authorizing exchange, condemnation, or buy-back of the subject lease.

Leases may contain various restrictions concerning surface disturbance, surface occupancy, and limited surface use. Lease stipulations provide that the DOI may impose such reasonable conditions, not inconsistent with the purposes for which the lease is issued, to protect the surface of the leased lands and the environment. The leases for the WRPA do not contain “No Surface Occupancy” stipulations.

The No Action Alternative would allow wells to be developed on fee minerals (through individual APDs on a case-by-case basis), and on tribal minerals to offset potential drainage of adjacent tribal minerals. The Operators estimate that under a No Action Alternative 64 wells would be drilled in Pavillion on fee minerals and 36 wells in Pavillion on tribal minerals as drainage offset, for a total of 100 new wells. No development would occur in the Muddy Ridge, Sand Mesa, Sand Mesa South, or Coastal Extension fields under this alternative.

The No Action Alternative results in approximately 316.6 acres of total new short-term surface disturbance from well locations, new roads or upgrades of existing roads, production facilities, new pipelines, and one additional compressor station with a capacity of 3,200 hp (see Appendix C for detailed disturbance calculations). While the short-term disturbance is a small percentage (0.34 percent) of the total WRPA, the disturbance would occur entirely in the Pavillion field, resulting in a disturbance of 2.69 percent of this field (see Table 2-3).

A smaller area of disturbance would occur at any time, since development would be phased. The number of wells that would be drilled annually under Alternative C is shown in Table 2-7.

Table 2-7. The Number of Wells to be Drilled Annually under Alternative C (No Action).

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	14	No wells drilled	No wells drilled	No wells drilled	No wells drilled
2005	14				
2006	14				
2007	14				
2008	14				
2009	14				
2010	14				
2011	2				
TOTAL	**100**				

Total surface disturbance would be reduced to 79.3 acres following reclamation of the pipelines and portions of the well pads not needed for production operations (36.5 acres from well pads, 23.1 acres from roads, and 19.7 acres from ancillary facilities).

Reclamation of the disturbed land would occur as soon as drilling and construction have been completed. Pipeline ROWs would be reclaimed after the completion of the drilling program, dry holes would be plugged and abandoned and well pads would be reclaimed. Wells reaching the ultimate recovery would also be plugged and abandoned. Thus, as new wells are drilled, other areas are being reclaimed.

Voluntary mitigation has been implemented by the Operators in the existing development areas, and would be undertaken in the No Action Alternative to further reduce short-term and residual impacts. The types of mitigation actions that would be taken by the Operators are discussed in Section 2.3 under the Proposed Action.

As with the Proposed Action and Alternatives A and B, additional site-specific proposal and resource information would be contained in the individual well APD and/or ROW applications when submitted to the BIA and BLM. The BIA or BLM would prepare environmental assessments, as needed.

2.7 PLAN OF OPERATIONS

2.7.1 Preconstruction Planning and Site Layout

The Operators would follow the procedures outlined below to gain approval for the proposed activity on tribal and BOR lands within the WRPA. Development activities proposed on private minerals would be approved by the WOGCC. The WOGCC permitting procedures require filing an APD with the WOGCC and obtaining a ROW approval from the surface owner.

- Prior to the start of construction activities, the applicant would submit a Notice of Staking (NOS) and Application for a Permit to Drill (APD) to the BLM and the BIA, and ROW Application to the BIA. The application would include maps; site-specific plans, where necessary, to describe the proposed development (i.e., drilling plans with casing/cementing program); surface use plans with road and drill pad construction details; and site-specific reclamation plans, etc. Approval of all planned operations would be obtained in accordance with the authority prescribed in Onshore Oil and Gas Order No. 1 (Approval of Operations on Onshore Federal and Indian Oil and Gas Leases).

- The proposed development would be staked by the applicant and inspected by an Interdisciplinary Team (IDT) member and/or officials from the BLM, the BIA, and the Tribes to ensure consistency with the mitigation measures for oil, gas, and gravel contained in the EA of Land Management Activities (BIA 1984), approved mitigation measures incorporated into the ROD, and plans provided by the applicant in the APD and ROW application.

- More detailed construction plans, when required by the BLM or BIA for the proposed development, would be submitted by the applicant. The plans would address concerns that may exist regarding construction standards, required mitigation, etc. Negotiation of these plans between the applicant and the BLM or BIA with tribal consultation to resolve differences, if necessary, would be based on field inspection findings and would take place either during or after the on-site inspection by the BLM, BIA and the Tribes.

- The applicant and/or its contractors would revise the APD or ROW application, as necessary, based on negotiations with the BLM and BIA. The BLM or BIA would complete a project-specific EA that incorporates agreed-upon construction and mitigation measures. The BIA and BLM would then approve the specific proposal and attach the Conditions of Approval to the permit. The applicant must then commence the proposed activity within one year or the approval would expire unless renewed for an additional one-year period.

2.7.2 Construction and Drilling Phase

A general discussion of construction techniques that would be used by the Operators for the Proposed Action is provided below. These construction techniques would be applicable to drilling, pipeline construction, and access road construction within the WRPA.

2.7.2.1 Access Road Construction

Access to the WRPA is provided by various roads in the vicinity of the WRPA (see Figure 1-2). Road access within the WRPA is provided by an existing network of secondary roads, maintained light-duty roads, and unimproved roads (see Figure 1-3) that would be utilized for the Proposed Action or alternatives and ongoing drilling and production activities. The road network within the WRPA is discussed in more detail in Chapter 3, Section 3.14.

All new access roads within the WRPA would be constructed for the specific purpose of natural gas field development. Roads would be located to minimize disturbances and maximize transportation efficiency. New access roads would be designed and constructed in accordance with surface owner or surface management agency (SMA) direction or to BLM road standards to facilitate reclamation should the well be a dry hole. Roads located on private lands would be constructed in accordance with standards imposed by the private landowner. In order to decrease impacts, the number of roads would be limited. Wells would primarily be accessed from short resource roads off the local roads. Roads would be closed and reclaimed by the operators when they are no longer required for production operations, unless otherwise directed by the BIA or private landowners. Roads would be designed to minimize disturbance and would be built and maintained, as specified by the BIA, to provide safe operating conditions at all times. Surface disturbance would be contained within the road ROW. A typical roadway cross-section with width specifications is shown on Figure 2-1.

The Operators estimate that each proposed new well would require an average of 800 feet of new or upgraded access road construction, for a total of approximately 49 miles (135 acres) of new roads. The width of road disturbance would be 16 feet in the Pavillion field and 30 feet in all other development areas. Approximately 140 miles (597.2acres) of pipelines, with a standard ROW width of 50 feet would also be constructed.

Construction equipment and techniques utilized by the Operators would be standard (e.g., crown-and-ditch method). Should soft spots develop on the roadway during construction or drilling operations, they would be promptly covered with crushed rock or gravel. Problem areas on access roads to producing well sites identified during on-site review by the BIA would be covered with gravel to a depth of 4 to 6 inches to reduce erosion and sedimentation. Gravel placement would be accomplished within a time period specified by BIA. Surfacing materials would be obtained from existing, active gravel pits obtained from private or tribal sources within or near the WRPA. Reclamation measures would be implemented during the first operating season after well completion or abandonment. The access road to an unproductive well site would be reclaimed upon abandonment of the well using stockpiled topsoil and the seed mixture contained in the approved APD and ROW permit.

In the event a drilled well is a dry hole, the disturbed areas, including the well pad and new access road, would be reclaimed to the approximate landform that existed prior to construction. Markers for abandoned wells would be placed below the surface in irrigated fields and at a height of approximately 6-7 feet at all other locations. The marker would be identified with the lease number. Reclamation and site stabilization techniques would be applied as specified in the APD Surface Use Plan or the Plan of Development (POD). If drilling is productive, the access roads to the well sites would remain in place for well servicing activities (i.e., maintenance, improvements, etc.). Partial reclamation would be completed on sections of the well pad, access road, and ROW that are no longer needed.

Estimated traffic requirements for drilling and completion operations are shown in Tables 2-8 and 2-9. The “Trip Frequency” column indicates the estimated number of round trips to the WRPA for each activity. The numbers for traffic provided in these tables should be considered general estimates, since activity levels vary over time in response to natural gas prices, weather, corporate decisions, and other factors. In addition to the drilling and completion personnel, the wells will be visited by BIA, BLM, surveyors, and cultural/biological personnel for clearance during site-specific approvals. It is estimated that these personnel would make an average of 11 trips per day during drilling operations and 20 trips per day during completion operations.

Figure 2-1. Typical Roadway Cross-Section with Width Specifications, WRPA.

Table 2-8. WRPA Drilling Traffic Estimates, by Field.

	Pavillion Well (7 - 10 days)				Muddy Ridge Well (30 days)				Sand Mesa Well (60 days)			
Drilling Traffic	**Pickup**	**Trucks**	**Other**	**Total**	**Pickup**	**Trucks**	**Other**	**Total**	**Pickup**	**Trucks**	**Other**	**Total**
Surveyor	1	0	0	1	1	0	0	1	1	0	0	1
Well Location & Access	3	4	2	9	3	4	2	9	3	4	2	9
Engineering	4	0	0	4	11	0	0	11	26	0	0	26
Geology	5	0	0	5	11	0	0	11	19	0	0	19
Office	0	0	0	0	0	0	0	0	0	0	0	0
Supervision	6	2	0	8	30	1	0	31	60	1	0	61
Ratholer	1	2	0	3	1	2	0	3	1	2	0	3
Wellhead	1	0	0	1	2	0	0	2	2	0	0	2
Drilling rig	24	25	0	49	105	0	0	105	120	0	0	120
Mobilization	2	20	0	22	2	20	2	24	2	20	2	24
Dewatering	2	0	1	3	0	0	0	0	0	0	0	0
Rentals	5	5	0	10	9	6	0	15	9	6	0	15
Welder	1	0	0	1	2	0	0	2	2	0	0	2
Nipple up & testers	1	1	0	2	1	1	0	2	2	2	0	4
Bit sales	3	0	0	3	12	0	0	12	15	1	0	16
Mud Engineer	6	2	0	8	27	13	0	40	31	19	0	50
Mud Logger	2	0	0	2	2	0	0	2	2	0	0	2
Transportation	2	4	0	6	4	8	0	12	4	10	0	14
Water Truck	0	21	0	21	0	50	0	50	0	75	0	75
Open hole logging	1	1	0	2	1	1	0	2	2	2	0	4
Casing Crews	2	2	0	4	2	2	0	4	3	3	0	6
Cementing	2	5	0	7	2	6	0	8	3	10	0	13
Roustabouts	1	0	0	1	1	0	0	1	1	0	0	1
Fuel Delivery	0	10	0	10	0	33	0	33	0	63	0	63
Miscellaneous	18	0	0	18	66	0	0	66	126	0	0	126
TOTALS	**93**	**104**	**3**	**200**	**295**	**147**	**4**	**446**	**434**	**218**	**4**	**656**

Table 2-9. WRPA Completion Traffic Estimates, by Field.

	Pavillion Well (2 - 3 days)				Muddy Ridge Well (30 days)				Sand Mesa Well (30 days)			
Completion Personal	**Pickup**	**Trucks**	**Other**	**Total**	**Pickup**	**Trucks**	**Other**	**Total**	**Pickup**	**Trucks**	**Other**	**Total**
Engineering	1	0	0	1	10	0	0	10	10	0	0	10
Geology	0	0	0	0	0	0	0	0	0	0	0	0
Office	0	0	0	0	0	0	0	0	0	0	0	0
Supervision	6	0	0	6	30	0	0	30	30	0	0	30
Wellhead	1	0	0	1	1	0	0	1	1	0	0	1
Completion rig	12	6	2	20	30	24	4	58	36	24	4	64
Perforating & logging	3	6	0	9	5	10	0	15	7	7	0	14
Acid Crews	0	0	0	0	0	0	0	0	7	8	0	15
Frac Crews	10	15	0	25	20	30	0	50	20	30	0	50
CO2	3	10	0	12	3	36	0	39	0	0	0	0
Flow Testers	2	0	0	2	4	2	0	6	4	4	0	8
Snubbing	2	2	0	4	0	0	0	0	2	2	0	4
Packers & plugs	2	0	0	2	3	6	0	9	5	0	0	5
Foam Unit	1	2	0	3	1	2	0	3	1	2	0	3
Transportation	1	2	0	3	0	1	0	1	1	3	0	4
Water Truck	0	12	0	12	0	39	0	39	0	40	0	40
Rentals	2	4	0	6	2	4	0	6	2	4	0	6
Roustabouts	3	2	0	5	2	3	0	5	2	3	0	5
Hot Oiler	0	2	0	2	0	2	0	2	0	2	0	2
Fuel Delivery	0	3	0	0	0	30	0	30	0	30	0	30
Miscellaneous	6	0	0	0	60	0	0	60	60	0	0	60
Well Pipeline	9	11	0	20	9	11	0	20	9	11	0	20
Reclamation	1	6	0	7	1	6	0	7	1	6	0	7
TOTALS	**65**	**83**	**2**	**140**	**181**	**206**	**4**	**391**	**198**	**176**	**4**	**378**

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2.7.2.2 Well Pad Design and Construction

The traditional single-well pad design has been utilized in the WRPA in the past and would continue to be the predominant design utilized under the Proposed Action. The traditional well pad would be constructed from materials located at the site. Drilling activity under the Proposed Action is planned in the Wind River, Fort Union, Lance, Meeteetse, Mesaverde, and Cody formations.

Under the Proposed Action, 325 well locations would be drilled during the 20-year drilling and development period, with an approximate drilling success rate of 81 percent (263 producing wells). An illustration of a typical well pad and drilling layout is shown in Figure 2-2. The actual well pad size would depend on terrain limitations existing at the site. The well pad would be designed so that construction materials balance (i.e., soil materials taken from cuts would be about the same quantity as that needed for fill to construct a level pad), while attempting to minimize the total disturbed area. Typical well pad design with production facility in the Pavillion field and Muddy Ridge field are shown in Figure 2-3 and Figure 2-4, respectively. After completion of drilling, the well pad would be partially reclaimed.

Projected initial surface disturbance for proposed new well sites in the five development areas would range from 1.15 acres per well for the shallow wells in the irrigated portions of the Pavillion Field to 3.06 acres in the other fields with deeper wells (Table 2-10). Total disturbance associated with 325 well pads under the Proposed Action would be 1,164.1 acres. Following partial reclamation of the productive well sites and full reclamation of all unproductive well sites, the remaining well site disturbance would be 263.3 acres. (See Appendix C for detailed calculations of surface disturbance from the Proposed Action).

All available topsoil suitable for reclamation (up to 12 inches) would be stripped from the well pad area and stored adjacent to the well pad. This storage site is to be designated in the well pad design plan in the APD prior to start of actual well pad construction. Cut and fill slopes would be constructed, if necessary, in a manner that would hold topsoil during reclamation and subsequent re-establishment of vegetation.

After topsoil-stripping operations have been completed, construction of the well pad would begin. Construction practices would involve use of standard earthmoving equipment. Components of the well pad include construction of a reserve pit to temporarily store drilling fluids, cuttings, and water produced during drilling, and a flare pit for emergency and development flaring. Construction of a well pad and associated facilities would usually require approximately 2 to 5 days to complete, depending on site and terrain limitations.

Table 2-10. Well Pad Dimensions for the Proposed Development Areas, WRPA[1].

Proposed Development	Initial Length (ft.)	Initial Width (ft.)	Initial Area (acres)	Reclaimed Length (acres)	Reclaimed Width (ft.)	Final Area (acres)
Pavillion, dry land	350	250	1.15	270	163	1.01
Pavillion, irrigated field	270	185	1.15	8	8	0.002
Muddy Ridge	410	325	3.06	327	222	1.67
Sand Mesa	410	325	3.06	327	222	1.67
Sand Mesa South	410	325	3.06	327	222	1.67
Coastal Extension	410	325	3.06	327	222	1.67

[1] Does not include spoil area.

Figure 2-2. Detail of Typical Well Pad with Drilling Equipment Layout, WRPA

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Figure 2-3. Detail of Typical Pavillion Well Pad with Production Facilities, WRPA.

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Figure 2-4. Detail of Typical Muddy Ridge and Sand Mesa Well Pad with Production Facilities.

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2.7.2.3 Drilling Operations

Drilling of a well would require transport of approximately 10 to 20 truckloads of drilling-related equipment and materials to facilitate the drilling operation, depending upon the development area. This includes transportation of the drill rig, drill pipe, drilling fluid products, and related support equipment, but does not include the truck traffic required for resupplying the operation (e.g., fuel, drilling fluid additives, etc.). The extent of additional traffic would be depend on the phase of the drilling operation, but would not include more than six or seven vehicles per day per drill site throughout the drilling operation. Total rig-up activities and installation of ancillary facilities would take approximately 3 days to complete.

At the beginning of drilling operations, surface casing is installed in the well. Surface casing is set deep enough and cemented to the surface to protect freshwater aquifers. Drilling and production operations would continue over the development phase of the Proposed Action, with 37 wells drilled each during the peak year in 2006. The number of wells drilled annually would depend on such factors as market prices, permit approval, and rig availability. Completion operations for each productive well would commence as soon as possible after the drilling rig moves off location.

The geologic formations to be tested in the WRPA are the Upper Wind River, Ft. Union, Lance, Meeteetse, Mesaverde, and Cody Formations. The drilling depth is approximately 20,000 feet for a gas well drilled into the Cody Formation, requiring approximately 40 to 60 days to drill a vertical well, barring any major drilling problems. The approximate drilling depth for a Ft. Union or Wind River Formation test in the Pavillion area is 3,700 to 5,800 feet and would take approximately 7 to 10 days to drill vertically. Drilling in the irrigated lands in the Pavillion field would be conducted between November and April, due to agricultural activities in spring, summer, and early fall. Drilling depth in the Ft. Union or Lance Formation in the Sand Mesa field would range from 14,500 to 17,000 feet and would take 40 to 60 days to drill. The approximate drilling depth in the Meeteetse or Mesaverde Formation is 12,000 to 13,000 feet and would take approximately 30 to 40 days to drill vertically.

Approximately 1,100 barrels/day of produced water is retrieved from the existing producing wells in the Pavillion, Muddy Ridge, and Sand Mesa fields. The produced water is injected in the Tribal PN #16-34 SWD located in T4N, R2E, Section 16 SWSE, which was converted into an underground injection well for storing produced water from all fields. On occasion, the produced water may be used in drilling a well. However, the produced water is not discharged into the environment.

A water-based mud system would be used for the drilling operations. Drilling muds and cuttings would be placed in an earthen reserve pit covered with an impermeable synthetic liner to prevent seepage into the soil. The synthetic liner would be at least 12 mm (0.012 inch) thick, and be resistant to decay from sunlight and hydrocarbons and compatible with the drilling fluids to be retained.

All reserve pits containing hydrocarbons are covered with netting or flagged to prevent access by birds and other animals. Hydrocarbons floating on the surface of the reserve pit would be removed as soon as possible after the drilling operations are complete. Reserve pit fluids would be allowed to dry by evaporation for approximately one year, prior to reserve pit closure and drill site reclamation. When the reserve pit is backfilled, cuttings and drilling muds would be covered to a depth of at least three feet. If drilling or production fluids remain in the pit after one year, alternate methods of drying, removal of the fluids, or other treatment measures would be determined by the Operators in consultation with the BIA. Permits are required if fluids are transported off-site for disposal.

Service trailers located on the well pad would be self-contained and would not require a septic system. Sewage would he hauled off-site to a government approved disposal site.

If a well is productive, site erosion and sedimentation would be controlled by promptly revegetating the areas around the well pads in the next fall or spring season, and providing surface water drainage controls, such as berms, sediment collection traps, diversion ditches and erosion stops as needed. These measures would be described in the individual APDs and ROW applications.

2.7.2.4 Directional Drilling

Directional drilling may be utilized under the following circumstances: 1) presence of topographic features where vertical drilling would not be technically feasible, 2) areas of high cultural/archaeological concern, 3) areas of high potential for environmental impact (e.g., threatened and endangered species), and 4) considerations of health and safety associated with occupied residences (see Section 2.9.2 for a discussion of directional drilling). A drilling method that the Operators may use to access bottom-hole locations in these areas is directional drilling from a single-well pad (multi-well, directional drilling). The most commonly used method of directional drilling is the S-shaped well (Figure 2-5). The multi-well single pad design provides for construction of one well pad with as few as two or as many as eight wells drilled from a central location. The first well is usually drilled as a vertical well and the remaining wells are drilled directionally. This design provides economic and environmental advantages associated with one access route for multiple wells along with common gathering, separation, storage, and transportation facilities. When multi-well drilling is utilized, several wells can be serviced at one time in one trip, thus minimizing vehicular traffic, dust control, and disturbance to wildlife.

Techniques and equipment for constructing a multi-well directional drill pad would be similar to those utilized in constructing a single-well traditional well pad. Directional drilling requires special drilling tools and procedures to change the direction of the well bore from vertical to directional in order to penetrate targets that cannot be reached by conventional vertical drilling methods. Advancement in directional drilling technology makes it possible to reach bottom holes 2,000 or more feet from the rig. Shallow depth of gas-bearing formations and certain geologic features limit the use of directional drilling (e.g., faults, structural dips, etc.). Additional discussion on the technical and economic feasibility of directional drilling is provided in Section 2.9.2.

2.7.2.5 Pipeline Construction

The existing pipelines within the WRPA include 3, 4, 6, 8, 10 and 12-inch diameter pipelines. The gas within the WRPA is gathered in 3, 4 and 6, and 8-inch pipelines (102.8 miles). From there it is compressed into a 10-inch line (18.2 miles) and moved to the 12-inch TBI pipeline. The 12-inch TBI pipeline connects to the 8-inch Kinder Morgan line at 12.12 miles and continues another 34.08 miles to connect with the 16-inch Colorado Interstate Gas

(CIG) pipeline and 12-inch Williston Basin (WBI) pipeline (C. Vickers, TBI, personal communication, November 2003).

The locations for new pipelines in the WRPA would be surveyed and staked prior to start of any construction activities. Prior to installation of the pipelines, detailed design plans would be submitted by the Operators to the BIA , as needed, (e.g., pipelines planned on slopes of 25 percent or greater). In order to minimize the total amount of surface disturbance, the pipeline corridor may or may not be cleared of heavy brush prior to any activities. This determination would be made by the BIA prior to construction and would take into consideration factors such as construction crew safety, side slopes, and brush density.

Pipeline construction would occur in a planned sequence of operations common to natural gas pipeline installation specifications and would take place along a corridor of continuous activity. Cross-country construction activities would be confined to a 50-foot ROW. The ROW would be placed adjacent to existing pipelines or roads, where possible. Figure 2-6 shows a typical section of a gas sales pipeline in the WRPA along an access road. A typical section of a gas pipeline across an irrigated land in the Pavillion field is shown in Figure 2-7; and a typical section of a gas sales pipeline parallel to an existing pipeline is shown in Figure 2-8.

The pipeline trench would be excavated mechanically with trenching equipment, such as a backhoe or trencher. The width of the trench would range from 18 - 24 inches. The trench would be constructed to a depth that would maintain 36 inches of normal soil cover or 24 inches of cover in consolidated rock.

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Figure 2-5. Typical S-shaped Directional Drilling Technique for a Muddy Ridge Well, Showing Cross-section and Plan View.

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Figure 2-6. Typical Section of a Gas Sales Pipeline along an Access Road

Figure 2-7. Typical Section of a Gas Sales Pipeline adjacent to an Irrigated Field.

Figure 2-8. Typical Section of a Gas Sales Pipeline parallel to an Existing Pipeline.

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Pipe laying activities would include pipe stringing, bending, welding, coating, lowering of pipeline sections, and backfilling the trench with soil. Newly constructed pipelines would be hydrostatically tested to evaluate structural soundness. Integrity tests would be conducted in full compliance with the mandatory BIA/BLM pipeline stipulations. Approximately 10 percent of the pipeline would be randomly x-rayed after welding to check the quality of the welds. All fittings on the pipeline would be also x-rayed. The pipeline pressure would be slowly increased to the maximum operating pressure of the pipeline. This pressure would be maintained for 24 hours. If a leak is discovered, the pipeline would be purged to the atmosphere, the pipeline repaired, and the pressure tested again by the same procedures. For the hydrostatic testing of the pipeline, water would be taken from water wells within or near the WRPA. In the winter ethylene glycol is used for testing to prevent the pipe from freezing. The hydrostatic testing liquid is transported by truck to the disposal well in the Muddy Ridge field. The ethylene glycol would be separated from the water and placed in a storage tank, and reclaimed for reuse. Water taken from wells with state water rights might require a state change of use permit. Water taken from tribal water rights might require a tribal change of use permit.

A total of 140 miles of new pipeline would be constructed within the WRPA under the Proposed Action. Gas flowlines from the wells to gathering system lines would average 1,000 feet in length. Disturbance from the pipeline trench plus the spoil area would be 8 feet. Disturbance for new ROWs would be 30 feet. Each field would also require new gathering pipelines for transporting the new production to in-field compression stations and pipelines connecting with the transmission lines. Total short-term disturbance from new pipelines for the Proposed Action would be 597.2 acres, which would be reclaimed after pipeline installation has been completed.

2.7.2.6 Natural Gas Production

Completion and Testing Operations

Well completion operations involve perforation, stimulation, and testing of potentially productive zones. Casing prevents drill hole cave-in and aquifer mixing, confines production to the well bore, and provides a means of controlling pressure to facilitate installation of surface and subsurface well equipment. Most completions in the WRPA use a string of tubing that is inserted in the casing to the top of the perforated productive zone to allow gas, condensate, and water to flow to the surface where it is collected, measured, and contained. Perforation, stimulation, and testing require heavy equipment to be transported and utilized at the well site, and flaring of the produced gas. A typical cased well bore generally consists of conductor pipe, surface casing, and production casing. A typical wellbore diagram for a vertical well in the Pavillion field is shown in Figure 2-9. Typical wellbore diagrams for vertical wells in the Muddy Ridge and Sand Mesa fields are shown in Figures 2-10 and 2-11, respectively.

At the termination of completion operations, the well casing would be perforated at the productive interval to allow the flow of hydrocarbons to the surface. Completion operations typically last up to 30 days for deeper wells (Muddy Ridge, Sand Mesa, and Coastal Extension) and 5 to 6 days for shallow wells (Pavillion).

Reclamation would be completed on parts of the well pad, access road, and ROW that are no longer needed after completion and testing operations. However, access roads to the productive well sites would be maintained for well servicing activities (i.e., maintenance, improvements, etc.).

Production and Maintenance Operations

Production operations would occur on a year-round basis, occasionally limited by weather, maintenance, workover operations, and ground and site conditions. Construction of new power lines to well sites is not anticipated, since current production operations in the WRPA do not require electrical power for compressors and other production facilities.

Maintenance of the access roads would occur during the summer and early fall months. Winter maintenance would include blading of snow from the access road, as necessary, with the blade kept above the ground surface.

Cut and fill slopes associated with each production well site would be reclaimed as prescribed in the APDs and ROW applications. Each producing well would be serviced by its own production facility, unless consolidation of production facilities for closely spaced wells is technically and economically feasible or wells are located on agricultural land. All wells would be manually operated and typically visited on a daily basis.

Figure 2-9. Typical Wellbore Diagram for a Vertical Well in the Pavillion Field.

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Figure 2-10. Typical Wellbore Diagram for a Vertical Well in the Muddy Ridge Field.

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Figure 2-11. Typical Wellbore Diagram for a Vertical Well in the Sand Mesa Field.

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2.7.2.7 Production Estimates

The BLM Reservoir Management Group (RMG) has estimated the gas reserves in the Pavillion and Muddy Ridge fields using production data from the IHS Energy/Dwight's Database. The data presented in Table 2-11 are provided as Estimated Ultimate Recoverable Reserves (EUR), which is defined as the total estimated gas production that a well or a field will produce in its lifetime. The EURs are a forecast tool in the estimation of a future well's gas reserves. Estimates of current reserves for the two fields were made using the "Summarize Leases" option of the PowerTools software (Almasy, 2003a). Sufficient gas well production histories do not exist in the Sand Mesa, Sand Mesa South and Coastal Extension fields to permit an accurate assessment of gas reserves (Almasy, 2003b).

Table 2-11. Estimated Ultimate Recoverable Reserves (EURs) from the WRPA

Pavillion	
Case	**EURs**
Estimated Reserves w/ existing wells	264.0 BCF
Production to Date	219.5 BCF
Remaining EURs w/ existing wells	45 BCF
Additional EURs from full development @ 40-acre spacing	448.4 BCF
Additional EURs from full development @ 20-acre spacing	693.6 BCF
Muddy Ridge	
Case	**EURs**
Estimated Reserves w/ existing wells	145.7 BCF
Production to Date	89.9 BCF
Remaining EURs w/ existing wells	55.8 BCF
Additional EURs from full development @ 40 acre spacing	94.8 BCF
Additional EURs from full development @ a mixture of 40-acre and 20-acre spacing	170.6 BCF

Source: Almasy 2003a.

2.7.2.8 Estimated Employment Requirements

The estimated numbers of persons employed in various phases of the pre-drilling, construction, drilling, completion/testing and production well services, including pipeline construction, are shown in Tables 2-12 and 2-13. It should be noted that many of the personnel employed in different phases of the project are not employed full-time on an annual basis, but are employed for shorter periods of time, as needed. The length of time for each activity is indicated, in addition to the expected time on-site for the different activities involved in field development.

2.7.2.9 Ancillary Facilities

The WRPA Operators and pipeline companies would construct ancillary facilities, as necessary, to meet production needs. Such facilities would include, but not be limited to:

- Produced water storage facilities.
- Individual well site compression.
- Individual well site liquid (hydrocarbon liquids) recovery units.,
- Gas metering stations.
- Pipeline pigging facilities.
- Field storage buildings.
- Cathodic protection facilities.

The number and exact location of such ancillary facilities is not known at this time, but most would be installed within the boundaries of existing disturbances. The Operators estimate that a total of 36.9 acres of new disturbance would occur from construction of new offsite production facilities and new compressor stations under the Proposed Action.

2.7.2.10 Geophysical Operations

No additional geophysical operations are currently planned by the Operators in the WRPA, but are possible in the future. If proposed, the effects would be analyzed in a separate environmental analysis.

2.7.2.11 Site Restoration and Abandonment

The Operators propose to completely reclaim all disturbed areas not needed for production activities including:

- Pipeline ROWs.
- Portion of access roads not needed in the safety of the road.
- Portion of the drill pad and offsite production facilities not needed during production.

Reclamation would generally include:

- Complete cleanup of the disturbed areas.
- Restoration of the disturbed areas to the approximate ground contour that existed prior to construction.
- Ripping of disturbed areas to a depth of 12 to 18 inches.
- Replacement of topsoil over all disturbed areas.
- Seeding of reclaimed areas with the seed mixture prescribed in the Surface Use Plan or POD for the Proposed Action.
- Fertilizing, if considered necessary by the BIA authorized officer.

Figure 2-12 shows the initial dimensions of a well pad and the reclaimed area in the Pavillion irrigated field, in which surface disturbance from the well pad is reduced from 250x350 feet (including spoil area) to 8x8 feet. Under the existing development approximately 24 of the 99 well pads in the Pavillion field were reduced to 8x8 feet (see Appendix C). However, in the proposed development project, well pads in irrigated fields would be reclaimed to 8x8 feet, unless the landowner specified otherwise. To date, however, landowners have not requested that a larger portion of the well pad remain in the crop fields. Figure 2-13 shows the reclaimed area of well and production facility on Pavillion dry land, and Figure 2-14 shows detail of reclamation of a Muddy Ridge or Sand Mesa well pad and production facilities.

Specific reclamation recommendations for use with the natural gas drilling and production operations within the WRPA are described in Appendix D. The final set of reclamation measures to be applied would be included in the APDs and ROW applications, and would be specific to each site and the conditions at that site.

As indicated previously, many acres of disturbance from drilling operations would be reclaimed. Disturbances associated with drill sites would thereby be reduced by reclaiming cut, fill, and soil stockpile areas. The average size of a remaining well pad in an irrigated field in Pavillion would be 0.002 acres after reclamation. The average size of the well pad after reclamation in Pavillion dry land would be 1.01 acres, while the residual disturbance from well pads at the other development areas would be 1.67. The total residual disturbance from well pads would be 263.3 acres. This would represent an approximate reduction of 900.8 acres of surface disturbance for all new well sites. All cross-country pipeline ROWs would be reclaimed, representing an approximate reduction of 597.2 acres of disturbed surface.

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Table 2-12. Wind River Drilling Manpower Estimates, by Field.

	Pavillion Well (7 - 10 Days/Well)				Muddy Ridge Well (30 Days/Well)				Sand Mesa/Sand Mesa South/Coastal Extension Well (40-60 Days/Well)			
Drilling Personnel	**Personnel**	**Hours/ well**	**Total hours**	**Total Days**	**Personal**	**Hours/ well**	**Total hours**	**Total Days**	**Personnel**	**Hours/ well**	**Total hours**	**Total Days**
Engineering	2	30	60	8	2	84	168	21	2	92	184	23
Geology	2	30	60	8	2	84	168	21	2	92	184	23
Office	5	30	150	19	5	84	420	53	5	92	460	58
Supervision	2	90	180	23	2	420	840	105	2	468	936	117
Ratholer	2	4	8	1	2	4	8	1	2	4	8	1
Wellhead	2	4	8	1	2	4	8	1	2	4	8	1
Drilling rig	25	90	2250	281	25	420	10500	1313	25	468	11700	1463
Mobilization	10	20	200	25	10	30	300	38	10	30	300	38
Dewatering	2	168	336	42	0	0	0	0	0	0	0	0
Rentals	5	8	40	5	5	12	60	8	5	12	60	8
Welder	1	8	8	1	1	8	8	1	1	8	8	1
Nipple up & testers	2	8	16	2	2	8	16	2	2	8	16	2
Bit sales	1	8	8	1	1	70	70	9	1	78	78	10
Mud Engineer	1	15	15	2	1	70	70	9	1	78	78	10
Mud Logger	2	120	240	30	2	420	840	105	2	468	936	117
Transportation	4	10	40	5	4	15	60	8	4	15	60	8
Water Truck	2	40	80	10	2	50	100	13	2	50	100	13
Open hole logging	4	10	40	5	4	15	60	8	4	15	60	8
Casing Crews	5	10	50	6	5	16	80	10	5	16	80	10
Cementing	3	8	24	3	3	10	30	4	3	10	30	4
Roustabouts	3	10	30	4	3	8	24	3	3	8	24	3
TOTALS	**85**		**3843**	**482**	**83**		**13830**	**1733**	**83**		**15310**	**1918**

Table 2-13. Wind River Completion Manpower Estimates, by Field.

	Pavillion Well (5 - 6 Days/Well)				Muddy Ridge/Coastal Extension Well (30 Days/Well)				Sand Mesa/Sand Mesa South Well (30 Days/Well)			
Completion Personnel	Personnel	Hours/ well	Total hours	Total Days	Personnel	Hours/ well	Total hours	Total Days	Personnel	Hours/ well	Total hours	Total Days
Engineering	2	30	60	8	2	124	248	31	2	184	368	46
Geology	2	30	60	8	2	124	248	31	2	184	368	46
Office	5	30	150	19	5	124	620	78	5	184	920	115
Supervision	2	48	96	12	2	696	1392	174	2	1020	2040	255
Wellhead	1	4	4	1	1	4	4	1	1	4	4	1
Completion rig	4	48	192	24	5	696	3480	435	5	1020	5100	638
Perforating & logging	5	24	120	15	5	48	240	30	5	48	240	30
Acid Crews	0		0	0	3	0	0	0	3	56	168	21
Frac Crews	10	14	140	18	15	36	540	68	15	72	1080	135
CO2	2	14	28	4	2	36	72	9	2	72	144	18
Flow Testers	2	36	72	9	2	96	192	24	2	96	192	24
Snubbing	3	6	18	2	3	5	15	2	3	5	15	2
Packers & plugs	1	12	12	2	1	58	58	7	1	58	58	7
Foam Unit	1	12	12	2	1	18	18	2	1	18	18	2
Transportation	2	8	16	2	2	20	40	5	2	20	40	5
Water Truck	2	12	24	3	2	40	80	10	2	40	80	10
Rentals	2	4	8	1	2	4	8	1	2	4	8	1
Roustabouts	3	10	30	4	3	10	30	4	3	10	30	4
Hot Oiler	1	10	10	1	1	12	12	2	1	12	12	2
TOTALS	**50**		**1052**	**135**	**59**		**7297**	**914**	**59**		**10885**	**1362**

Figure 2-12. Drilling Pad Reclamation Detail for Irrigated Land in the Pavillion Field, WRPA.

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Figure 2-13. Drilling Pad Reclamation Detail, Pavillion Field Dry Land, WRPA.

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Figure 2-14. Drilling Pad Reclamation Detail for a Typical Muddy Ridge and Sand Mesa Well and Sand Mesa Well and Production Facility, WRPA.

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2.8 MITIGATION MEASURES

2.8.1 Project-Wide Mitigation Measures

Mitigation guidelines and stipulations have been developed by the BLM (1986) and BIA (1984) to avoid or minimize adverse effects to various resources from surface disturbing activities (e.g., oil and gas operations). Mitigation requirements for threatened and endangered species have been prepared by the USFWS (2002) for the Wind River Gas Field Development Project. Agency-required or recommended mitigation measures are provided in Appendix B. The mitigation measures are applicable to surface disturbance in the WRPA that has the potential to impact geological resources, water quality, air quality, land uses, vegetation, wildlife, threatened and endangered species, cultural resources, recreation areas, human health and safety, Wildlife Habitat Management Areas, and other areas of high value.

Agency-recommended or required mitigation measures would also be applied on privately owned surface, unless otherwise specified by the private surface owners. An exception to implementation of specific mitigation measures may be approved on tribal or federal land on a case-by-case basis, when deemed appropriate by the BIA. The exception would be approved only after a thorough site-specific analysis determined that the resource or land use would not be significantly impacted.

2.8.1.1 Pre-construction Planning and Design Measures

- The Operators, BIA, and BLM would make an on-site inspection of each proposed and staked well, production facility site, new access road, and pipeline alignment plans within the WRPA, so that site-specific recommendations and mitigation measures can be developed.

- New road construction and maintenance of existing roads in the WRPA would be accomplished in accordance with BLM Manual 9113, unless the BIA, BOR, or private surface landowners specify otherwise.

- The Operators would prepare and submit an APD for each proposed well site on federal and tribal leases to the BIA for approval prior to initiation of construction. Prior to construction, the Operators or their contractors would submit a Sundry Notice and/or ROW application for each pipeline and access road segment on tribal or federal leases. The APD would include a Surface Use Plan that would show the layout of the well pad over the existing topography, dimensions of the pad, volumes and cross sections of cut and fill, location and dimensions of reserve pits, and access road egress and ingress. The APD, Sundry Notice, and/or ROW application would also itemize project administration, time frame, and responsible parties. In addition, a Reclamation Plan would be developed by the Operators for each facility in consultation with tribal, federal, and private surface owners.

- The Operators would utilize slope-stabilizing structures in areas of steep or unstable slopes, and obtain approval from the BIA prior to initiation of construction.

2.8.2 Resource-Specific Mitigation

The following mitigation measures identified by resource may be recommended or required by the BIA, BLM, Tribes or other appropriate authorities. Operator-committed mitigation measures are provided in Section 2.3. Additional mitigation measures that may be implemented are discussed in Chapter 4.

2.8.2.1 Geological and Mineral Resources

Geological and mineral resources within the WRPA would be protected through the following mitigation measures.

- Drilling and production activities proposed on federal or tribal lands that may impact geological or mineral resources would be conducted in accordance with regulations and guidelines of the BIA, BLM, or BOR, depending on which agency has jurisdiction. On fee surface lands these activities would be conducted according to regulations and guidelines of the WOGCC. The WOGCC permitting procedures require filing an APD with the WOGCC and obtaining ROW approval from the surface owner.

- The Operators would avoid precluding the development of other surface mineral resources. Conflicts between oil and gas development and other mineral interests that arose, would be mediated by the BIA or BLM.

- The BIA, BLM, or other agencies responsible for casing and cementing policies, may require additional protection of geological or mineral resources from the potentially adverse impacts from the Wind River Gas Field Development Project.

2.8.2.2 Paleontological Resources

Paleontological resource values would be protected through the following mitigation measures.

- Areas of proposed ground disturbance within the WRPA that have been identified as containing the tertiary Wind River formation at the surface, would be surveyed for fossils by the BIA.

- If significant and scientifically important paleontologic resources are discovered in the WRPA during construction, construction activities in the vicinity of the discovery would cease and the BIA would be notified immediately. Work would not resume until a qualified paleontologist had evaluated the discovery.

- Fossils of scientific interest and significance that are collected during paleontological evaluation would be identified and placed into the retrievable collections of a museum or institutional repository acceptable to the agency that holds jurisdiction. Associated geological and geographical data concerning the fossils would be collected and housed with the specimens.

2.8.2.3 Soils

Soils would be protected through the following mitigation measures.

- The Operators would reclaim all disturbed areas not needed for production activities. Portions of access road ROWs, not needed in the function of the road, and those parts of the well pad not needed during production, would also be reclaimed.
- Where feasible, buried pipelines would be located immediately adjacent to roads to avoid creating separate areas of disturbance and to reduce the total area of disturbance.
- The Operators would avoid using frozen or saturated soils as construction material.
- The Operators would minimize construction activities in areas of steep slopes and other sensitive soils and apply special slope-stabilizing structures, if construction cannot be avoided in these areas.
- Cut-slopes would be designed in a manner that would allow retention of topsoil.
- Selectively strip and salvage topsoil or the best suitable medium for plant growth up to a depth of 12 inches from all areas to be disturbed for construction of well pads and facilities.
- Where possible, minimize disturbance to vegetated cuts and fills on existing roads.
- Install runoff and erosion control measures, such as water bars, berms, and interceptor ditches, if needed, as described in the Reclamation Plan (Appendix D).
- Install culverts for ephemeral and intermittent drainage crossings. Design all drainage-crossing structures to carry the 25- to 50-year discharge event, or as otherwise directed by the BIA or BLM.
- Implement minor routing variations during access road layout to avoid steep slopes adjacent to ephemeral or intermittent drainage channels. Maintain a 100-foot wide buffer strip of natural vegetation, where possible, between all construction activities and ephemeral and intermittent drainage channels.
- Include adequate drainage-control devices and measures in road design (e.g., road berms, drainage ditches, diversion ditches, cross drains, culverts, out-sloping, and energy dissipators) at sufficient intervals to adequately control and direct surface runoff above, below, and within the road environment, to avoid erosive concentrated flows. In conjunction with surface runoff or drainage control measures, use erosion-control devices and measures, such as temporary barriers, ditch blocks, erosion stops, mattes, mulches, and vegetative covers.
- Implement a re-vegetation program, as soon as possible, to re-establish the soil protection afforded by vegetative cover.
- Upon completion of construction activities, restore topography to pre-existing contours at the well sites, along access roads and pipelines, and at other facilities. Replace up to 12

inches of topsoil or suitable plant growth material over all disturbed surfaces and apply fertilizer, seed, and mulch, as specified in the Reclamation Plan.

2.8.2.4 Air Quality

Air quality would be protected through the following mitigation measures.

- Minimize air pollutant emissions through the application of Best Available Control Technology (BACT) as required by EPA or State of Wyoming air permitting programs.
- Apply water on unpaved well access roads and pads when necessary during construction operations to reduce fugitive dust.
- Prohibit on-site burning of trash.
- Post speed limits on roads controlled by the Operators to reduce road traffic dust.

2.8.2.5 Water Resources

Surface water and groundwater resources would be protected through the following mitigation measures.

- Limit construction of drainage crossings to no-flow or low-flow periods.
- Minimize the area of disturbance within ephemeral and intermittent drainage channels.
- Prohibit construction of well pads, access roads, and pipelines within 500 feet of surface water and/or riparian areas. Exceptions would be granted by the BIA or BLM, based on an environmental analysis.
- Minor routing variations during access road layout would be implemented to avoid steep slopes adjacent to ephemeral or intermittent drainage channels. A 100-foot wide buffer strip of natural vegetation, where possible, would be maintained between all construction activities and ephemeral and intermittent drainage channels.
- Culverts would be installed for all ephemeral and intermittent drainage crossings. All drainage crossing structures would be designed to carry 25- to 50-year discharge events, or as otherwise directed by the BIA or BLM.
- Design channel crossings to minimize changes in channel geometry and subsequent changes in flow hydraulics.
- Construction activities would be minimized in areas of steep slopes, and special slope-stabilizing structures would be applied, if construction cannot be avoided in these areas.
- Runoff and erosion control measures, such as water bars, berms, and interceptor ditches would be installed, as needed.
- Adequate drainage control devices and measures would be included in road design (e.g., road berms and drainage ditches, diversion ditches, cross drains, culverts, out-

sloping, and energy dissipators) at sufficient intervals to adequately control and direct surface runoff above, below, and within the road environment to avoid erosion concentrated flows. Erosion control devices would also be used in conjunction with the surface runoff and drainage control devices, such as temporary barriers, ditch blocks, erosion stops, mattes, mulches, and vegetative covers. A re-vegetation program would be implemented as soon as possible to re-establish the soil protection afforded by a vegetation cover.

- Construct channel crossings for buried pipelines, such that the pipe is buried a minimum of four feet below the channel bottom.

- Regrade disturbed channel beds to the original geometric configuration with the same or very similar bed material.

- Upon completion of construction activities, the topography would be restored to near pre-existing contours at the well sites, along access roads, pipelines, and other facilities sites. Up to 12 inches of topsoil or suitable plant growth material would be replaced over all disturbed surfaces. Fertilizer, seed, and mulch would be applied, as specified in the Reclamation Plan.

- The project would comply with Executive Order 11990 (floodplains protection) and BIA or BLM management directives that relate to protection of water resources and include avoidance of stream channels, to the maximum extent practicable. Where streams and floodplains cannot be avoided, the Operators would be required to show the BIA and BLM, during the APD process, how impacts would be minimized.

- All wells would be cased and cemented in accordance with Onshore Order No. 2 to protect accessible high quality aquifers (i.e., aquifers with known water quality of 10,000 ppm TDS or less). Include well casing and welding of sufficient integrity to contain all fluids under high pressure during drilling and well completion.

- Reserve pits would be constructed so that a minimum of one-half of the total depth is below the original ground surface at the lowest point within the pit. To prevent seepage of fluids, polyethylene liners would be utilized to line reserve pits. Liners would be of sufficient strength and thickness to withstand normal installation and use. The liner would be impermeable (i.e., having a permeability of less than 10^{-7} cm/sec) and chemically compatible with all substances which may be placed in the pit. If leakage is found outside the pit, drilling operations would be shut down until the problem is corrected.

- Hydrostatic test water used in conjunction with pipeline testing and all water used during construction activities from tribal, federal or private sources would be sampled and analyzed.

- Develop and implement a Storm Water Management Plan (SWMP) for storm water runoff at drill sites, as required by applicable law.

- The Operators must coordinate with the U.S. Army Corps of Engineers (COE) to determine the specific Clean Water Act (CWA) Section 404 permit requirements and conditions for each facility that occurs in Waters of the U.S. to prevent the occurrence of significant impact to such waters.

- Exercise stringent precautions against pipeline breaks and other potential accidental discharges of toxic chemicals into adjacent streams. If liquid petroleum products storage capacity exceeds criteria contained in 40 CFR Part 112, a Spill Prevention Control and Countermeasure (SPCC) plan would be developed.

2.8.2.6 Vegetation and Wetlands

Vegetation and wetlands would be protected through the following mitigation measures.

- Use existing roads, corridors, and open areas to the extent possible.
- Re-vegetate disturbed and abandoned areas with native species or non-invasive temporary cover.
- Seed and stabilize disturbed areas with seed mixtures and treatment guidelines prescribed in the approved APD and ROW application.
- Evaluate all project facility sites for occurrence and distribution of Waters of the U.S., special aquatic sites, and jurisdictional wetlands. All project facilities would be located out of these sensitive areas. If complete avoidance is not possible, minimize impacts through modification and minor relocations. Coordinate activities that involve dredge or fill into wetlands with the U.S. COE.
- Incorporate invasive/noxious weed management strategies in preconstruction planning and design process for all surface disturbance activities including road, pipeline, well pad, and ancillary facility construction.
- File noxious weed monitoring forms with the BLM and BIA, and implement a weed control and eradication program, if necessary.
- Obtain a Pesticide Use Permit before the application of herbicides or other pesticides for the control of noxious weeds.

2.8.2.7 Land Use

The various land uses with the WRPA would be protected through the following mitigation measures.

- Utilize off-site production facilities in agricultural areas to reduce impacts to landowners.
- Expedite construction and reclamation activities within agricultural lands to minimize total time of disruption to landowners. Concentrate construction activities during the non-productive crop seasons (i.e. winter).
- Construct cattle guards and fences, where appropriate, to minimize impacts to rangeland.

- Locate facilities away from residential areas to maintain residential land uses of these areas.
- Locate facilities away from recreational areas and their access routes to maintain the quality and value of the recreational uses of these areas.
- Avoid placing new facilities in WHMAs to preserve the maximum amount of habitat for wildlife management.

2.8.2.8 Wildlife

Wildlife impacts would be minimized through implementation of the following mitigation measures.

- No disturbance would be allowed during the raptor breeding season from Feb. 1–July 31 (varies by species) within ½-1 mile of an active nest (varies by species). The nature of the restrictions and the protection radius would vary according to the raptor species involved and would be determined by the BLM.
- No permanent above-ground structures would be constructed within ½-1 mile of a raptor nest. The distance from a raptor nest would vary by species. Where disturbance of a raptor nest is unavoidable, construction of artificial nest structures may be required by the BLM or BIA.
- Ensure that electric power lines and other transmission facilities used for oil/gas development activities are designed and constructed to minimize electrocution hazards to raptors.
- All carcasses would be removed from access roads, shoulders and ROWs to minimize collisions between vehicles and scavenger species.
- Design fences and overland conveyors to permit passage of game animals.
- In order to protect migratory birds and wildlife, all reserve pits that contain potentially hazardous materials would be fenced and netted or flagged, in accordance with BIA and BLM requirements.
- Avoid disturbances to habitats of high value for fish and wildlife (e.g., riparian and native vegetation).
- Reduce noise from construction and drilling or traffic in wildlife breeding and brood-rearing habitats.
- All drivers would undergo training describing the types of wildlife in the area that are susceptible to vehicular collisions, the circumstances under which such collisions are likely to occur, and the measures that can be employed to minimize them.

2.8.2.9 Threatened and Endangered Species

Threatened and endangered (T/E) and state-sensitive species would be protected through the following mitigation measures.

- A Biological Assessment would be prepared for all threatened and endangered species potentially impacted by the Wind River Gas Field Development project.
- Ensure that electric power lines and other transmission facilities used for, oil/gas development activities are designed and constructed to minimize electrocution hazards to bald eagle and State species of special concern.
- No disturbance would be allowed during the critical nesting season of the bald eagle (Feb. 1 –July 31) within 1 mile of an active nest.
- Carcasses of road-killed animals and birds would be removed from access roads, shoulders, and ROWs to minimize bald eagle exposure to vehicles.
- Do not use salt (NaCl) during winter plowing operations, to reduce big game mortality from vehicle collisions. Salt attracts bald eagles, wolves and grizzly bears to the road corridor.
- Document and report all observations, track sightings, and mortality of gray wolves and grizzly bears to USFWS.
- Conduct an inventory for black-footed ferrets within white-tailed prairie dog colonies prior to initiation of construction operations. Should black-footed ferrets be documented in a prairie dog complex located within the WRPA, all previously authorized project-related activities within the prairie dog complex would be suspended immediately.
- Operators would conduct education outreach to employees regarding the nature and symptoms of canine distemper, and its effects on black-footed ferrets, focusing attention on why employees should not have pets at work sites.
- All suspected observations of black-footed ferrets, their sign, or carcasses on the WRPA, however obtained, would be promptly reported to the USFWS.
- No surface disturbance will occur within two miles of an active or known greater sage-grouse lek between March 1 and June 30.
- Potential lek habitat (i.e., sites with minimal sagebrush, broad ridge tops, grassy openings and disturbed sites such as burns, abandoned well locations, and roads) would also be identified and disturbance to these areas would be avoided, as much as possible.
- No activities would occur within ¼ mile of identified mountain plover nesting habitat from April 1 to July 10. Identification and avoidance of mountain plover nesting areas and minimization of disturbance to prairie dog colonies would reduce the potential for disturbing mountain plover habitats. If no mountain plovers are observed, then construction activities would be initiated.

- Fence, cover, or flag reserve pits to exclude T/E and state-sensitive species from the pits, in accordance with BIA and BLM requirements.
- Avoid disturbances to, wetlands, and riparian vegetation along rivers and streams and bordering ponds and lakes used by T/E species or state-sensitive species.

2.8.2.10 Recreation

Recreation resources would be protected through the following mitigation measures.

- Expedite development and re-vegetation, and consolidate facilities in areas frequently used by game species in order to avoid disruption of use by game.
- Protect water resources that support sport fisheries to ensure that the probability of water pollution is minimized where sport fisheries are at risk.
- Limit conflicts between project vehicles and equipment and recreation traffic by posting appropriate warning signs, implementing Operator safety training, and requiring project vehicles to adhere to low speed limits.
- Limit ground disturbances that would potentially affect the habitat of game and wildlife that may be hunted or viewed.
- Limit impacts to the landscape from wells and production facilities visible from recreation areas and public roads accessing them.
- Locate facilities away from existing recreational areas and their access routes to maintain the recreational value of these areas.
- Avoid placing new facilities within WHMAs, where possible, and expedite construction and reclamation of facilities placed within WHMAs to minimize impacts to these areas.

2.8.2.11 Visual Resources

Visual resources would be protected through the following mitigation measures.

- Avoid placement of wells and production facilities, where possible, in locations that would be visible to large numbers of people, (i.e. along mesa edges, along WYO 134 and Bass Lake Road, and in Boysen State Park, and Ocean Lake).
- Utilize existing topography to screen roads, pipeline corridors, drill rigs, well pads, and production facilities from view.
- Paint well and facilities with flat colors that blend with the adjacent surrounding undisturbed terrain, except for structures that require safety coloration in accordance with Occupational Safety and Health Administration (OSHA) requirements. The color selected for the Wind River Gas Field Development Project is Mesa Brown.
- Well pad grading and leveling on rolling or hilly terrain would be designed to minimize side-slope cutting, where possible.

- The consolidation of facilities through the placement of multiple facilities on one pad and/or directional drilling would reduce the number of individual well pads and, thereby, reduce the visual contrasts associated with pad clearings scattered throughout the landscape.

- Roads that cut diagonally up the sides of mesas contrast with horizontal ridgelines. Berming and undulating the outer edge of the access roadways on mesa side slopes, where possible, would partially disguise their appearance when viewed from the valley floor.

- In order to minimize surface disturbance that contrasts with the surrounding landscape, new drill sites would be accessed from existing roads, where possible.

- During well drilling, any lights on rigs would be down-lighted, shrouded and directed towards the drilling platform, where possible, in order to reduce glare and negative night lighting impacts. Lights would be mounted at the lowest height possible in order to achieve the proper lighting, while minimizing disturbance to visual resources for residents and others.

2.8.2.12 Cultural Resources

Cultural and spiritual resources would be protected through the following mitigation measures.

- On tribal surface, federal surface, or lands with tribal minerals, a cultural resources survey is required for all well pad sites, access roads, pipeline construction corridors, and other areas of potential surface disturbance. Results of a cultural resources survey would be submitted to the BIA and BLM prior to or concurrent with submittal of the APD or other development plan.

- Mitigation of adverse effects to cultural/historical properties that cannot be avoided would be accomplished by the preparation and execution of a cultural resources mitigation plan. For cultural/historical properties on tribal lands, preparation of the mitigation plan would include consultation with representatives of the Eastern Shoshone and Northern Arapaho Tribes. The mitigation plan would be approved by the BIA, prior to execution.

- If cultural resources are discovered at any time during construction on lands with tribal or federal surface ownership, all construction activities would cease and the BIA would be immediately notified. The BIA would conduct a site visit within 24 hours and issue a Notice to Proceed, if construction is permitted to continue.

- If a site is considered eligible for, or is already on the National Register of Historic Places (NRHP), avoidance is the preferred method for mitigating adverse effects to that property.

2.8.2.13 Socioeconomics

Standard socioeconomic mitigation measures are listed below.

- Require all contractors to comply with applicable tax laws.
- Implement hiring policies that encourage the use of local and tribal workers who would not have to relocate in the vicinity of the WRPA. Require compliance with the Tribes' TERO laws.
- Coordinate project activities with agricultural operations to minimize conflicts involving agricultural operations. Project activities would be scheduled to minimize the potential disturbance during planting and harvesting of crops. Frequent communication with farmers during the construction and development phase would minimize potential impacts to farming.

2.8.2.14 Transportation

The impacts from increased transportation would be mitigated through the following mitigation measures.

- Require all employees to strictly observe all traffic laws and regulations, including speed limits.
- Limit use of roads by trucks and heavy equipment during periods when roads are muddy, to the extent possible.
- Formation of a transportation planning committee to address natural gas access and road maintenance issues. The committee would include the Operators, the Shoshone and Arapaho tribes, the BIA, Fremont County, the BOR and WYDOT. Prior to each year's drilling program, the operators would meet with the committee and present their drilling and field development program. The members of the committee would identify road maintenance issues, road and bridge sufficiency and safety issues, and preferred access routes. The committee as a whole would identify measures to avoid or minimize impacts and assign responsibilities for addressing issues. The committee would meet throughout the year as necessary.

2.8.2.15 Health and Safety

Health and safety of oil field workers and the general public would be protected through the following mitigation measures.

- OSHA, U.S. DOT, BIA, BLM, and the Tribes regulate various safety aspects of the oil and gas industry. Compliance with applicable safety regulations would greatly reduce the probability of occupational accidents and fatalities.
- To minimize undue exposure to hazardous situations, warning signs and fencing would be installed around facilities, as required by regulations, to prevent unauthorized access and alert the public to potential hazards in the area.

- Speed limits on operator–constructed access roads would be reduced to minimize the risk of traffic accidents, dust generation, and noise levels.

- Unpaved access roads constructed by the Operators would be watered on a frequent basis or treated with magnesium chloride to minimize the release of dust into the air.

- Pipeline markers would be posted at frequent intervals along gas pipelines, including road crossings and other areas likely to be disturbed by construction activities, to warn excavators and to reduce the risk of accidental rupture.

- The Operators would monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. If pressure losses are detected, the wells would be shut in and the problem repaired to minimize risks of fire or explosion.

- During construction and upon commencement of production operations, the Operators would prepare a chemical or hazardous substance inventory for all such items. The Operators would institute a Hazard Communication Program for their employees and would require subcontractor programs in accordance with OSHA 29 CFR 1910.120.

- For every chemical or hazardous material that is brought on location, a Material Safety Data Sheet (MSDS) would accompany that material and would become part of the file kept at the field office, as required by 29 CFR 1910.120. All employees would receive the training in proper storage, handling, and disposal of hazardous substances.

- Any hazardous wastes, as defined by the Resource Conservation and Recovery Act (RCRA), would be transported and/or disposed of in accordance with all applicable federal, state, and local regulations.

- Chemical and hazardous materials would be inventoried and reported in accordance with the Superfund Amendments and Reauthorization Act (SARA) Title III (40 CFR Part 335), if quantities exceeding 10,000 pounds or the threshold planning quantity (TPQ) are produced or stored in association with the proposed development. The appropriate Section 311 and 312 forms would be submitted at the required time to the applicable government emergency management coordinators and the local fire departments.\

2.8.2.16 Noise

The impacts of noise from drilling and production operations would be reduced through the following mitigation measures.

- Muffle and maintain all motorized equipment according to manufacturers' specifications.

- Install and maintain mufflers on compressor engine exhaust. The muffler should be installed to direct the noise away from the closest residence.

- The noise levels from compressors near residences would be mitigated so that the maximum noise level would be equal to or less than 55dBA. The estimated distance between a compressor and a residence would be based on the number of engines in the compresor. Based on preliminary compressor design, the following separation between a compressor and a residence would be required:

- One engine - 700 feet.
- Two engines - 900 feet.
- Three engines - 1100 feet.
- Four engines - 1600 feet.

2.9 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Other alternatives were considered, but eliminated from detailed study in this EIS in accordance with 43 CFR 1502.14(a), which requires that an agency "[r]igorously explore and objectively evaluate all alternatives which were eliminated from detailed study, [and] briefly discuss the reasons for their having been eliminated." Alternatives considered, but eliminated from detailed study are discussed below.

2.9.1 Extending the Life of the Project

An alternative to extend the life of the Wind River gas field development project was considered at the request of the BIA. It would involve decreasing the number of wells drilled by the Operators each year for the purpose of extending the life of the project and, thus, the length of time that severance and royalty revenues accrue to the Tribes. However, the total number of wells drilled would remain at 325.

Because the purpose of this alternative would be to extend the duration over which revenues accrue to the Tribes, an analysis was conducted to explore the impact of extending the "life of project" (LOP) in terms of total potential gas recovery and the severance tax and royalty revenue that would accrue to the Tribes over time. The Operators were requested to prepare a *pro forma* operating analysis of drilling and production operations in the WRPA under two scenarios.

Both scenarios assumed that 325 total wells would be drilled, but whereas the Proposed Action assumes a 13-year elapsed time drilling schedule, the LOP alternative assumes a 31-year elapsed time schedule to generate revenue over an extended period of time. Tables 2-14 and 2-15 provide a field-by-field comparison of the level and pace of drilling under each alternative.

Table 2-14. Proposed Action Drilling Schedule

Field	Average # Wells Drilled/Year	Length of Drilling (Years)	Total Wells
Pavillion	14	11	155
Muddy Ridge	10	10	50
Sand Mesa	8	13	100
Sand Mesa South	3	4	12
Coastal Extension	1	8	8

Table 2-15. LOP Alternative Drilling Schedule.

Field	Average # Wells Drilled/Year	Length of Drilling (Years)	Total Wells
Pavillion	5	31	155
Muddy Ridge	2	25	50
Sand Mesa, Sand Mesa South and Coastal Extension	4	30	120

Both scenarios were predicated on 205 new producing wells in the Pavillion (155) and Muddy Ridge (50) fields. Analysis of potential future production from Sand Mesa, Sand Mesa South and Coastal Extension fields were omitted from both scenarios. Exploratory drilling in these fields is highly speculative from a reserves and production standpoint, so that the results of analyses including these fields would have a high level of uncertainty.

The projections prepared by the Operators included projected annual production of oil and natural gas, the corresponding gross value, and the projected operating costs and capital investment associated with each scenario. These projections provided the basis for estimating future severance tax and royalty revenues, assuming severance taxes at 8.0 percent of the net revenue (gross revenue less operating costs) and royalties at 16 percent of the net revenue. The annual revenues were derived and summed over time. A discounted net present value (NPV) of future revenue was then derived for each scenario. Discounting is a tool used for converting future streams of monetary values (either costs or revenues) to a single equivalent value, typically expressed in current monetary terms, for the purposes of comparison.

The annual revenue that would accrue to the Tribes under the two scenarios is shown in Figure 2-15. The dark bars show the revenue under the Proposed Action, with the cross-hatched bars showing the revenue accruing under the LOP alternative. Given the more rapid drilling schedule under the Proposed Action, the rate of revenue accrual is substantially higher through about 2016, after which revenue falls below the level that would accrue given the LOP alternative.

The analysis provided by the Operators indicates that the net resource recovery and un-recovered reserves would be comparable under the two scenarios: 434 million Mcf produced and 47 million Mcf un-recovered for the Proposed Action vs. 441 million Mcf produced and 40 million Mcf un-recovered under the LOP alternative. The gross revenue generated is approximately equal under the two alternatives, with a trade-off in the rate of accrual, earlier and higher versus later and lower. However, that apparent equivalency vanishes once the costs of production are considered, particularly those associated with the long-term maintenance and operation of the gas collection (i.e., pipelines), processing, and compression system.

The field infrastructure system is capital intensive and has a substantial fixed cost component. Because the LOP alternative produces a lower volume of gas over the first 12 to 13 years, a larger share of the gross revenue is required to cover the costs. In fact, the fixed costs of the system eventually result in the production falling below the threshold for economic viability, approximately 5 million Mcf per year, triggering the cessation of production by the Operators and abandonment of 40 to 47 million Mcf of gas. That point is illustrated when the respective bars reach a $0 value in Figure 2-15 and result in lower gross income and hence lower severance tax and royalty payments to the Tribe. When considered on a discounted present value basis, the difference in terms of economic value to the Tribe and its members is significant.

Figure 2-16 illustrates the effects of maintaining and operating the infrastructure of the fields over a longer duration. The plots of cumulative revenue for the two scenarios, illustrated when the lines become horizontal, peak at $154.9 million under the Proposed Action, compared to $140.3 million under the LOP alternative. However, the NPV of those two revenue streams indicate an even wider disparity, in favor of the Proposed Action.

Under the Proposed Action, the NPV of future production, using a 10 percent discount rate, is $81.0 million. By comparison, the NPV of the LOP option, using the same 10 percent discount rate, is $46.9 million. The additional $34.1 million in present value under the Proposed Action (PA) is equivalent to a 73 percent increase over the LOP alternative.

A sensitivity analysis was conducted using lower discount rates of 7.0 percent and 4.0 percent, which corresponds to lower preferences for receiving income sooner as opposed to later. This analysis indicates that the Tribes would receive substantially lower revenues, in terms of present monetary value, from the LOP alternative.

A summary of the differences between the revenues derived from the Proposed Action versus an alternative that would extend the life of the field, using discount rates of 10 percent, 7 percent and 4 percent, is demonstrated below.

10% Discount Rate: $81.0 million Proposed Action vs. 46.9 million LOP Alternative.
A $34.1 million difference or 73% increase over the LOP Alternative.

7% Discount Rate: $96.2 million Proposed Action vs. $60.7 million LOP Alternative.
A $35.5 million difference or 58% increase over the LOP Alternative.

4% Discount Rate: $116.3 million Proposed Action vs. $82.9 million LOP Alternative.
A $33.4 million difference or 40% over the LOP Alternative.

Figure 2-15. Annual Severance and Royalty Income to the Tribes.

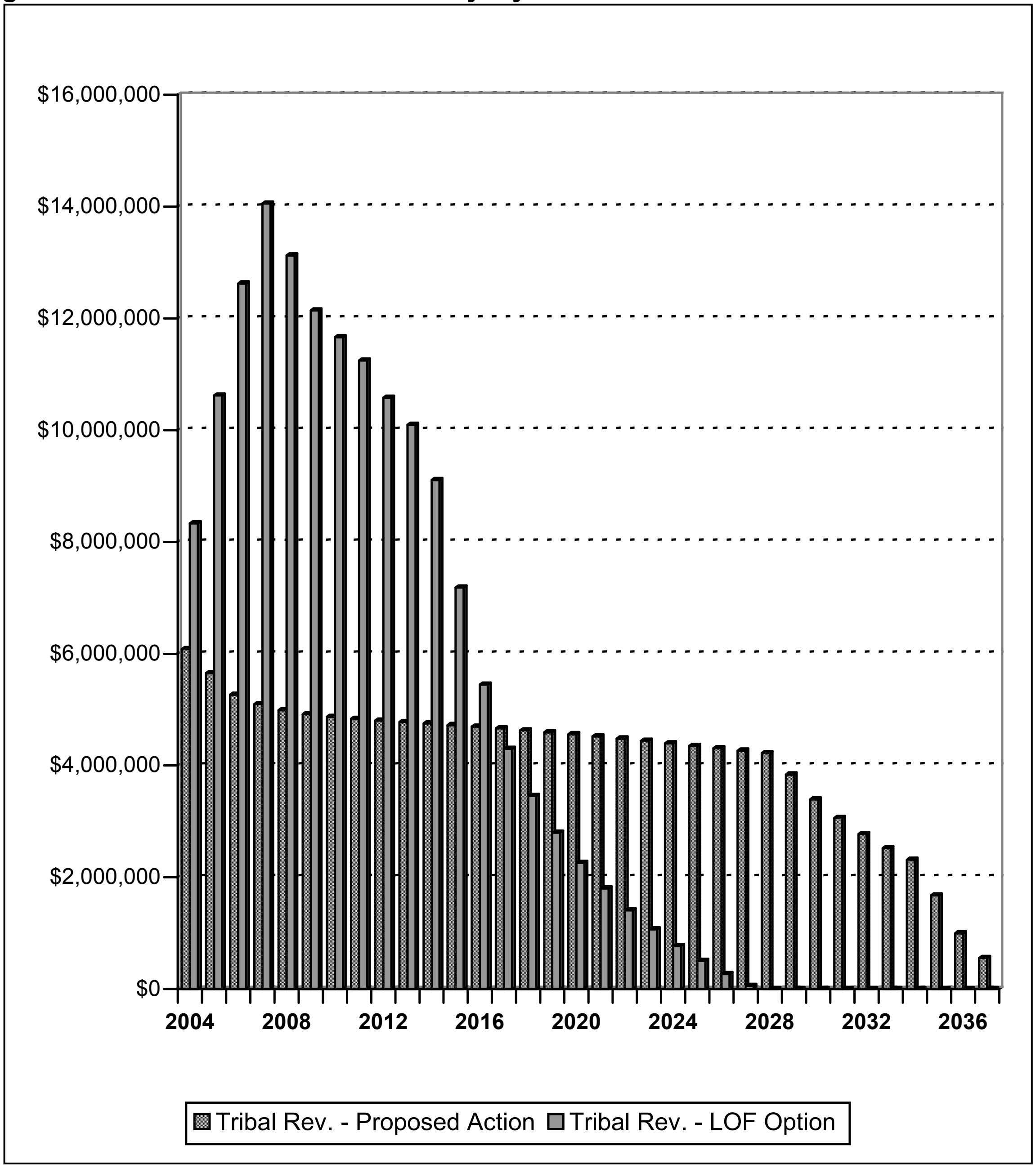
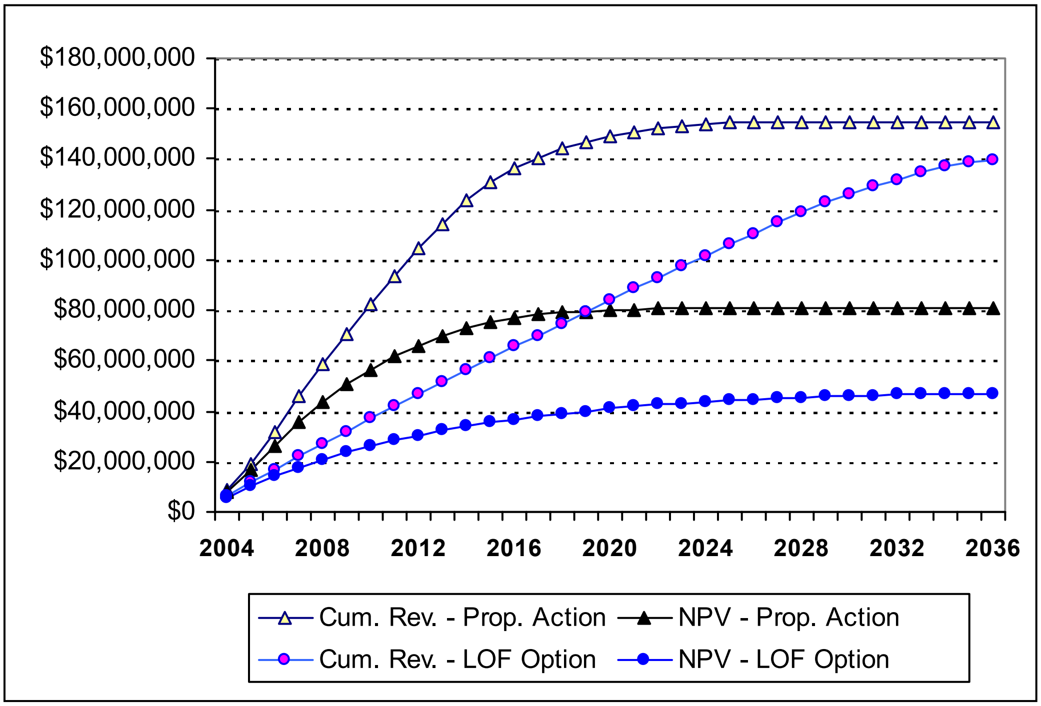


Figure 2-16. Cumulative Revenue and Cumulative Discounted Present Value of Future Tribal Revenues.



Conclusion

The purpose of the LOP alternative is to extend the period of time that production-related severance and royalty revenues from Tribal leases would accrue to the Tribes. Although the LOP alternative would generate revenue to the Tribes for a longer period of time, it would yield substantially less revenue to the Tribes, in both absolute and present value terms, than the Proposed Action. In addition, a substantially larger share of the gross revenue would be required to support and maintain infrastructure.

Tribal minerals within the WRPA are held in trust for the Tribes by the Department of the Interior (DOI). Under the 1916 Act, the IMLA, and the IMDA, the DOI has a fiduciary responsibility to assure that the Tribes receive the maximum economic benefit from the minerals on their lands. The reduction in both absolute and present value revenue associated with LOP alternative would clearly be contrary to this obligation. Therefore, the LOP alterative was rejected by the BIA.

2.9.2 Directional Drilling

The requirement to directionally drill all wells within the WRPA was considered as an alternative, since directional drilling was recommended in comments to the scoping notice. The comments stated that directional drilling would result in a potential decrease in environmental impacts, as well as impacts to agricultural and grazing lands. A requirement to directionally drill all wells under the Proposed Action, and Alternatives A, B, and C was rejected as an alternative by the BIA, since it would not be technically and economically feasible to directionally drill all wells.

In the WRPA directional drilling may be used by the Operators under the following conditions listed below.

- Presence of topographical features where vertical drilling would be technically unfeasible.
- Presence of high density of cultural/historical sites.
- High potential for impacts (e.g., “take”) to threatened, endangered, and state-sensitive species.
- Health, safety, and environmental concerns associated with occupied residences.

The most common technique for directional drilling is the S-shaped well (see Figure 2-5), which would be technically feasible at some, but not all, locations in the WRPA. The S-shaped well has some of the technical advantages of vertical wells, but also has technical and economic disadvantages, as described below.

- Drilling of directional wells result in increased costs and an increased risk of failure. Two S-shaped wells per pad (without a vertical well) may produce the same reserves as two vertical wells on the same spacing, but at an estimated increased drilling cost of $150,000 per well or more. In addition to the direct increase in drilling costs, there is an increased risk of developing borehole problems during directional drilling operations that result in the loss of the well. The loss of a well as a result of directional drilling problems would most probably necessitate moving the drilling rig to a nearby location and re-drilling the well.

- Directional drilling results in an increase in direct costs. The potential cost savings in surface infrastructure that would be realized by drilling two wells per pad would not be offset by the increased directional drilling and completion costs.
- Offsetting an existing vertical well with an S-shaped well would be economically less efficient, resulting in a decrease in the per-well reserves and an increase in the per-well expenses.

Another type of directional drilling is horizontal drilling. Horizontal drilling techniques are commercially successful in productive zones that are continuous without significant faulting and severe inclination. Horizontal drilling methods are used mainly to develop fractured reservoirs consisting of a single zone formation with low permeability or to limit water encroachment. In the WRPA, multiple producing formations and multiple producing zones can be encountered in each well. The discontinuous sandstones of the Wind River, Fort Union, Meeteetse, and Mesaverde formations cannot be efficiently developed with the application of horizontal drilling.

Vertical wells have the following advantages over directionally-drilled wells.

- Multiple sands can be hydraulically fractured and produced in a single completion with low risk, using proven technology.
- Vertical wells can readily be re-completed in other productive zones when production from the initial completion declines to non-commercial rates.
- The risk of failure during drilling and completion operations is very low as compared to the risk for directionally drilled wells.
- Vertical wells maximize the recovery of gas reserves in multi-reservoir sections, which are prevalent within the Pavillion area.

In the Pavillion area, drilling would occur in the Wind River formation, extending from the surface to approximately 3,500 feet in depth, and in the Fort Union formation, extending to approximately 5,800 feet in depth. Productive intervals occur in the Wind River formation at depths as shallow as 700 feet. As a result of the shallow productive intervals, directional drilling an S-shaped well in the Pavillion area quickly becomes infeasible as the distance between the location of the well on the surface and the location of the bottom of the well increases. The risk associated with directional drilling in Pavillion may be as high as 75 percent when the distance between the well surface and bottom hole location is 930 feet (typical 20-acre spacing distance). Some of the primary factors resulting in the increased mechanical risk from directional drilling in the Pavillion area are described below.

In drilling a directional well, there are practical limits for the radius of curvature, or how sharply the well turns. When directional wells exceed practical limits, the following problems may be encountered:

- Well bore stability and cleaning during drilling operations becomes more difficult.
- “Key seating” or sticking of the drill string is more likely, and may result in the loss of the well.
- Piping used to produce the well can be stressed when forced to bend sharply, potentially resulting in rupture and well failure.
- Artificial lift, necessary for the removal of produced liquids from the well, becomes more difficult in directional wells and may not be possible in wells with sharp turns or high angles. All Pavillion wells will require artificial lift at some point in the life of the well.
- Fracture stimulation, necessary for improving the flow of gas from the reservoirs, becomes ineffective at high (over 20-degree) angles.
- Electric logging of the wells, required to determine where potential gas-bearing zones are located, becomes very difficult and more costly (TBI 2003a).

The shallow depth of the producing formations in the Pavillion field would require high angles to directionally drill a well. The high angles required would be difficult to achieve, would increase the likelihood of engineering problems during drilling, and would be difficult to produce over the long term. Directional drilling an S-shaped well in the Pavillion field quickly becomes infeasible as the distance between the location of the well on the surface and the location of the bottom of the well increases. The risk associated with directional drilling in Pavillion may be as high as 75 percent when the distance between the well surface and bottom hole location is 930 feet (typical 20-acre spacing distance). Thus, directional drilling all wells in the Pavillion field was rejected, since it is not mechanically feasible and does not meet the criterion of a “reasonable alternative,” in accordance with 43 CFR 1502.14(a).

In the Muddy Ridge field, where the depth of drilling is estimated to be 12,500 feet, the mechanical risk of directionally drilling is low (i.e., an estimated 5 percent failure rate), and would cost an additional $150,000 per well (TBI 2003a). Although directional drilling is also feasible in the Sand Mesa field, adverse drilling conditions increase the risk of failure to approximately 25 percent. The cost of directional drilling at Sand Mesa can be more than $300,000 higher than at Muddy Ridge, resulting in a total additional cost of $450,000 (D. Walton, TBI, personal communication May 20, 2004). The feasibility of directional drilling in the Sand Mesa South and Coastal Extension fields has not been determined due to the exploratory nature of these fields.

2.9.3 Phased Development of Wells

There was some discussion in the scoping comments about “phasing” gas development. Phased development is already a component of the Proposed Action and each alternative, both in the annual number of wells proposed for drilling and the timing of the drilling program. The Operator’s drilling program for the Proposed Action and alternatives consists of phased development of the five development areas. The specific number of wells to be drilled each year is shown in Table 2-16. The drilling schedule for the Proposed Action in the Pavillion field is approximately 10-18 wells per year for 10 years; the proposed drilling schedule in the Muddy Ridge field is approximately 12 wells per year for four years; the proposed drilling schedule in the Sand Mesa field is approximately eight wells per year for 13 years; the proposed drilling schedule for the Sand Mesa South field is approximately three wells per year between 2006 and 2009, contingent on the success of the Sand Mesa Field; and the proposed drilling schedule for the Coastal Extension field is one well per year between 2006 and 2013, contingent on the success of the Big Sky Prospect (which is not in WRPA). Consequently, phased development of wells is adequately considered under the existing alternatives and was eliminated from further analysis.

Table 2-16. Number of Wells within the WRPA to be Drilled Annually under each Alternative.

PROPOSED ACTION (325 NEW WELLS)

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	11	12	8		
2005	12	12	8		
2006	13	12	8	3	1
2007	12	12	8	3	1
2008	13	2	8	3	1
2009	17		8	3	1
2010	17		8		1
2011	18		8		1
2012	15		8		1
2013	17		8		1
2014	10		8		
2015			8		
2016			4		
TOTAL	**155**	**50**	**100**	**12**	**8**

ALTERNATIVE A (485 NEW WELLS)

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	14	12	8		
2005	14	12	8		
2006	14	12	8	3	2
2007	14	12	8	3	2
2008	14	12	8	3	2
2009	14	6	8	3	2
2010	14		8	3	2
2011	14		8	3	2
2012	14		8	3	2
2013	14		8	3	2
2014	14		8	3	2
2015	14		8	3	2
2016	14		8	3	2
2017	14		8	3	2
2018	10		8	3	2
2019			8	3	2
2020			5	3	2
2021				3	2
TOTAL	**206**	**66**	**133**	**48**	**32**

ALTERNATIVE B (233 NEW WELLS)

Year	Pavillion	Muddy	Sand Mesa	Sand Mesa	Coastal

		Ridge		South	Extension
2004	14	12	8		
2005	14	12	8		
2006	14	12	8	3	1
2007	14	4	8	3	1
2008	14		8	3	1
2009	14		8	1	1
2010	12		8		1
2011			8		1
2012			8		1
2013			8		
TOTAL	**96**	**40**	**80**	**10**	**7**

ALTERNATIVE C (100 NEW WELLS)

Year	Pavillion	Muddy Ridge	Sand Mesa	Sand Mesa South	Coastal Extension
2004	14	No wells drilled	No wells drilled	No wells drilled	No wells drilled
2005	14				
2006	14				
2007	14				
2008	14				
2009	14				
2010	14				
2011	2				
TOTAL	**100**				

2.9.4 Natural Resource Protection

Several respondents to the scoping notice expressed concern about the potential impacts of the Proposed Action on agricultural land, wildlife, surface and groundwater quality, and air quality. One of the respondents to the scoping notice stated that the EIS should analyze an alternative that provides greater protection for sensitive resources and values affected by impacts from natural gas development activities. Many natural resource conservation measures, including those suggested in the scoping comments are either already required by existing regulations or lease requirements, or would be performed as Operator-committed mitigation measures to protect threatened, endangered and sensitive species, and minimize the impact to wildlife, vegetation, soils, agriculture, air quality, and water quality. These measures have been implemented for the wells that have been drilled by the Operators within the last several years and would also be incorporated as part of the Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action Alternative). Operator-committed mitigation measures that would be implemented under the Proposed Action and alternatives on federal lands are listed below. Mitigation measures on private surface are established with the individual landowner.

- On agricultural land in the Pavillion field, wells are only drilled in the winter months (November to April) to minimize the impact on the irrigated fields.

- On agricultural land in the Pavillion field, only the wellhead is located in the crop field. Residual environmental impact of the well pad in agricultural areas is reduced from 185x270feet (1.15acre) to 8x8feet (0.002 acre) after construction and drilling has been completed.
- Fill material, purchased from the landowner, is used to pad the irrigated field during drilling operations to protect the crops and is removed before spring thaw.
- The Operators accommodate the landowners, as much as possible, in the location of the well pads, while maintaining adequate well spacing required in the spacing orders.
- Existing rights-of-way are used for pipeline construction, where possible.
- Reserve pit spoil material is relocated as soon as drilling is completed.
- Private water wells are tested for the presence of contaminants before and after drilling operations.
- Unpaved access roads are watered on a frequent basis to minimize the release of dust into the air.
- Minor sources of air pollution meet Best Available Control Technology (BACT) standards.
- The size of the reserve pit is reduced in agricultural areas to minimize environmental impact.
- No drilling occurs within 500 feet of waterbodies (e.g., Muddy and Fivemile Creeks).
- New wells are drilled on existing well pads, where possible.
- Speed limits are reduced within the WRPA to reduce dust generation and noise levels.

In areas where threatened, endangered and state sensitive species may occur, TBI would follow the requirements of the USFWS. For example, if the Operators propose to drill within the white-tailed prairie dog colonies, a survey for the endangered black-footed ferret would be conducted in the year in which drilling would occur, in accordance with USFWS requirements. The purpose of the survey is to determine whether the ferrets are present. If ferrets are found, no drilling would be permitted to occur within the prairie dog colonies. If mountain plovers (listed by the State as species of concern, and protected under the Migratory Bird Treaty Act) are observed nesting in areas where drilling is planned, drilling would be halted during the mountain plover breeding period between April 1 and July 10. As required by the USFWS, one-mile buffer zones will be established in areas within the WRPA where bald eagle and golden eagle nests have been observed. In areas where sage grouse have been observed to nest, activities that would disturb brood rearing would be discontinued between June 1 and July 31.

In addition, a monitoring program would be undertaken during drilling and production for evaluating the potential effects of the Proposed Action or alternatives on wetlands and riparian areas, wildlife, air quality, water quality, federally listed species and state sensitive species.

Since the Proposed Action and the other alternatives contain agency-specified and Operator-committed measures to minimize effects on natural resources, a "natural resource protection" alternative would be redundant, and, therefore, has not been evaluated in detail in this EIS.

2.8.5 FORTY-ACRE SPACING IN PAVILLION AND MUDDY RIDGE FIELDS

Several respondents to the scoping notice expressed concern that the proposed increase density of wells for the Proposed Action in the Pavillion and Muddy Ridge fields from one well per 40 acres to one well per 20 acres would increase environmental impacts as well as impacts on land use, such as agriculture and livestock grazing. A consistent well density of one well per 40 acres was suggested in some of the scoping comments in order to reduce these potential impacts.

The density of wells in the WRPA is authorized by spacing orders prepared by the State of Wyoming Oil and Gas Conservation Commission (WOGCC) for private minerals and the BLM Reservoir Management Group (RMG) for tribal and federal minerals. The purpose of the spacing requirements is to prevent waste and to protect "correlative rights" of the owners of the mineral rights. The well densities established in the spacing orders are based upon the maximum area that can be efficiently drained by a single well. The Operators are required to adhere to the BLM and WOGCC spacing orders and to the BLM Notice to Lessees (BLM 1997) for wells on tribal lands where spacing has not been designated in specific spacing orders.

If the drilling density is insufficient to remove the maximum amount of gas reserves, some gas-bearing reservoirs would not be developed for economic reasons and the gas reserves would not be recovered. The remaining unrecovered reserves would constitute "waste." The Mineral Leasing Act and 43 CFR parts 3160-3165 requires the lease holders to conduct their drilling program in a manner that it would result in the "maximum ultimate economic recovery of oil and gas." Therefore, a consistent well density of one well per 40 acres would not be in compliance with these statutes and the BLM and WOGCC Spacing Orders, In addition, it would not maximize the recovery of hydrocarbons from the lands in question (i.e., WRPA). Therefore, this alternative does not meet the criterion of a "reasonable alternative," in accordance with 43 CFR 1502.14(a), and was eliminated from detailed analysis.

2.10 SUMMARY OF POTENTIAL IMPACTS FROM THE PROPOSED ACTION AND ALTERNATIVES A, B, AND C.

The potential impacts to each resource resulting from the Proposed Action, Alternative A, Alternative B, and Alternative C (No Action), are analyzed for each resource in Chapter 4 of this EIS. A summary table of the potential impacts is provided in Table 2-17.

Table 2-17. Summary of Impact Determinations for the Proposed Action, Alternative A, Alternative B, and Alternative C.[1,2,3]

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
GEOLOGY				
Increased surface runoff	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Increased surface erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Collapse/piping/gullying	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Initiate mass movements	Negligible	Negligible	Negligible	Negligible
MINERALS				
Deplete petroleum reserves	Major, permanent	Major, permanent	Major, permanent	Major, permanent
Impede development of non petroleum resources	Negligible	Negligible	Negligible	Negligible
PALEONTOLOGY				
Damage to fossils	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Uncover new fossils and localities **(beneficial)**	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increased vandalism	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Increased illegal collection	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
SOIL				
Exposure of soil from vegetation removal	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Compaction/decreased permeability	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Collapse/piping/gullying	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Increased susceptibility of soil to wind and water erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
AIR QUALITY				
Increases in Local Pollutant Concentrations	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term	PM_{10}: Minor, Short Term; NO_2, CO O_3: Minor, Long Term
Increases in Regional Pollutant Concentrations	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	PM_{10}: Minor, Short Term; NO_2, SO_2: Negligible, Long Term	All Pollutants: Negligible, Long Term
Hazardous Air Pollutant Non-Cancerous Health Effects	Negligible, Long Term	Negligible, Long Term	Negligible, Long Term	Negligible, Long Term
Hazardous Air Pollutant Cancerous Health Effects	Minor, Long Term	Minor, Long Term	Negligible, Long Term	Negligible, Long Term
Increases in Terrestrial Acid Deposition	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Minor, Long Term; Sulfur Deposition: No Impacts	Nitrogen Deposition: Negligible, Long Term; Sulfur Deposition: No Impacts
Increases in Aquatic Acid Deposition (Decreased Lake ANC)	No Impacts	No Impacts	No Impacts	No Impacts
Reductions in Visibility (Regional Haze)	Moderate, Short Term; Minor, Long Term	Moderate, Short Term; Minor, Long Term	Minor, Short Term	No Impacts
SURFACE WATER				
Disruption of surface drainage systems	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Negligible, Long
Increased runoff and erosion	Moderate, Short term; Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Reduction in peak flows	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
Increased sedimentation in lakes and reservoirs	Minor, Short term; Negligible, Long term	Moderate, Short term; Minor, Long term	Negligible, Long term	Negligible, Long term
Change in surface water networks	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Minor, Long term
Increase in suspended solids (turbidity)	Moderate, Short term; Minor, Long term	Moderate, Short term; Minor, Long term	Minor, Long term	Minor, Long term
Change in water quality	Minor, Short term; Negligible, Long term	Minor, Short term; Negligible, Long term	Negligible, Long term	Negligible, Long term
GROUNDWATER				
Decrease in water levels	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Change in water quality	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Change in hydraulic properties	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
VEGETATION				
Increased erosion	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Placement of riprap	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Loss of vegetation	Minor, Short term	Moderate, Short term	Minor, Short term	Minor, Short term
Reduction in species diversity	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increase in bare ground	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increase in noxious weeds and nuisance species	Minor, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
WETLANDS				
Loss of wetlands	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Reduction in wetland species diversity	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
				term
Exposure to contaminants	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Loss of riparian areas	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
LAND USE				
Impact to agricultural lands	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Short term[4]
Impact to range resources	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Impact to residential areas	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Impact to recreational areas/ WHMAs	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Impact to resource extraction	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Impact to Land Use Plans	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
WILDLIFE				
Impacts to game species, birds, mammals, and fish	Negligible to Minor, Short term	Negligible to Minor, Short term	Negligible to Minor, Short term	Negligible to Minor, Short term
Loss of habitat	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Wildlife displacement	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Increased mortality	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Habitat fragmentation	Negligible, Long term	Minor, Long term	Negligible, Long term	Negligible, Long term
Potential exposure to contaminants	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Reduction in prey species	Negligible, Short term	Minor, Short term	Negligible, Short term	Negligible, Short term
Increased predation	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short

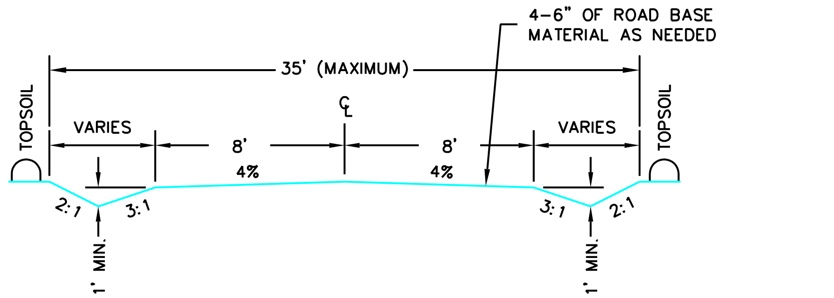
DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
				term
THREATENED/ ENDANGERED/ STATE SENSITIVE SPECIES				
Loss of Canada lynx habitat	No habitat	No habitat	No habitat	No habitat
Loss of bald eagle nesting, roosting, foraging habitat	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Loss of black-footed ferret habitat	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Loss of gray wolf habitat	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Loss of grizzly bear habitat	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Loss of mountain plover habitat	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term
Increase in bare ground **(beneficial for mountain plover)**	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Loss of sage-grouse habitat	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Increased mortality of T/E or State-sensitive species	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Potential exposure to contaminants	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
RECREATION				
Loss of federal and trust lands available for recreation	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Reduction in hunting and fishing opportunities	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Reduction in other recreation opportunities – wildlife viewing and ORV recreation	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Decreased enjoyment from recreational experience	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
VISUAL RESOURCES				
Alteration of landscape character	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Reduction in scenic quality	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Reduction in night sky quality	Moderate, Short term	Moderate, Short term	Moderate, Short term	Minor, Short term
Impact to VRI Class IV areas	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Impact to VRI Class III areas	Minor, Long term	Moderate, Long term	Negligible, Long term	Negligible, Long term
CULTURAL RESOURCES				
Increased vandalism	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Increased unauthorized collection	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Construction damage to sites	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Disturbance of Native American traditional uses	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
SOCIOECONOMICS				
Regional economic output **(beneficial)**	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Employment **(beneficial)**	Moderate, Long term	Moderate, Long term	Moderate, Long term	Minor, Long term
Personal income **(beneficial)**	Major, Long term	Major, Long term	Major, Long term	Minor, Long term
Revenues to the Eastern Shoshone and Northern Arapaho Tribes **(beneficial)**	Major, Long term	Major, Long term	Moderate, Long term	Minor, Long term
Revenues to Fremont County taxing entities **(beneficial)**	Moderate, Long term	Moderate, Long term	Minor, Long term	Minor, Long term
Increased local population	Negligible to minor, Long term	Minor, Long term	Negligible to minor, Long term	Negligible, Long term
Housing demand	Negligible, Long term	Negligible to minor, Long	Negligible, Long term	Negligible, Long term

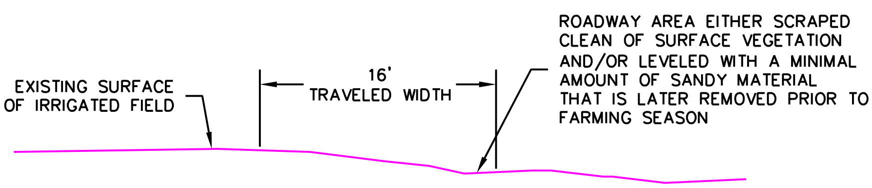
DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
		term		
Law enforcement and emergency response	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Midvale Irrigation District revenues and operations	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Split estate conflicts	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
Change in rural character	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
TRANSPORTATION				
Increased traffic and maintenance demands on state and federal Highways	Minor (except for WYO 134, which would be moderate), Long term	Minor (except for WYO 134, which would be moderate), Long term	Minor (except for WYO 134, which would be moderate), Long term	Negligible (except for WYO 134, which would be minor), Long term
Increased traffic and maintenance demand on county roads.	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term	Minor to Moderate (varying over time and across the WRPA), Long term
Traffic on private and operator-maintained roads	Minor, Long term	Moderate, Short term, Minor, Long term	Minor, Long term	Minor, Long term
Highway and road safety	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
HEALTH AND SAFETY				
Increased work-related accidents	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Increased vehicle traffic and accidents	Minor, Long term	Minor, Long-Term	Minor, Long term	Minor, Long term
Increased likelihood of wildfires	Negligible, Short term	Negligible, Short term	Negligible, Short term	Negligible, Short term
Pipeline Fire and Explosion Hazards	Minor, Long term	Minor, Long term	Minor, Long term	Negligible, Long term
Hazardous Materials and Waste – spills and releases	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term
Use of magnesium chloride for dust control	Negligible, Long term	Negligible, Long term	Negligible, Long term	Negligible, Long term

DESCRIPTION OF POTENTIAL IMPACT	MAGNITUDE AND DURATION			
Resource	**Proposed Action (325 Wells)**	**Alternative A (485 Wells)**	**Alternative B (233 Wells)**	**Alternative C (No Action)**
NOISE				
Well pad and access road construction	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Drilling operations	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Venting operations	Moderate, Short term	Moderate, Short term	Moderate, Short term	Moderate, Short term
Access roads	Minor, Long term	Minor, Long term	Minor, Long term	Minor, Long term
Compressor stations	Moderate, Long term	Moderate, Long term	Moderate, Long term	Moderate, Long term
Increased vehicle-related noise	Minor, Short term	Minor, Short term	Minor, Short term	Minor, Short term
Changes in wildlife behavior due to presence of humans and noise	Minor, Short term	Minor, Short term	Minor, Short term	Negligible, Short term

[1]**Definitions:**
Negligible impacts – Changes in resource condition are lightly above level of detection.
Minor Impacts – Changes is resource condition are measurable, but small and localized.
Moderate Impacts – Changes in resource condition are measurable and result in consequences that are relatively localized.
Major Impacts – Changes in resource condition are measurable and have substantial consequences at a regional level.
Short-term Impacts – Effects of short duration, that would occur during construction, drilling, completion and reclamation of a well.
Long-term Impacts – Effects of long duration, that would persist beyond the construction, drilling and reclamation phases, or continue for the life of the project.
[2]See Chapter 4 for detailed discussion of impacts.
[3]All impacts are adverse unless identified as "beneficial."
[4]Impacts from gas development in the Pavillion field are considered Short term, since disturbance from well pads will be reduced to 8'x8' in agricultural areas.



TYPICAL SECTION OF CROWN AND DITCH ROAD



TYPICAL SECTION OF ACCESS TRAIL ACROSS IRRIGATED FIELD

NOTE:
ACCESS TO A MAJORITY OF THE PAVILLION FIELD IS VIA GRAVEL AND ASPHALT COUNTY ROADS ADMINISTERED BY FREMONT COUNTY, WYOMING.

WHERE NECESSARY TO SERVE ONE OR MORE WELLS A 16 FOOT WIDE CROWN AND DITCH ROAD IS CONSTRUCTED. THE MUDDY RIDGE FIELD IS PRIMARILY CROWN AND DITCH ROADS CONSTRUCTED TO SERVE THE DRILLING AND PRODUCTION OPERATIONS.

TEMPORARY ROADS ACROSS FIELDS ARE COMPLETELY RECLAIMED AND RESEEDED TO MEET THE REQUIREMENTS OF THE INDIVIDUAL LANDOWNER.

Figure 2-1. Typical Roadway Cross-sections with Width Specifications, WRPA.

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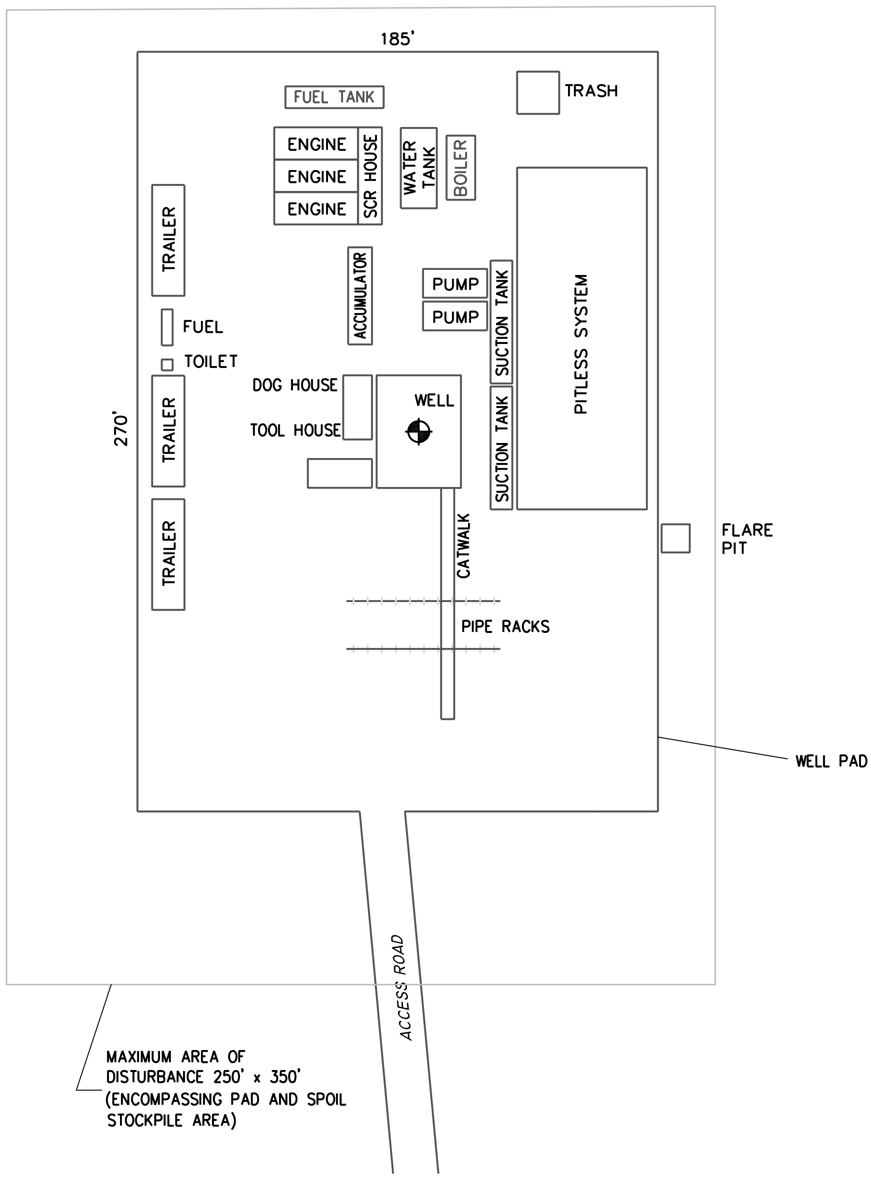

Figure 2-2. Detail of Typical Well Pad with Drilling Equipment Layout, WRPA.

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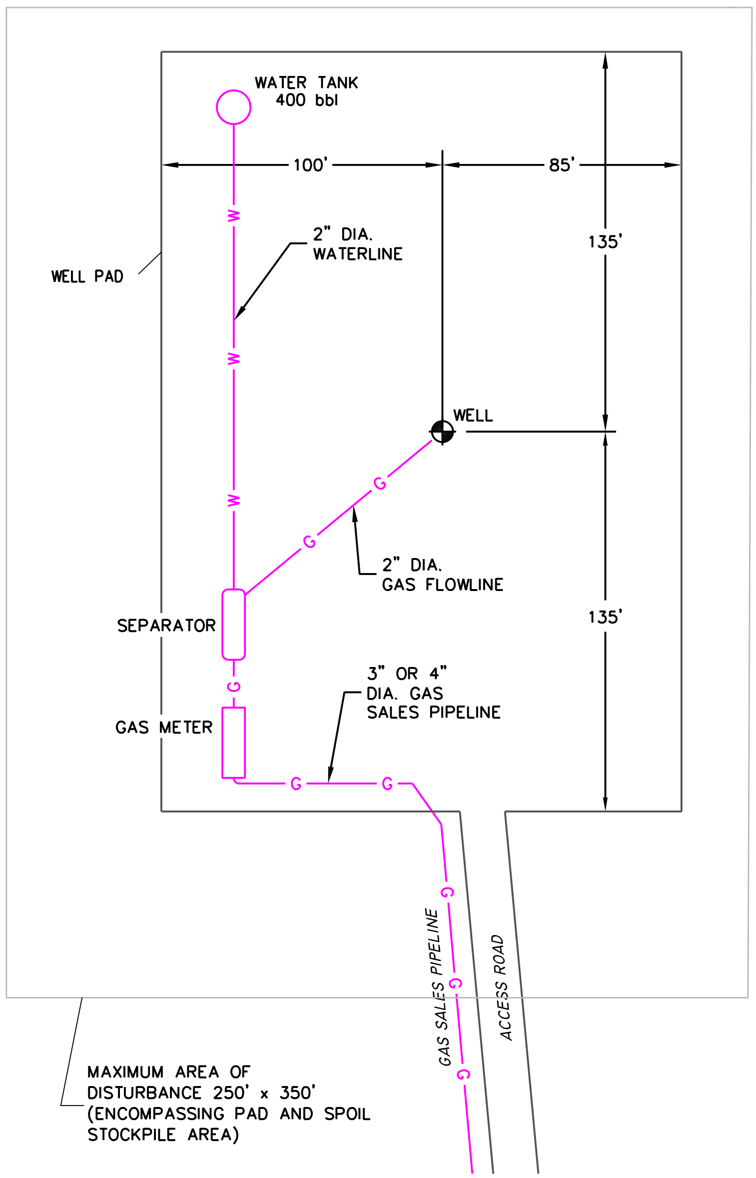

Figure 2-3. Detail of Typical Pavillion Well Pad with Production Facilities, WRPA.

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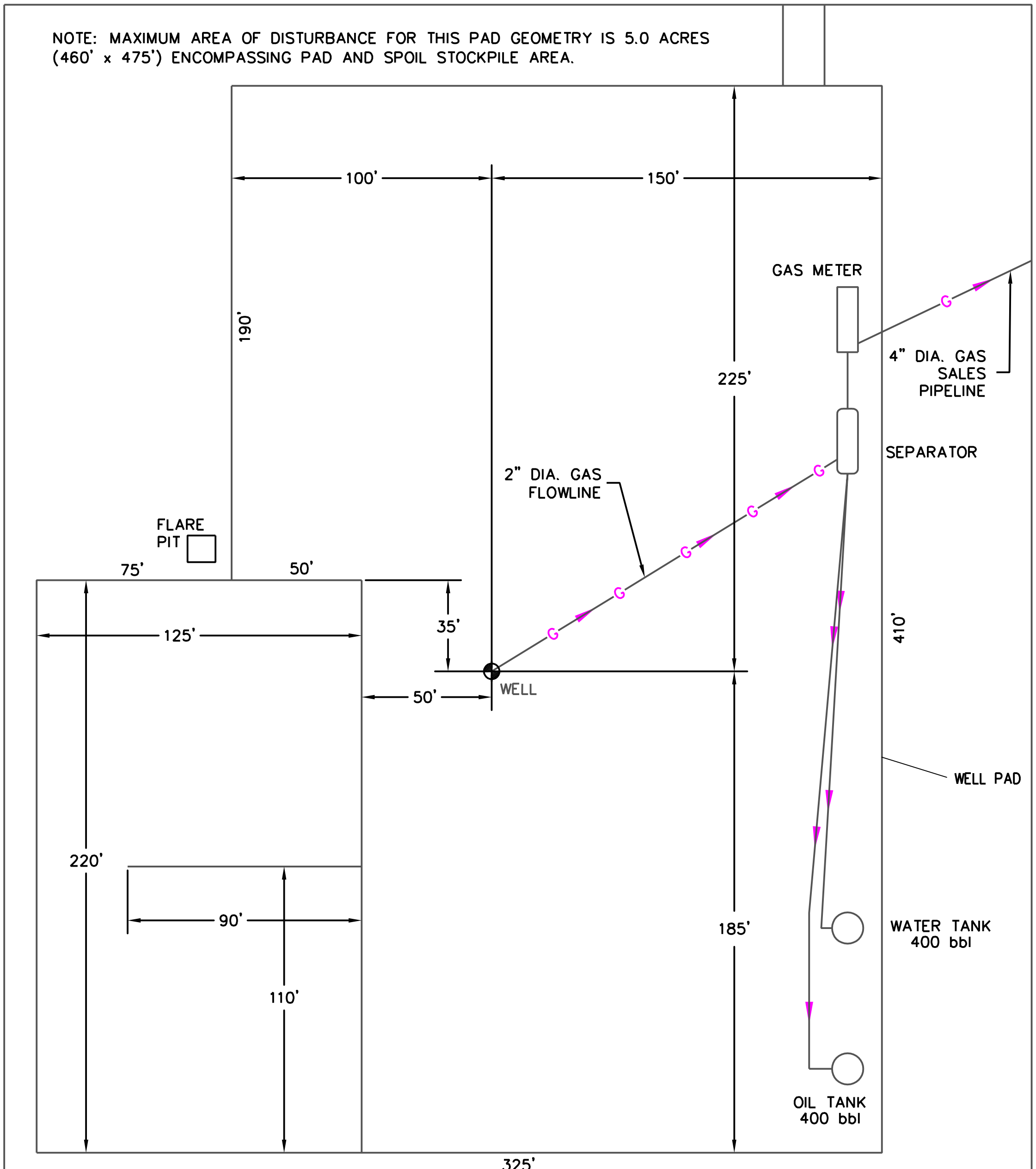

Figure 2-4. Detail of Typical Muddy Ridge and Sand Mesa Well Pad with Production Facilities, WRPA.

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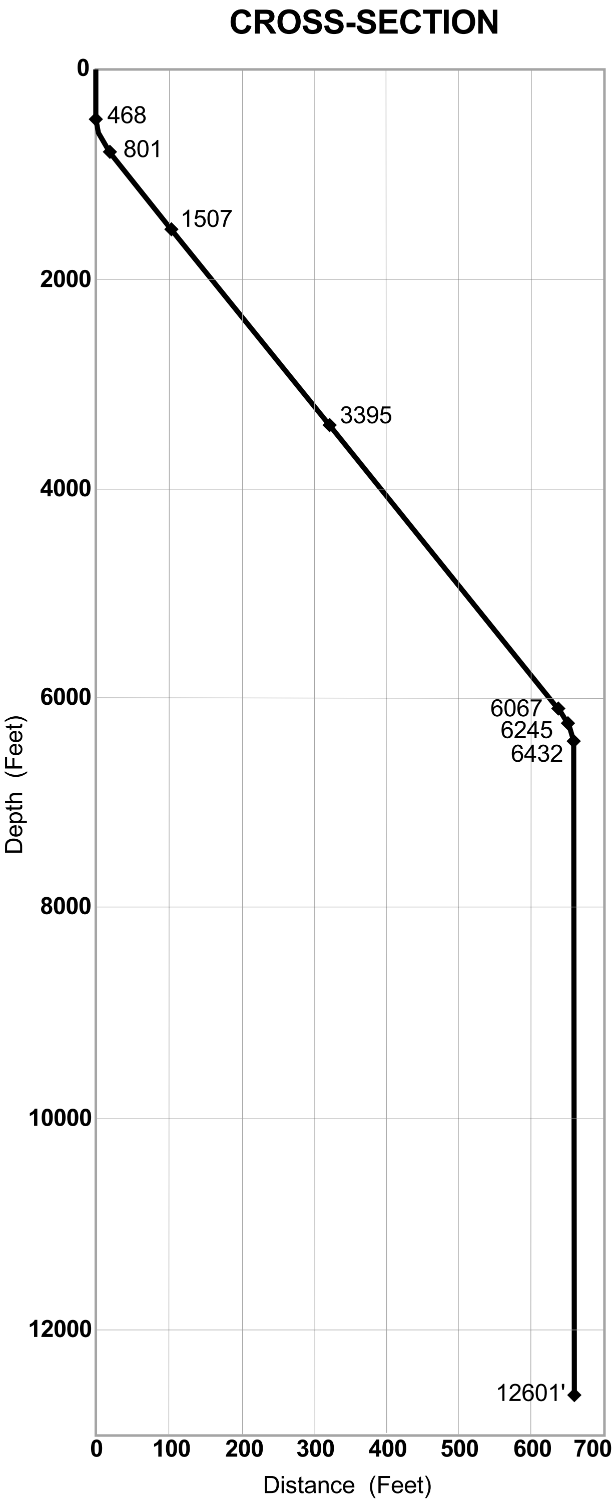

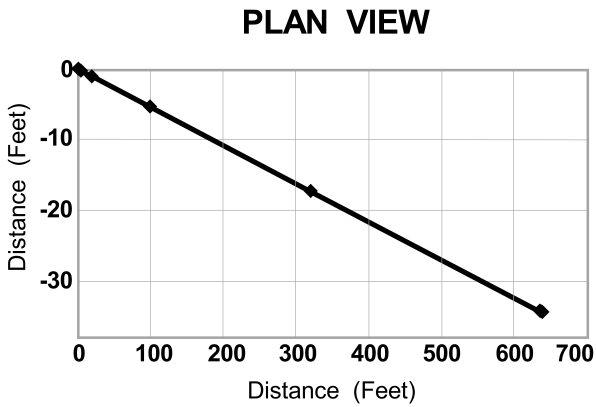

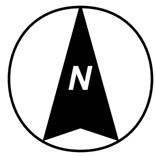

Formation	***Depth***
Wind River	Surface
Fort Union	3,432'
A Coal	6,032'
B Coal	7,052'
Lance	8,132'
Meeteetse	9,457'
Meeteetse Coal	10,232'
Mesaverde	10,902'
Lower Mesaverde	11,392'

◆ = TVD

Figure 2-5. Typical S-shaped Directional Drilling of a Muddy Ridge Well Showing Cross-section and Plan View.

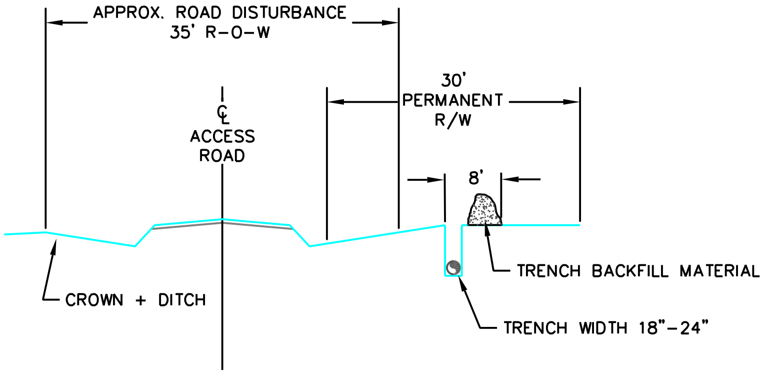

Figure 2-6. Typical Section of Gas Sales Pipeline Along Access Road, WRPA.

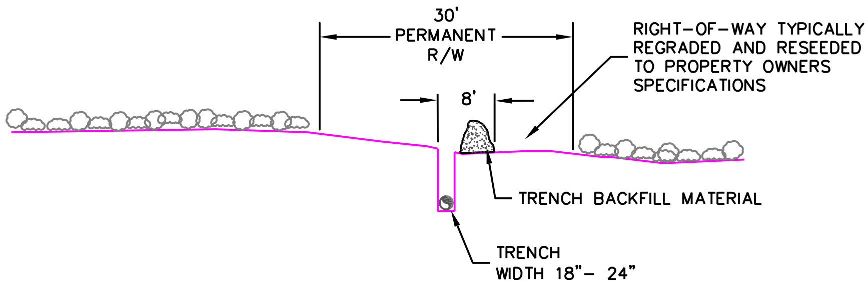

Figure 2-7. Typical Section of Gas Sales Pipline Across Irrigated Field, WRPA.

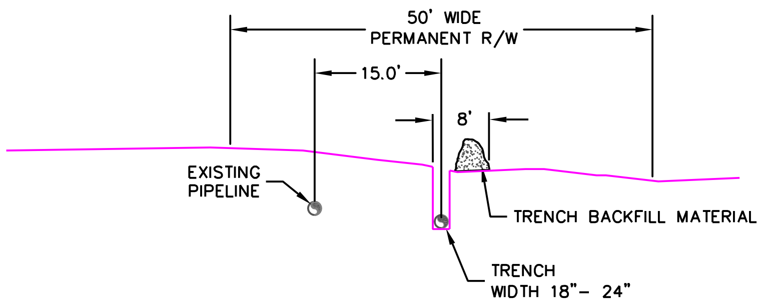

Figure 2-8. Typical Section of Gas Sales Pipeline Parallel to an Existing Pipeline, WRPA.

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PAVILLION WELLBORE DIAGRAM

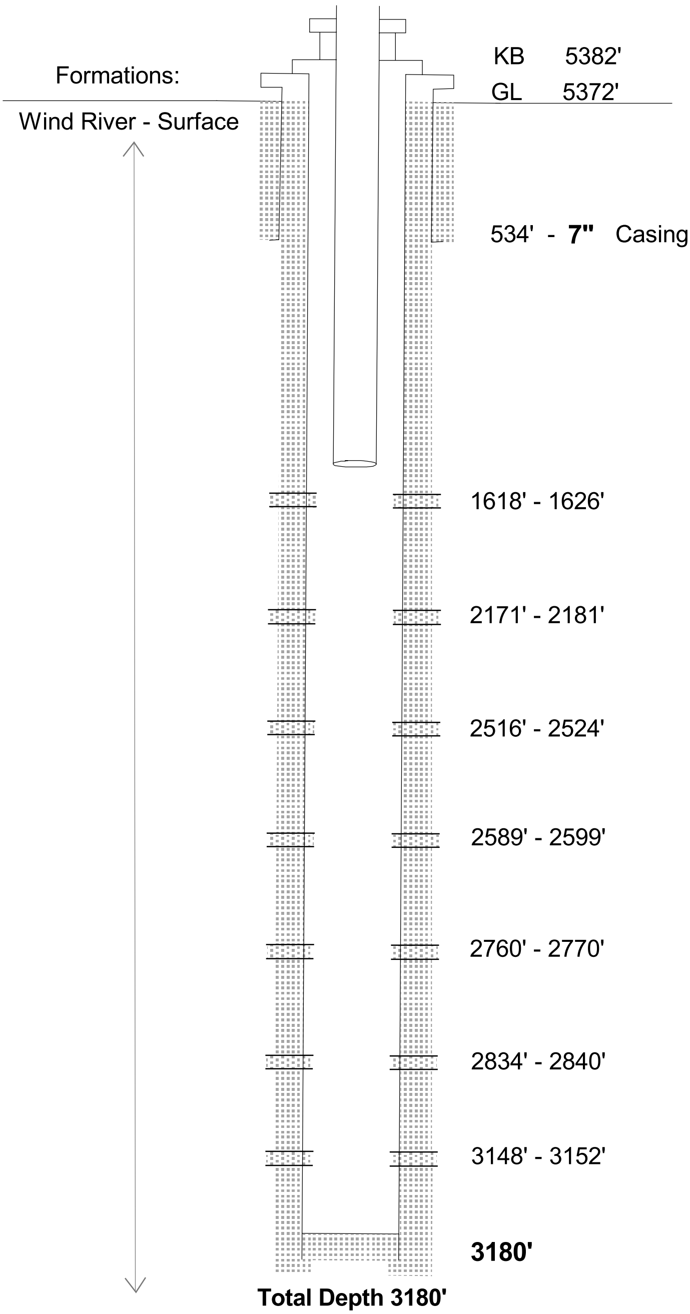

Figure 2-9. Typical Wellbore Diagram for a Vertical Well in the Pavillion Field (From Tom Brown, Inc. 2002).

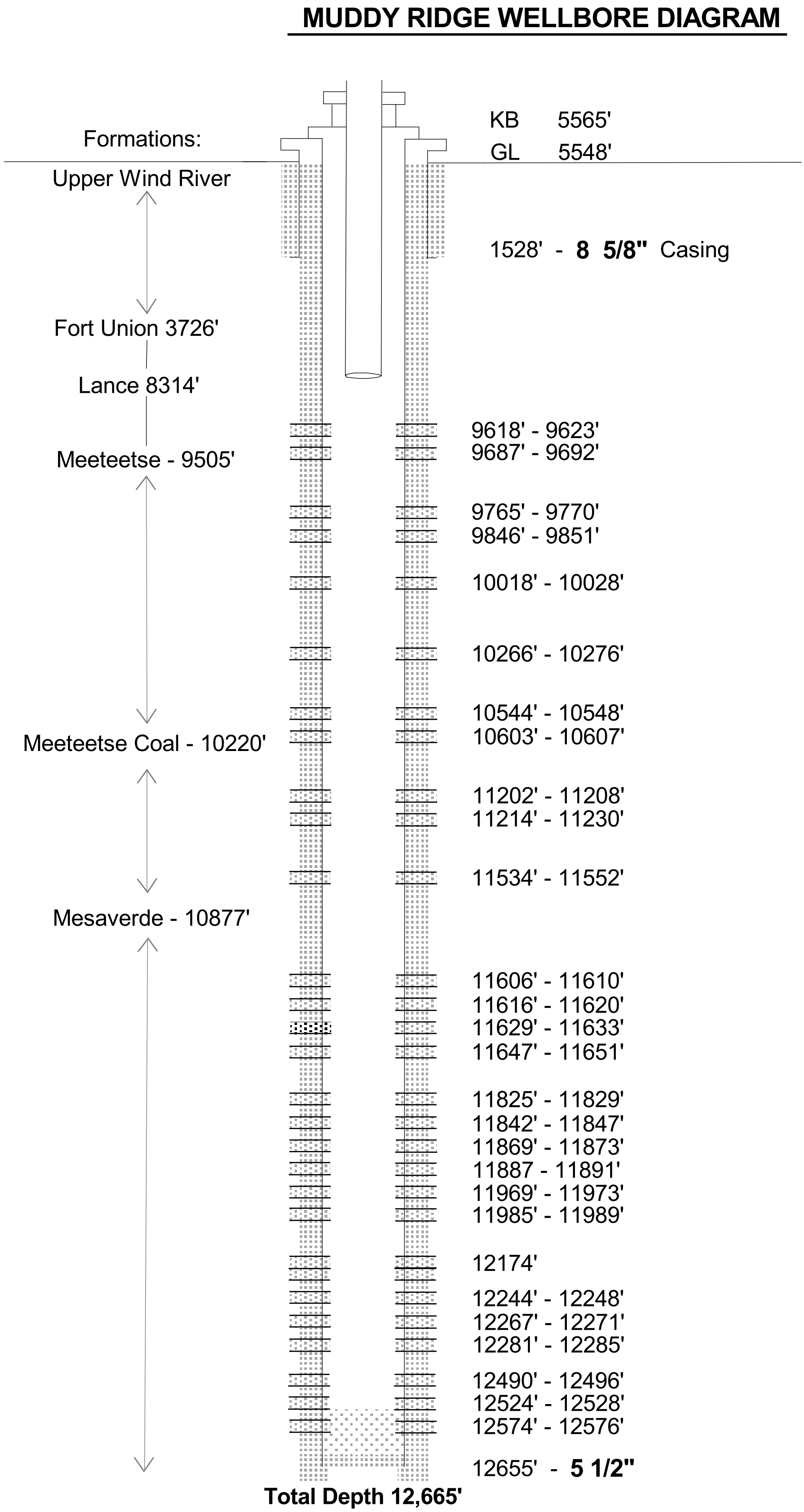

Figure 2-10. Typical Wellbore Diagram for a Vertical Well in the Muddy Ridge Field (From Tom Brown, Inc. 2002).

SAND MESA WELLBORE DIAGRAM

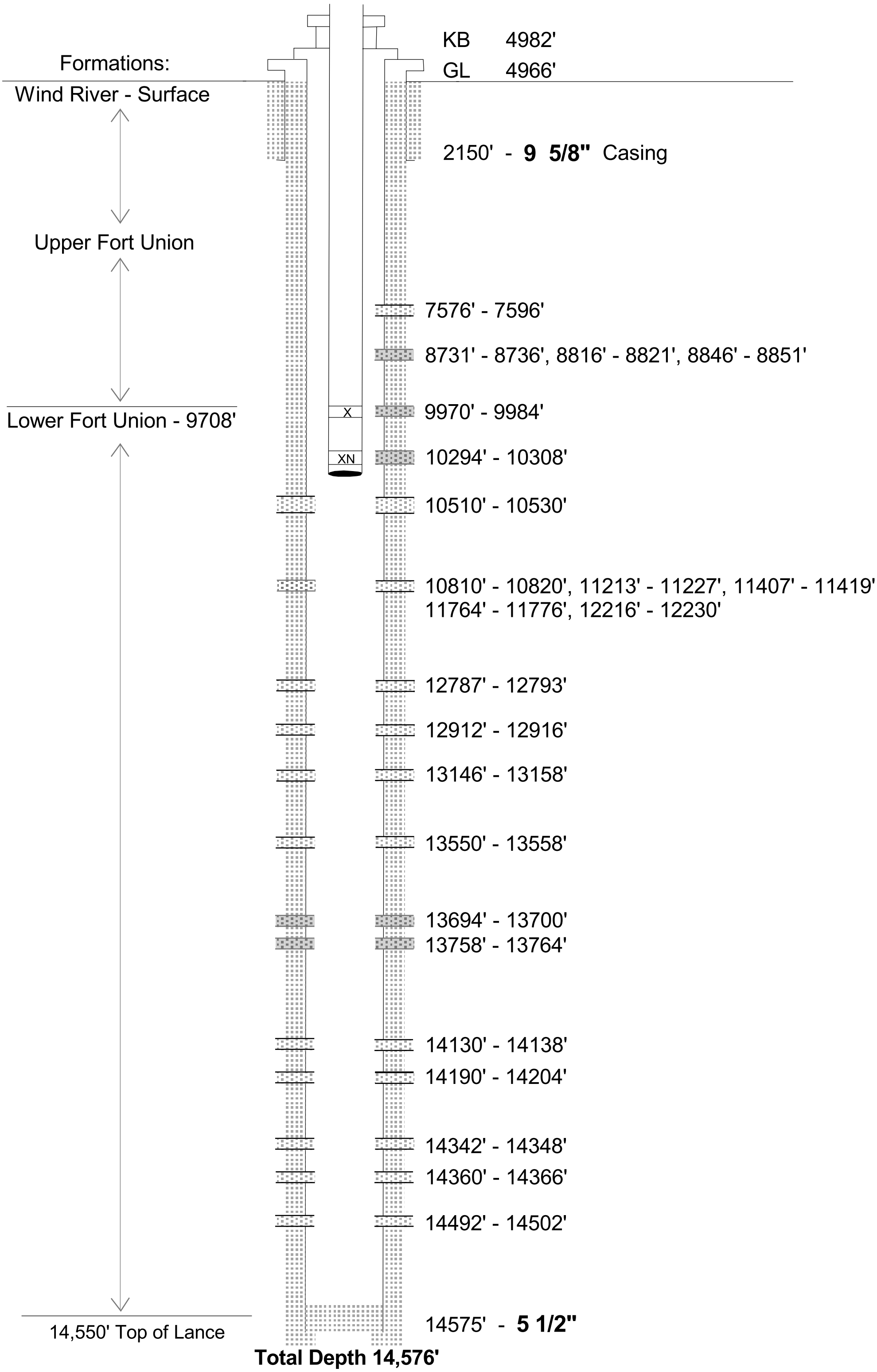

Figure 2-11. Typical Wellbore Diagram for a Vertical Well in the Sand Mesa Field (From Tom Brown, Inc. 2002).

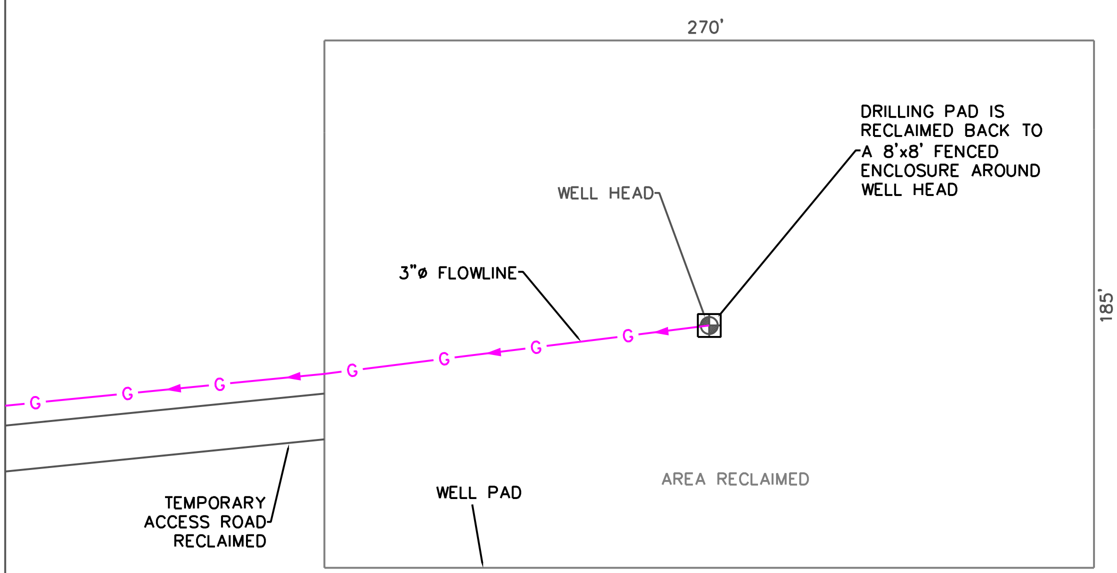

Figure 2-12. Drilling Pad Reclamation Detail for Irrigated Land in the Pavillion Field, WRPA.

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DRILLING PAD RECLAMATION DETAIL
TYPICAL OF PAVILLION FIELD
WELL IN IRRIGATED FIELD
PRODUCTION FACILITIES
LOCATED OFF SITE

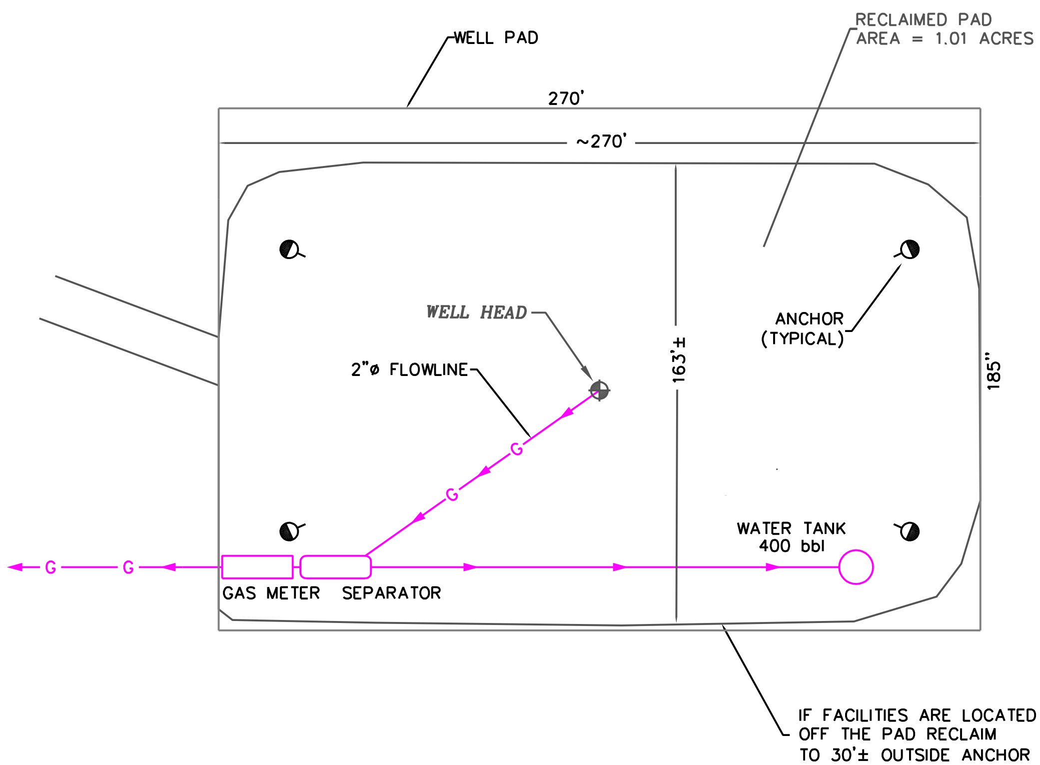

Figure 2-13. Drilling Pad Reclamation Detail, Pavillion Field Dry Land, WRPA.

NOT TO SCALE

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Riverton, Wyoming 82501
(307)856-1647

Job:
Bk:
Pg:

TOM BROWN, INC.

DRILLING PAD RECLAMATION DETAIL

TYPICAL OF PAVILLION FIELD

PERMANENT PAD INSTALLATION
WITH OR WITHOUT
PRODUCTION FACILITIES
ON SITE

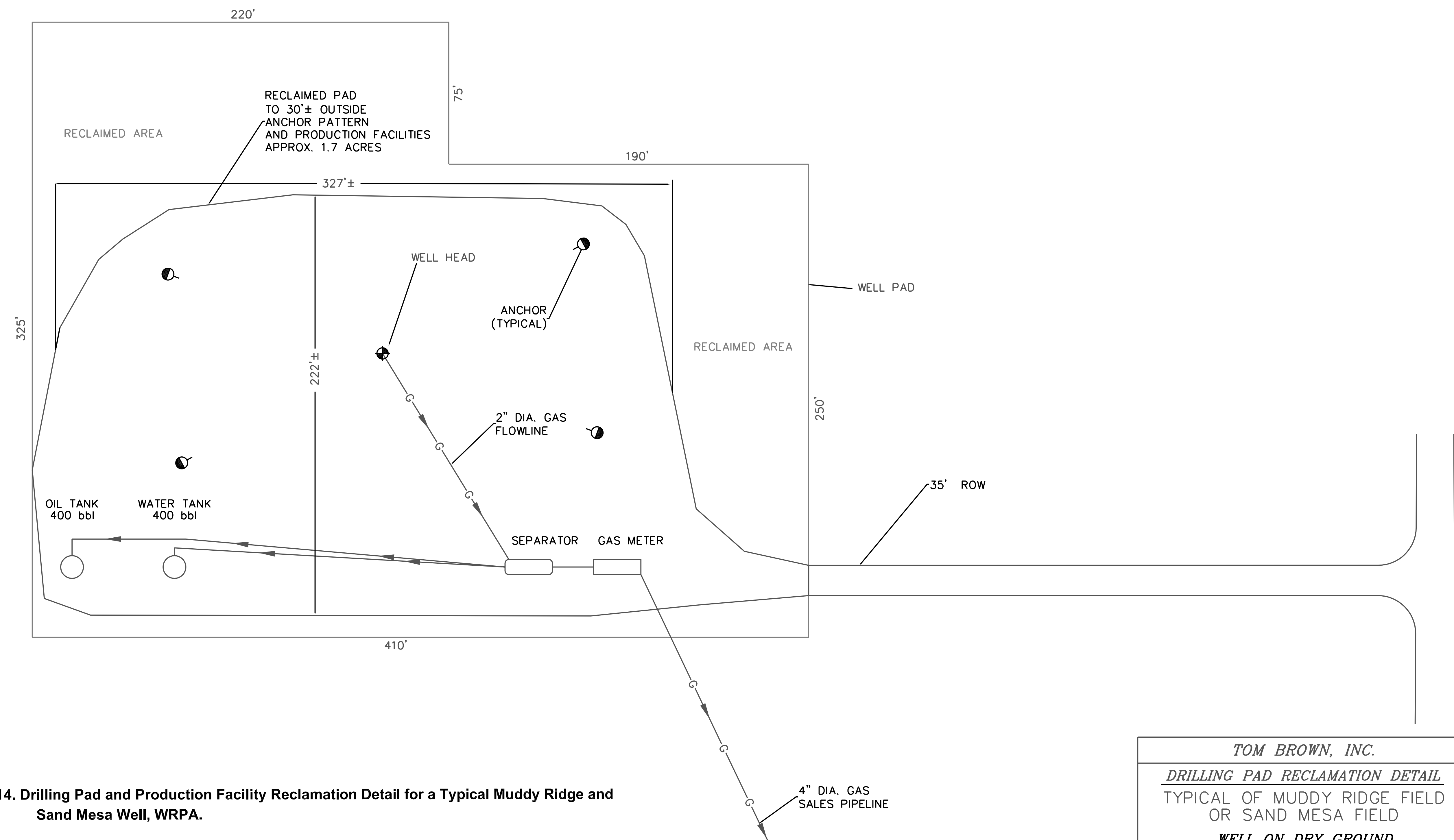

Figure 2-14. Drilling Pad and Production Facility Reclamation Detail for a Typical Muddy Ridge and Sand Mesa Well, WRPA.

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DRILLING PAD RECLAMATION DETAIL

TYPICAL OF MUDDY RIDGE FIELD
OR SAND MESA FIELD

WELL ON DRY GROUND
PRODUCTION FACILITIES
LOCATED ON SITE

3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

Chapter 3 describes the affected environment for the proposed Wind River Natural Gas Field Development Project and discusses the existing environmental, cultural, social, and economic conditions within the Wind River Project Area (WRPA). The affected environment varies for each resource due to the nature of the resource and the characteristics of the Proposed Action and alternatives. The following sections provide the information necessary to assess the potential effects of the Proposed Action and alternatives on the human environment.

The critical elements of the human environment that need to be addressed in an EIS are specified in National Environmental Policy Act (NEPA) Handbook H-1790 (BLM 1988). These elements and their potential to be affected by the Proposed Action and alternatives are listed in Table 3.1-1.

Table 3.1-1. Critical Elements of the Human Environment

Critical Element	Status within the WRPA	Addressed in this EIS
Air Quality	Potentially Affected	Yes
Surface and Groundwater Quality	Potentially Affected	Yes
Floodplains	Potentially Affected	No[1]
Wetlands/Riparian Areas	Potentially Affected	Yes
Invasive, Non-native Species	Potentially Affected	Yes
Prime or Unique Farmlands	Potentially Affected	Yes
Areas of Critical Environmental Concern	Potentially Affected	Yes
Threatened and Endangered Species	Potentially Affected	Yes
Cultural Resources	Potentially Affected	Yes
Native American Religious Concerns	Potentially Affected	Yes
Wild and Scenic Rivers	None Present	No
Wilderness	None Present	No

Environmental Justice	Potentially Affected	Yes
Hazardous or Solid Wastes	Potentially Affected	Yes

[1]Currently no federal, state, or local agency has delineated floodplains within the WRPA.Source: BLM 1988.

3.2 PHYSIOGRAPHY/GEOLOGY/MINERALS/GEOLOGIC HAZARDS/PALEONTOLOGY

3.2.1 Physiography

The Wind River Project Area (WRPA) is located within the Wyoming Basin physiographic province (Fenneman and Johnson 1946), also defined as the Intermountain Semi-desert Ecosystem Province (Bailey 1995). This province is characterized by high plains with elevations of 5000-8000ft., broken by isolated hills and low mountains that reach 1000-2000 feet higher. Low-lying eroded badlands are typical of the areas on the outer fringes of the province.

The Wind River Basin covers about 8,500 square miles (Keefer 1965, 1970). The highest point in the basin is 13,795 feet above mean sea level (AMSL) on Gannett Peak in the Wind River Mountains. The lowest elevation is at Boysen Reservoir, which is 4,735 feet AMSL for a total relief of 9,060 feet. The Wind River originates in the Absaroka Range, northwest of the WRPA, and flows into Boysen Reservoir and through the Wind River Canyon before becoming the Big Horn River, which eventually flows into the Missouri River.

The Wind River drainage basin roughly coincides with the boundaries of the Wind River structural basin. The basin is bounded by the Owl Creek Mountains to the north, the Absaroka and Washakie Ranges to the north and northwest, and the Wind River Range to the south. To the east, there are the Bridger Mountains. Major tributaries of the Wind River include the Little Wind River and of the Popo Agie Rivers, which drain the north flank of the Wind River Range, and the East Fork Wind River, which drains the southern portion of Absaroka Range. Badwater Creek drains the western portion of the basin and originates in the Bridger Mountains.

The WRPA consists of relatively flat land that slopes gently towards the east and covers approximately 7,701 square miles within the Wind River Basin. Elevations within the WRPA range from 5,500 feet to less than 3000 feet AMSL. The majority of the land is open field used for agriculture, cattle grazing, and oil and gas production.

The Wind River Basin provides habitat for a wide variety of wildlife. Some major mammals of the province include pronghorn antelope, mule deer, coyote, bobcat, and mountain lion. The area also serves as winter habitat for birds and mammals that typically live in the mountains, but migrate to the semi-desert during colder months. (Refer to Section 3.8 for additional wildlife information).

A majority of lands within the region are publicly held, managed by the Forest Service (USFS), Bureau of Land Management (BLM), Bureau of Reclamation (BOR), and the State of Wyoming. The Wind River Indian Reservation (WRIR) covers approximately 2 million acres, with some of the surface ownership within the reservation being privately-owned. The Bureau of Indian Affairs (BIA) manages the tribal lands within the WRIR. Much of the privately-owned land within the region is agricultural, particularly in the lower valleys, where irrigation water is more readily available.

3.2.2 Geology

3.2.2.1 Regional Geology

The Wind River Project Area (WRPA) lies within the central part of the Wind River Basin, a large trapezoidal-shaped structural and topographic basin that occupies about 8,500 square miles in central Wyoming (Keefer 1965, 1970) (Figure 3.1-1). The basin is surrounded by a series of anticlinal structural uplifts including: (1) the Washakie Range to the northwest; (2) the Owl Creek Mountains to the north; (3) the southern Bighorn Mountains to the northeast; (4) the Casper Arch to the east; (5) the Rattlesnake Hills Anticline to the southeast; (6) the Sweetwater Arch to the south; and (7) the Wind River Range to the southwest.

The Wind River Basin began forming in the late Cretaceous Period (145-65 million years ago) with pronounced downwarping of the basin trough and broad doming of parts of the surrounding areas (Keefer 1970). The formation of the basin continued through the Paleocene Epoch (65-55.5 million years ago) and culminated in the early Eocene Epoch (55.5-33.7 million years ago) as high mountains were uplifted along reverse faults surrounding the basin. Sediments eroded from the flanks of the rising mountains filled the basin and formed the Lance, Fort Union, and Wind River Formations. The thickness of these sedimentary rocks ranges from approximately 7,285-26,825 feet (2,220-8,180 meters). The thickest and oldest sediments accumulated in the basin center with progressively thinner and younger sediments accumulating toward the basin margins.

Basin subsidence and mountain uplift had virtually ceased by the end of the early Eocene. During the middle and late Tertiary Period (65-1.8 million years ago), the Wind River Basin filled completely with volcaniclastic debris, derived predominantly from the Yellowstone volcanic field. By the Pliocene Epoch (5.3-1.8 million years ago) only the highest mountain ridges projected above the accumulated sedimentary basin fill. Beginning in the middle to late Pliocene, a long period of erosion began that excavated the basin to its present topographic level.

The Tertiary Wind River and Fort Union Formations and the Cretaceous Lance Formation overlie older Mesozoic Era sedimentary rocks (248-65 million years ago) dominated by shales, siltstones, and sandstones. These Mesozoic rocks overlie Paleozoic Era strata (544-248 million years ago) consisting chiefly of resistant limestone, dolomite, and sandstone that accumulated during repeated transgressions of the sea along the then stable western edge of the North American continent. The Paleozoic rocks overlie Precambrian Time (4,500-544 million years ago) metamorphic and igneous rocks of Archaean Era (3,800-2,500 million years ago) that comprise the ancient Wyoming Craton, one of the older stable continental areas that comprise North America.

Recent and pertinent geologic publications and geologic and resource mapping in and adjacent to the WRPA include those by Houston and Murphy (1962); Hausel and Holden (1978); Harris et al. (1985); Hickling et al. (1989); Gregory et al. (1991); Jones (1991); Gersic (1993); Johnson et al. (1993); Keefer and Johnson (1993); Peterson (1993); Harris (1996); and DeBruin (1999). In addition, many pertinent articles about Wyoming geology are included in Snoke (1993).

3.2.2.2 Project Area Geology

Figure 3.2-2 presents the geologic map for the WRPA and Figure 3.2-3 provides a geologic cross-section for the WRPA. A summary of geologic units preserved at the surface and beneath the WRPA is provided in Table 3.2-1.

The Wind River Formation is exposed over most of the WRPA. The Wind River Formation (early Eocene) has been mapped west of the WRPA by Warlow et al. (1987) and throughout most of the Wind River Basin by Love and Christiansen (1985). More detailed studies of Wind River Formation stratigraphy were undertaken by Keefer (1965) from exposures in the Wind River Basin in general, and by Soister (1968) in the uranium-rich Gas Hills District (east of the WRPA). Winterfeld (1986) and Stucky (1984) provide detailed studies of the formation in the westernmost and easternmost parts of the basin, respectively.

In and near the WRPA, exposures of the Wind River Formation consist of up to 1,000 feet of drab green to variegated mudstones and gold to brown sandstones, with minor amounts of shale, carbonaceous shale, limestone, conglomerate, and thin coal seams. The marked local variegation of mudstones in the formation is the result of paleosol (ancient soil) development. Regionally, surface exposures of the Wind River Formation increase to 1,800 feet thick, and the formation attains 3,000 feet or more in thickness along the basin axis (Keefer 1965). At appropriate depths the Wind River Formation produces oil and gas.

Quaternary sediments cover a large portion of the WRPA and consist of unconsolidated terrace gravels, alluvium along intermittent streams, volcanic ash, and eolian deposits. Jaworowski (1985) mapped and defined Quaternary terrace gravels west of the WRPA, and both Jaworowski and Harris et al. (1985) have recorded pumicite (volcanic ash) deposits both within and adjacent to the WRPA. In addition, unconsolidated stream alluvium and wind blown (eolian) deposits are widespread across the WRPA.

A bright white, volcaniclastic sandstone with overlying gray and brown conglomerate unconformably overlies sandstones of the Wind River Formation at several outcrops along the northern side of Muddy Ridge in the Pavillion Butte and Harris Bridge Quadrangles. The sandstone is strongly channelized and differs strikingly from the underlying sandstones of the Wind River Formation. The unconformable nature of the lower contact of the sandstone with the underlying Wind River Formation and its volcanic-rich nature suggest the channel deposits belong to the younger Oligocene White River Formation. This is the first report of deposits of White River Formation in the area northwest of Riverton. These newly discovered outcrops have not been mapped yet. The nearest mapped deposits of the White River Formation occur on Beaver Rim Divide, east of Lander, Wyoming, about 48 miles away. There are small outcrops of the White River Formation on the top of Muddy Ridge.

Underlying the Wind River Formation are geological formations consisting of pre-Eocene sedimentary rocks. The nature of these formations is summarized in Table 3.2-1. Petroleum is currently produced from the Wind River, Fort Union, Lance, Meeteetse, Mesaverde, Cody, and Frontier formations (Keefer 1960, 1965; Wyoming Oil and Gas Conservation Commission 2003).

Figure 3.2-1. Location of the Wind River Indian Reservation, WRPA, Wind River Drainage Basin, Owl Creek Drainage Basin, and the Approximate Outline of the Wind River Physiographic Basin and Surrounding Uplifts.

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Figure 3.2-2. Geology within and near the WRPA.

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Figure 3.2-3. Structural Cross-section Across the WRPA.

Table 3.2-1. Geologic Formations within the WRPA

Formation	Geologic Age	Environment/Lithology	Reported Mineral Resources
Formations Exposed at the Surface			
Unnamed Quaternary Deposits	Holocene-Pleistocene	Terrestrial: Eolian/fluvial/ landslide. Sand, gravel, clays, weathered in place residuum from exposed outcrops.	sand, gravel
White River Formation	Oligocene	Terrestrial: Fluvial channel deposits volcanic tuff, conglomerates and tuffaceous sandstone.	pumicite, gravel
Wind River Formation	Early Eocene	Terrestrial: Fluvial/flood plain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale and coal.	petroleum
Formations Not Exposed at the Surface			
Fort Union Formation	Paleocene	Terrestrial: fluvial/flood plain/swamp, chiefly light-colored sandstones, mudstones, carbonaceous shale, and coal.	coal, petroleum
Lance Formation	Late Cretaceous	Terrestrial: fluvial/flood plain/swamp, brown and gray sandstone, shale and mudstone, coal, and carbonaceous shales.	coal, petroleum
Lewis Shale	Late Cretaceous	Marine: offshore, gray marine shale and thin sandstones.	none
Meeteetse Formation	Late Cretaceous	Terrestrial: fluvial/flood plain/swamp, sandstones, siltstones, mudstones, carbonaceous and lignitic shales, and coal.	coal, petroleum
Mesaverde Formation	Late Cretaceous	Marine/Terrestrial: beach, deltaic flood sandstone, mudstone, siltstone, shale, carbonaceous shale, and coal.	petroleum
Cody Shale	Late Cretaceous	Marine: near shore to offshore, gray shale containing gray, brown sandstones.	petroleum
Frontier Formation	Late Cretaceous	Marine: massive sandstone at the base (Peay Sand of the Bighorn Basin), chert-bearing conglomerate near the top, distinctive salt-and-pepper appearance, commonly contains appreciable sand-sized grains of black chert.	petroleum

Table 3.2-1 (continued)

Mowry Shale	Late Cretaceous	Marine: silver-gray, brown and gray hard siliceous and porcellanaceous shale, bentonites, with abundant fish scales and thin sandstones.	petroleum source rock
Muddy Sandstone	Early Cretaceous	Marine/Terrestrial: near shore, lagoonal, deltaic, white to light gray and brown sandstone.	petroleum
Thermopolis Shale	Early Cretaceous	Marine: offshore, black, soft, fissile shale.	petroleum source rock
"Rusty Beds" Cloverly Formation	Early Cretaceous	Terrestrial: alluvial, strikingly orange-brown sandstones.	none
Cloverly Formation (Dakota Sandstone)	Early Cretaceous	Terrestrial: fluvial and flood plain, variegated mudstone, bentonitic, conglomeratic and lenticular sandstones	none
Morrison Formation	Jurassic	Terrestrial: fluvial and flood plain, varicolored mudstones, white sandstone, bentonite lenticular sandstone and variegated mudstones	none
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone.	none
Gypsum Springs	Jurassic	Marine: near shore, red sandstones, siltstones, shales, and massive, bedded gypsum.	none
Chug water Formation	Triassic	Terrestrial: mud flat, brick red sandstones with red gypsiferous shale, siltstone, and massive beds of white, granular to fibrous gypsum, red shale and siltstone, sandstone.	none
Dinwoody Formation	Triassic	Marine: offshore, green to red sandstone and sandy gypsiferous shale.	none
Park City Formation	Permian	Marine: offshore limestone, dolomite, phosphatic limestone and dolomite, chert, and shale.	none
Tensleep Sandstone	Pennsylvanian	Terrestrial/Marine sand dunes and beach, buff, tan, and gray massive to thin-bedded, and highly cross-bedded quartzitic sandstones, with minor amounts of limestone, chert, and dolomite.	petroleum

Table 3.2-1 (concluded)

Amsden Formation	Mississippian to Pennsylvanian	Marine: red and green shale and dolomite, red to brown quartzitic sandstone	petroleum
Madison Limestone	Mississippian	Marine: gray, massive to thin-bedded cherty limestone, and dolomitic limestone.	petroleum
Bighorn Dolomite	Ordovician	Marine: gray, cliff-forming massive granular dolomite, and thin-bedded, pink, platy, porcellaneous dolomitic limestone and dolomite.	none
Gallatin Formation	Late Cambrian	Marine: thin-bedded to massive limestones, greenish-gray shale, and conglomerate	none
Gros Ventre Formation	Middle Cambrian	Marine: green quartzitic sandstone and glauconitic shale.	none
Flathead Sandstone	Cambrian	Marine: shoreline, quartzitic conglomeratic and arkosic sandstone red, banded, sandstone.	none
metamorphic complex	Precambrian	Igneous/metamorphic, granitic and/or intrusive	none

Source: Keefer 1970; Love and Christiansen 1985; Love et al. 1993.

3.2.3 Mineral Resources

Mineral resources within the WRPA include petroleum, coal, sand, gravel, phosphorite, bentonite, pumicite, and uranium. Each of these resources is described below.

3.2.3.1 Petroleum

Most oil and gas production in the Wind River Basin is from structural traps in faulted anticlines having some degree of surface expression. Two such structures, the Pavillion Dome (Pavillion Gas Field) and Muddy Ridge Anticline (Muddy Ridge Oil and Gas Field, occur beneath the WRPA. These structures produce oil and gas from both Cretaceous and Tertiary rocks. The Paleocene Fort Union Formation is the most prolific producer of hydrocarbons (Keefer and Johnson 1993). Natural gas and oil have also been produced from the Wind River Formation (Eocene), Lance Formation (Late Cretaceous), Meteetse Formation ((Late Cretaceous), and Frontier Formation (Late Cretaceous) in the WRPA.

Natural gas and oil is also produced in the WRPA from sandstones in the upper part of the Upper Cretaceous Cody Formation, and from reservoirs in the Mississippian (Madison Limestone), Pennsylvanian (Amsden Formation and Tensleep Sandstone), and Permian (Park City Formations) age rocks.

Johnson et al. (1993) have provided estimates of the natural gas resources in the Upper Cretaceous Mesaverde Formation for the central Wind River Basin. For low, medium, and high productivity estimates for different depths of drilling, they estimate that the Mesaverde Formation gas resources total 110, 269, and 604 billion cubic feet (BCF) for the 300-3,000-foot interval, 1.05, 1.75, and 2.45 trillion cubic feet (TCF) for the 3,000-6,000-foot interval, and 1.46, 2.30, and 3.14 TCF for the 6,000-9,000-foot interval. However, only a fraction of these estimated resources may be recoverable.

The Pavillion and Muddy Ridge fields, which are the major producing fields in the WRPA, are further described below.

Pavillion Field

The Pavillion Field is a closed dome exhibiting up-dip pinchouts of lenticular sandstones, with the petroleum (chiefly natural gas) occurring in the Upper Cretaceous Mesaverde, Meeteetse, and Lance formations, and the Paleocene Fort Union Formation (Keefer and Johnson 1993). The development area also yields gas from lenticular sandstones in the upper part of the Fort Union Formation and the Wind River Formation at depths of 1,500-5,000 feet (Bjorkland 1978).

Petroleum was first discovered in the Pavillion Field in 1960 by Shell Oil in well No. 14-212 (Sec 12, T3N, R2E), which was drilled to a total depth of 6,505 feet in the Fort Union Formation. The well was initially completed from 3,838 to 3,858 feet and produced gas at a rate of 1.9 million cubic feet (MCF) annually. The Pavillion Field was one of the first development areas to produce hydrocarbons from rocks of Tertiary age in Wyoming. The deepest test well in the development area, Shell tribal No. 33x-1,0 was drilled to a depth of 19,235 feet and completed in the Madison Limestone.

Since 1960, there have been 113 wells drilled and completed in the Fort Union and Wind River Formations alone in the Pavillion Field. A total of 94 wells are currently producing gas and the development area has produced about 6,762 barrels of oil and 228 BCF of gas to date (Wyoming Oil and Gas Commission 2003).

Muddy Ridge Field

The Muddy Ridge Field was discovered in 1961 by Chevron in the Hornbeck W-24513 well (Sec 19, T4N, R3E), which was drilled to a total depth of 11,012 feet and completed in the Mesaverde Formation. The well initially produced gas at a rate of 1,350 MCF. Since 1960 there have been 89 wells drilled and completed in the Fort Union, Lance, Meeteetse, and Mesaverde Formations beneath the Muddy Ridge Field. A total of 70 wells are currently producing and the development area has produced approximately 399,723 barrels of oil and 101.4 BCF of gas.

3.2.3.2 Coal

The WPRA lies within the Beaver Creek and Muddy Creek Coal Districts of the Wind River Basin (Glass and Roberts 1978). The thickest and most important coal deposits within the basin occur in the Upper Cretaceous Mesaverde and Meeteetse Formations. In the Beaver Creek Field, coal occurs in 29 individual beds. These beds range in thickness from 2-15 feet, with an aggregate thickness of 165 feet through a total stratigraphic interval of 1,200 feet. In the Muddy Creek Field, the Welton coal bed of the Meeteetse Formation attains 16 feet in thickness. Hickling et al. (1989) state that significant amounts of Wind River Basin coal occur in the Frontier, Mesaverde, and Meeteetse formations.

Peterson (1993) defined four significant coal beds in the Pilot Butte Coal Field (west of the WRPA) and the Muddy Creek Coal Field (including part of the WRPA). These are: (1) the A coal bed of the Mesaverde Formation, with a maximum thickness of 8 feet; (2) the U coal bed of the Mesaverde, with thicknesses of 2.5-8.7 feet; (3) the Barquin coal bed of the Mesaverde (no thicknesses given); and (4) the Welton coal bed of the Meeteetse Formation, with thicknesses ranging from 2.5-18 feet.

None of these resources lie near enough to the surface in the WRPA to make surface mining economic. The potential for exploitation of coal bed methane remains to be explored.

3.2.3.3 Other Mineral Resources

In addition to coal and oil and gas resources, the Wind River Basin contains significant resources of phosphorite, pumicite, sand and gravel, bentonite, gypsum, uranium, and heavy metal placer deposits. The adjacent anticlinal uplifts (especially the Wind River Mountains) are also host to economic resources of building stone, mineral crystals, gold, and iron ore (Hausel and Holden 1978; Gersic 1993). For example, King (1947) records economic phosphorite deposits in the Park City Formation near Lander. Gersic (1993) describes 2-7 feet of pumicite in terrace deposits just south of the WRPA in Section 5, T3N, R4E. Houston and Murphy (1962) documented iron and titanium-rich black sands in the Mesaverde Formation in the Wind River Basin. Hausel and Holden (1978) note the occurrences of economically significant Wind River Basin resources of: (1) bentonite in the Cretaceous Thermopolis, Mowry, Frontier, and Steele (Cody) formations; (2) gypsum in the Triassic Chugwater and Jurassic Gypsum Spring formations; (3) phosphorite in the Permian Park City Formation; and (4) uranium in localized roll deposits of the lower Eocene Wind River Formation. With the exception of sand, gravel, and pumicite deposits, none of the rocks containing these resources occur at the surface in the WRPA. In addition, the newly recognized channels of White River Formation might be exploited for gravel in localized areas.

3.2.4 Geologic Hazards

3.2.4.1 Introduction

Potential geologic hazards include mass movements such as landslides, subsidence, flooding, and earthquakes that may occur along active or suspected active faults. Landslide potential is greatest in areas where steep slopes occur, particularly where the geologic dip of bedrock rock formations is steep and parallel to the slope or where erosional undercutting may occur. Areas with unstable soils may also be susceptible to mass movement such as slumping, sliding, and creep (see Section 3.3).

Elevations within the WRPA range from 4,772 feet adjacent to Cottonwood Creek in the NE ¼ NE ¼ Section 8, T4N, R5E, to 5,855 feet atop Muddy Ridge in the NW ¼ NE ¼ Section 8, T4N, R2E. Relief in the WRPA is 1,082 feet. The topography is relatively gentle in most places exhibiting a maximum slope over any three-mile intersect of an approximately 2 percent grade (328 feet rise over 15,840 ground feet), and the maximum slope over a one-mile intersect is 5.5 percent in Section 23, T4N, R2E. Steeper areas exist along the flanks of Muddy Ridge and Sand Mesa where maximum slope may be vertical along cliff faces of sandstone.

3.2.4.2 Mass Movement

The greatest potential for mass movement, primarily slumping, is along the edges of the stream drainages of Muddy Creek, Fivemile Creek, and upper reaches of Cottonwood Creek, as well as in areas where rapid headward erosion has created steep gullies, such as in Sections 6 and 7, T4N, R2E. However, despite the steep slopes in these areas, no significant areas of mass movement (slumping or landsliding) were observed during field reconnaissance conducted for this project and no such areas are mapped by the USGS or Wyoming Geological Survey (WGS) in the WRPA. The minimum slope in the WRPA approximates a 0 percent grade in several regions, especially within the reclaimed areas along Fivemile Creek (Pavillion Drain) in the southern part of the WRPA and, farther north, on other reclaimed land along Muddy Creek (Wyoming Ditch).

3.2.4.3 Flooding

Flooding may occur along waterways and canals when precipitation exceeds the infiltration capacity of soils and runoff into channels and canals accumulates faster than the waterways can discharge. The greatest potential for flooding is along Cottonwood Creek, which is posted with flash flood warnings. Cottonwood Creek has a relatively large watershed that extends northward out of the WRPA. Major tributaries of the creek join in a relatively large, low flat, area in T5N, R3E, where flash flooding is known to occur during heavy downpours.

3.2.4.4 Earthquakes

Earthquakes have not been recorded in the WRPA. The nearest two earthquakes occurred immediately west of the WRPA. One of these earthquakes occurred on October 12, 1961 in Section 30 of T4N, R1E. No information on the intensity of the earthquake is available. The other earthquake occurred on April 26, 1967 in Sec 17, T5N, R1E, and had a magnitude of 4.7 (Case et al 1994). No active or inactive faults are mapped within the WRPA, but several small normal faults have been mapped in townships immediately to the north in T5N, R3-5E (Keefer 1970). These faults occur both in the Wind River Basin and on the edge of the Owl

Creek Mountain overthrust. Mapping shows these faults to be buried beneath Quaternary alluvium indicating that they are inactive. However, Case et al (1994), depict these faults as having segments known or suspected to have been active during the Quaternary.

3.2.5 Paleontology

3.2.5.1 Introduction

Of the geologic deposits exposed on the surface of the WRPA (Quaternary, Oligocene and Eocene age), only the Wind River Formation is known to produce fossils of scientific significance, primarily vertebrate fossils. Deposits in the White River Formation are likely of such limited extent and too coarsely conglomeratic to yield scientifically significant fossils. The unconsolidated Quaternary deposits that are widespread across the WRPA are probably too young to produce fossils. However, alluvium preserved in Fivemile Creek and Muddy Creek may contain vertebrate remains dating to historic times during Native American occupation.

3.2.5.2 Wind River Formation

The Wind River Formation is the most extensive sedimentary deposit exposed in the Wind River Basin. Sediments of the formation were deposited during the early Eocene (circa 52 million to 50 million years ago) in a variety of environments that correlate to their distance from the mountain fronts. Near the mountains, landslides, mudslides and alluvial fans accumulated coarse-grained sediments. Progressively basinward from the mountains and upward through the stratigraphic section as deposition effectively reduced mountain relief, streams, rivers, and ponds or lakes accumulated fine-grained sediments in a broad ancient flood plain and lake basin. Fossil vertebrates, plants, and invertebrates are known from a great number of widely dispersed localities in the Wind River Formation throughout the Wind River Basin (Denison 1937; Love 1939; Keefer 1965; Guthrie 1971; Krishtalka 1976; Stucky and Krishtalka 1982, 1983; Schoch 1986; Winterfeld 1986; Hirsch et al. 1987; Rose et al. 1991; Stucky et al. 1990; Beard et al. 1992), but the eastern and northwestern parts of the basin have been most extensively studied. With the exception of early paleontological evaluations in the early 1900s and brief reconnaissance effort by the USGS in the 1980s, the central parts of the basin remain essentially unstudied (Brown 2003).

Traditionally the Wind River Formation has been divided into two members, the upper Lost Cabin Member and lower Lysite Member (Granger 1910; Sinclair and Granger 1911; Keefer 1965; Korth 1982; Lillegraven 1993). Stucky et al (1989a) recognized three additional lithologic units, the Red Creek Facies, Arminto unit, and Pavillion Butte unit. Of these units the Lost Cabin, Lysite, and Pavillion Butte units are thought to be exposed at the surface within the WRPA.

The Lost Cabin Member is recognized over large areas of the central parts of the Wind River basin and includes the youngest deposits of the Wind River Formation. Fossil mammals from the Lost Cabin Member range from late early Eocene (Lost Cabinian) to earliest middle Eocene (Gardnerbuttean) in age. Two fossil localities known from the Lost Cabin Member in the northeastern part of the basin are of major importance and provide documentation on the rich yield of fossil vertebrates from the member – the Buck Spring Quarries and Davis Ranch. The Buck Spring Quarries discovered in 1984, have produced 105 fossil vertebrate taxa including 65 species of mammals, and 22 species of frogs, salamanders, lizards, snakes, and birds. Many of these taxa are represented by skulls and associated skeletal remains. Quarries have produced abundant small lizards and mammals and surface collection has produced abundant large mammals. The Davis (or Sullivan) Ranch locality is one of the most diverse Eocene fossil localities known from in North America (Stucky et al. 1989b). More than 2,000 specimens, representing 75 mammalian species, have been collected from this locality.

The Lysite Member, which underlies the Lost Cabin Member, is exposed along the southern margin of the Bighorn and Owl Creek Mountains and is distinguished by its dark red mudstones, relatively limited sheet sandstones, and the predominance of Mesozoic and Paleozoic clasts in conglomerates. The member differs from the overlying Lost Cabin Member in having a lesser amount of variegated sediments. Fossil vertebrates are common in the red mudstones of the member. The mammalian fossil assemblage from the Lysite Member typifies the paleofauna of the Lysitean Land Mammal Stage of the Wasatchian and compares well with that from the lower and middle *Heptodon* Range Zone, as defined in the Bighorn Basin (Schankler 1980; Stucky 1989). Compared to the mammalian fauna of the Lost Cabin Member, the paleofauna of the Lysite Member appears to include fewer smaller mammals and is less diverse.

The Pavillion Butte Unit, which may include the bulk of the deposits of the Wind River Formation in the WRPA, is exposed broadly in the central parts of the Wind River Basin. The unit consists of alternating sheets of thick sandstone and drab claystones and mudstone and is virtually unstudied.

3.2.5.3 Field Evaluation

Field evaluation of the Wind River Formation for paleontological resources led to the discovery of five new fossil vertebrate localities within tribal and BOR lands within the WRPA (Table 3.2-2). All of these localities were identified in variegated mudstones that represent paleosol (ancient soil) horizons. All variegated beds within the formation in WRPA yielded fossil vertebrate material of some kind, but individual beds varied greatly in the type of material, quality of preservation, and scientific significance. All five of the localities produced scientifically significant fossil vertebrate material, but none of the five localities discovered are considered to be richly fossiliferous, when compared with other localities in the Wind River Formation in northeastern and eastern parts of the basin or with localities in similar aged strata of the Wasatch and Willwood Formations in southwestern Wyoming and Bighorn Basin, respectively. However, the material documents the presence of scientifically significant vertebrate fossils within the WRPA and the need for consideration of mitigation. Collected fossils will be curated into the collections of the Department of Geology and Geophysics at the University of Wyoming, as specified in the BLM permit under which they were collected.

Table 3.2-2. Fossil Vertebrate Localities Discovered in the Wind River Formation on Bureau of Reclamation land, WRPA[1]

Locality	Location			Fossils Identified
	Section	Township	Range	
WR- FA	C of N/2, SW/4 of 9	4N	5E	Class Mammalia Order Condylarthra Family Phenacodontidae *Phenacodus* sp., cf. *P. vortmani*; right M2 *Phenacodus* sp., cf. *P. vortmani*; fragment of right p3 Order Perissodactyla Family Helaletidae *Heptodon calciculus*; right M1 and fragments Family Equidae *Hyracotherium* sp., cf. *H. angustidens*; left m3 and molar fragments Family Anthracotheriidae *Lambdotherium* sp., cf. *L. popoagicum*; right M1 Order Rodentia Family Ischyromyidae *Ischyromyid indet*.; fragment of lower incisor Class Reptilia Order Crocodilia Family Allognathosuchidae *Allognathosuchus* sp.; tooth
R-FB	SE ¼, NE ¼ NE ¼ of 3	3N	3E	Class Mammalia Order Perissodactyla Family Helaletidae *Heptodon calciculus*; right p4-m1, left m2 Family Equidae *Hyracotherium* sp.; right dP2 Order Tillodontia Family Esthonychidae *Esthonyx* sp., cf. *E.lysitensis*; left p4-m2 and associated bones *Esthonyx* sp., cf. *E. lysitensis*; left p4-m2, right p3-m1, right M2-3, and associated bones Order Condylarthra Family ?Phenacodontidae *Cf. Phenacodus* sp.; associated bones Miscellaneous bones of turtles, alligator, and mammals

Table 3.2-2 (continued)

Locality	Location			Fossils Identified
	Section	Township	Range	
WR-FD	C of NE ¼, NW ¼ 19	4N	4E	Class Mammalia Order Tillodontia Family Esthonychidae *Esthonyx* sp., cf. *E.lysitensis*; right M1 Order Condylarthra Family Hyopsodontidae *Hyopsodus* sp., cf. *H. miticulus*; left m1-3 Family Meniscotheriidae Cf. *Meniscotherium* sp.; left p3, partial p4, m1-2, and associated right m2-3 Class Reptilia Family Glyptosauriidae Cf. *Glyptosaurus* sp.; jaw with 7 teeth Miscellaneous mammal bones, edentulous jaws and tooth fragments, trionychid turtle carapace fragment
WR-FE	C of N ½, NW ¼ of 31	4N	3E	Class Mammalia Order unknown Calcareous concretion with associated ?tibia, ?fibula, pelvic fragments, and ribs Carapace fragment of chelonian; ichnofossil (burrow) of indeterminate origin
WR-FF	S ½, NE ¼, NE ¼ of 33	4N	3E	Class Mammalia Order Tillodontia Family Esthonychidae *Esthonyx* sp., cf. *E. lysitensis*; right C Orders unknown Miscellaneous associated bones; distal radius; associated fragments of femur

[1]Upper case = upper tooth; lower case = lower tooth.

3.3 SOILS

3.3.1 Introduction

Soil development is a function of parent material, living matter, climate, relief, and time. With the exception of limited areas underlain by bedrock channels of White River Formation, the dominant bedrock and parent material for soils in the Wind River Project Area (WRPA) is the Wind River Formation. The Wind River Formation, as described in Section 3.2, is a continental-terrestrial basin filling sequence consisting chiefly of interbedded sandstone and mudstone, with minor amounts of conglomerate, limestone, and coal.

The dominant natural vegetation within the WRPA grows in spaced thickets and consists of salt sage, Wyoming sage, cottonwood, bunch grass, greasewood, and blue grama (*Bouteloua gracilis*). Lichen are abundant on rocks, especially on sandstone outcrops at the higher elevations. Cultivation and leveling of the soil during farming has modified the natural soil horizons over a large part of the WRPA. Excess irrigation or shallow water tables cause soils to become wet or salty. The excess salt accumulation that is deposited during evaporation adversely affects plant growth and retards soil formation.

Climate has a direct and indirect effect on soil development through its principal components, precipitation, temperature, humidity, wind, and sunshine. The climate of the WRPA is one of a windy, semiarid desert, in which the annual precipitation ranges from 8-15 inches/year (20-38 cm/year), and the annual temperature extremes vary from about –30^{o}F in winter to more than 105^{o}F in summer. Wind is an important component in soil formation in the WRPA. Sand and clay transported by the wind dilutes the concentrations of organic material in the A horizons of the soils.

Relief, or topography, influences soils principally through its effect on microclimate and runoff. Within the WRPA, older, more mature soils have developed high on gravel-topped buttes and young immature soils have developed on the floodplains within drainages. Between the drainages of Cottonwood Creek and Muddy Creek, high remnant terraces are present atop Muddy Ridge and Sand Mesa. The oldest and most developed soils in the WRPA have formed on these terraces, which are underlain and preserved from erosion by the gravels and underlying resistant sandstone of the Wind River and White River formations. These surfaces may have remained stable for thousands of years.

Appendix F provides a discussion of the factors that lead to erosion of soils and methods to evaluate potential soil erodability.

3.3.2 Soil Types within the WRPA

Young (1981) described soils present in the Riverton area of Fremont County, Wyoming. His area of study included the WRPA as well as some areas outside the WRPA boundary (Figure 3.3-1). These soils can be grouped into broad soil associations, each of which contains several different specific types of soils. Field evaluations conducted for this project confirmed the distribution of soil association types described by Young (1981) and determined the general morphological and engineering properties of individual soil types that are likely to be disturbed during the proposed development.

Eight soil associations were recognized by Young (1981) in the Riverton area. Six of these soil associations occur in the WRPA, as shown in Figure 3.3-2. Specific characteristics of these soils are discussed below. Descriptions of soil samples collected for this project are provided in Appendix F.

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Figure 3.3-1. Surficial Geology within and adjacent to the WRPA.

Figure 3.3-1. Abbreviations

ai	Alluvium with Scattered Terrace, Slopewash, Eolian, Residuum, Grus, and Glacial Deposits
bdi	Dissected Bench with Scattered Residuum, Slopewash, Landslide, and Eolian Deposits
bi	Bench Deposits, including Eolian, Slopewash, Outwash, and or Mesa
tdi	Dissected Terrace Deposits Mixing with Alluvium, Residuum, Eolian, and Slopewash Deposits
ti	Terrace Deposits Mixed with Scattered Alluvium, Residuum, Eolian, Slopewash, and Outwash Deposits
Ri	Residuum Mixed with Alluvium, Eolian, Slopewash, Grus Deposits, and/or Bedrock Outcrops
sci	Slopewash and Colluvium Mixed with Scattered Slopewash, Residuum, Grus, Glacial, Periglacial, Alluvium, Eolian Deposits, and/or Bedrock Outcrops
fdi	Alluvial Fan and Gradational Fan Deposits Mixed with Scattered Slopewash, Residuum and Eolian Deposits
ei	Residuum Mixed with Alluvium, Eolian, Slopewash, Grus Deposits, and/or Bedrock Outcrops

Figure 3.3-2. Soil Types Within and Adjacent to the WRPA.

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3.3.2.1 Apron—Lostwells Association

The Apron—Lostwells Association refers to deep, nearly level to sloping, well-drained sandy loams, and sandy clay loams developed on alluvial fan alluvium derived from sandstone and clay shale (or mudrock), at elevations ranging from 4,800-5,500 feet, and on slopes varying from 0-10 percent.

Within the WRPA, Apron—Lostwells soils are developed in two broad areas; the first lies north and northeast of Ocean Lake, and the second occurs between the town of Pavillion and Muddy Ridge.

3.3.2.2 Persayo—Oceanet Association

The Persayo—Oceanet Association refers to shallow, nearly level to moderately steep, well-drained sandy clay loams, and sandy loams formed from weathered clay shale and sandstone derived from the lower Eocene Wind River Formation, at elevations ranging from 5,000-5,700 feet, and on slopes varying from 0-30 percent.

Within the WRPA, the Persayo-Oceanet association of soils is confined to steeply sloping badland areas adjoining Muddy Ridge. From the mapping of Young (1981), these are largely simple residual soils, consisting of little more profile development than the deep weathering of mudstones and sandstones of the Eocene Wind River Formation. Such residual soils are relatively absorbent where they form flat surfaces. However, their induration, fissuring, and/or high clay mineral content just beneath the weathered exposed surface makes them subject to piping, collapse, and gullying by headward erosion. An example of dramatic headward erosion is seen in Secs. 6 and 7, T5N, R2E.

3.3.2.3 Tipperary—Trook Association

The Tipperary—Trook Association refers to deep, nearly level to moderately steep loamy sands and sandy loams developed on alluvial fans and old, high terraces, at elevations ranging from 4,800-5,300 feet, and on slopes varying from 0-20 percent.

Within the WRPA, soils of the Tipperary—Trook association are confined to the lower reaches of Cottonwood Creek, several miles north and northwest of Muddy Ridge.

3.3.2.4 Apron—Trook Association

The Apron—Trook Association refers to deep, nearly level to moderately steep well-drained sandy loams developed on alluvial fans and terraces, at elevations ranging from 4,800-5,300 feet, and on slopes varying between 0-15 percent.

Young (1981) assigned to the Apron—Trook Association all soils on the high terrace capping Muddy Ridge as well as those formed on appreciably greater slopes, but significantly lesser elevations in the drainage of Muddy Creek (north of Muddy Ridge). However, this association was not assigned to soils of similar character and elevation south of Muddy Ridge. Two soils developed at the top of Muddy Ridge were examined during the course of fieldwork conducted for this project, at elevations of approximately 5,530 and 5,650 feet. Both soils exceed the elevations given by Young (1981) for the Apron—Trook Association. However, based on field evaluation, these soils belong to the Apron—Trook Association. Similarly, both Muddy Ridge soils profiled in this study are relatively shallower than those reported by Young (less than 60 cm combined A + B horizon thickness).

3.3.2.5 Fivemile—Binton Association

The Fivemile—Binton Association refers to deep, nearly level to gently sloping silty clay loams developed on floodplains and lower stream terraces, at elevations ranging from 4,800-5,500 feet, and on slopes varying between 0 and 6 percent.

Within the WRPA, the distribution of soils of Young's (1981) Fivemile—Binton Association is restricted to an approximately mile-wide band following the drainage of Fivemile Creek and bordering the Wyoming Canal (an artificial drain). In the nearly 30 years since Young's study, this area has been so modified by agriculture and other development that no original, undisturbed soil profiles could be observed.

3.3.2.6 Birdsley—Effington—Boysen Association

Birdsley—Effington—Boysen Association refers to deep, nearly level to sloping well-drained and alkali-rich clay loams and sandy clay loams developed on alluvial fans and "uplands," at elevations ranging from 5,000-5,500 feet and on slopes varying from 0 to 10 percent.

Within the WRPA, the distribution of soils of the Birdsley—Effington—Boysen Association is limited to a small area south of the southeast margin of Muddy Ridge. From Young's (1981) descriptions, it appears that soils of this association are essentially the same as some soils in the aerially adjacent Apron—Lostwells Association, except that Birdsley—Effington—Boysen soils are generally more alkaline. Birdsley—Effington—Boysen soils were not observed during field work conducted for this project within the WRPA.

3.3.3 Long Term Regional Erosion Rates

Dethier et al (2002) estimated regional erosion rates of 45 to 250 meters in a million years at sites in southern Wyoming and Northern Colorado underlain by weakly lithified Cenozoic basin fill sediments. Reiners and Heffern (2002) estimated a regional erosional rate of about 0.1-0.2mm/yr. This is equivalent to an average yearly loss of ground surface of 1,180 - 2,360 tons/acre/year. These rates include erosion of all types that have excavated the intermontane basins of the Rocky Mountains.

3.4 CLIMATE AND AIR QUALITY

3.4.1 Introduction

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

3.4.2 Climate

The WRPA is located in a semiarid mid-continental climate regime typified by dry windy conditions, limited rainfall, and long cold winters. Low relative humidity, a high percentage of sunshine, and windy conditions generally contribute to high rates of evaporation typical of the area. There is little spatial variability in climatic conditions within the WRPA, as the topography and elevation are fairly uniform.

3.4.2.1 Temperature and Precipitation

Dry conditions prevail near the WRPA with average annual precipitation rate between six and eight inches measured near Boysen Reservoir (Daddow 1996; Plafcan et al. 1995). Outside the WRPA on the flanks of the surrounding mountains, precipitation is greater than 30 inches per year, and near the top of the Wind River Range it is greater than 50 inches per year. Between October and March, precipitation occurs as snow. In the WRPA snowfall is generally less than 20 inches per year. In the Owl Creek Mountains just north of the WRPA, snowfall averages 40 to 80 inches per year and in the Wind River Range to the southwest over 150 inches.

The nearest National Weather Service (NWS) climatological measurements were recorded at Pavillion, Wyoming for the period 1948 through 2002. The Pavillion station is located approximately 10 miles west of the WRPA at an elevation of 5,440 feet (Western Regional Climate Center 2003a). Table 3.4-1 presents the average temperature range, precipitation and snowfall by month as recorded at the Pavillion, WY station. The Pavillion climatic conditions are charted in Figures 3.4-1 through 3.4-3.

Table 3.4-1. Average Temperature Range, Total Precipitation and Snowfall at Pavillion, Wyoming (1948 – 2002).

Month	Average Temperature Range (F)		Average Precipitation (inches)	Average Snowfall (inches)
	Low	High		
January	7.8	32.4	0.17	3.2
February	13.2	38.8	0.18	3.0
March	20.7	47.9	0.36	4.8
April	29.7	58.2	0.94	4.0
May	39.1	67.7	1.71	0.7
June	47.0	77.0	1.22	0.2
July	53.3	85.2	0.79	0.0
August	51.6	83.4	0.51	0.0
September	42.3	72.7	0.82	0.6
October	31.9	60.3	0.53	1.7
November	18.3	43.2	0.35	3.8
December	9.9	34.0	0.22	3.3
Annual Average	30.4	58.4	7.81	25.3

Source: Western Regional Climate Center (2003a). Data collected at Pavillion, Wyoming from 1948 through 2002.

Prevailing synoptic-scale westerly air masses originating from the Pacific Ocean are interrupted by the Continental Divide and subsequently lose much of their moisture before reaching the eastern plains and the WRPA. The annual average precipitation at Pavillion is 7.81 inches, and ranges from a minimum of 2.50 inches recorded in 1974, to a maximum of 12.54 inches recorded in 1971. January is the driest month with an average precipitation rate of 0.17 inches, and May is the wettest month with an average of 1.71 inches. The annual average snowfall is 25 inches, with March, April and November being the snowiest months. A maximum snowfall of 65.5 inches was recorded in 1959. In contrast, annual average precipitation and snowfall at the Pinedale station, located west of the Continental Divide, is 11 inches and 61 inches, respectively (Western Regional Climate Center 2003b).

In the direct vicinity of the WRPA there are eight weather stations (Daddow 1996). Table 3.4-2 presents a summary of precipitation and temperature data for these stations. The stations located closest to the WRPA are Boysen Dam, Riverton, and Pavillion.

Table 3.4-2. Average Annual Precipitation and Temperature for Selected Stations Near the WRPA.

Weather Station	Latitude (deg-min)	Longitude (deg-min)	Altitude (ft. amsl)	Period of Record	Average Annual Precipitation (inches)	Average Annual Temperature (F)
Anchor Dam	43° 40'	108° 50'	6,460	1961-1979	15.2	41.3
Boysen Dam	43° 25'	108° 11'	4,642	1961-1990	9.29	47.4
Burris	43° 22'	109° 17'	6,140	1961-1990	8.93	44.3
Diversion Dam	43° 14'	108° 56'	5,575	1961-1990	8.97	44.9
Fort Washakie	42° 59'	108° 53'	5,550	1961-1990	11.9	42.2
Lander WSO AP	42° 49'	108° 44'	5,370	1951-1979	13.0	46.0
Pavillion	43° 15'	108° 41'	5,440	1961-1990	7.53	44.3
Riverton	43° 01'	108° 23'	4,950	1961-1990	7.74	42.6

Source: Daddow 1996.

The WRPA, which is situated on the eastern slope of the Continental Divide, ranges in elevation from 5,000 feet to 5,500 feet above mean sea-level (amsl), resulting in a relatively cool climate with an annual average temperature of 44.4 F. Recorded daily extreme temperatures are – 40 F in 1983 and 98 F in 1949.

In the wintertime, it is characteristic to have rapid and frequent changes between mild and cold spells. Average winter temperatures at Pavillion range from 10 F to 35 F, while average summer temperatures range from 51 F to 82 F.

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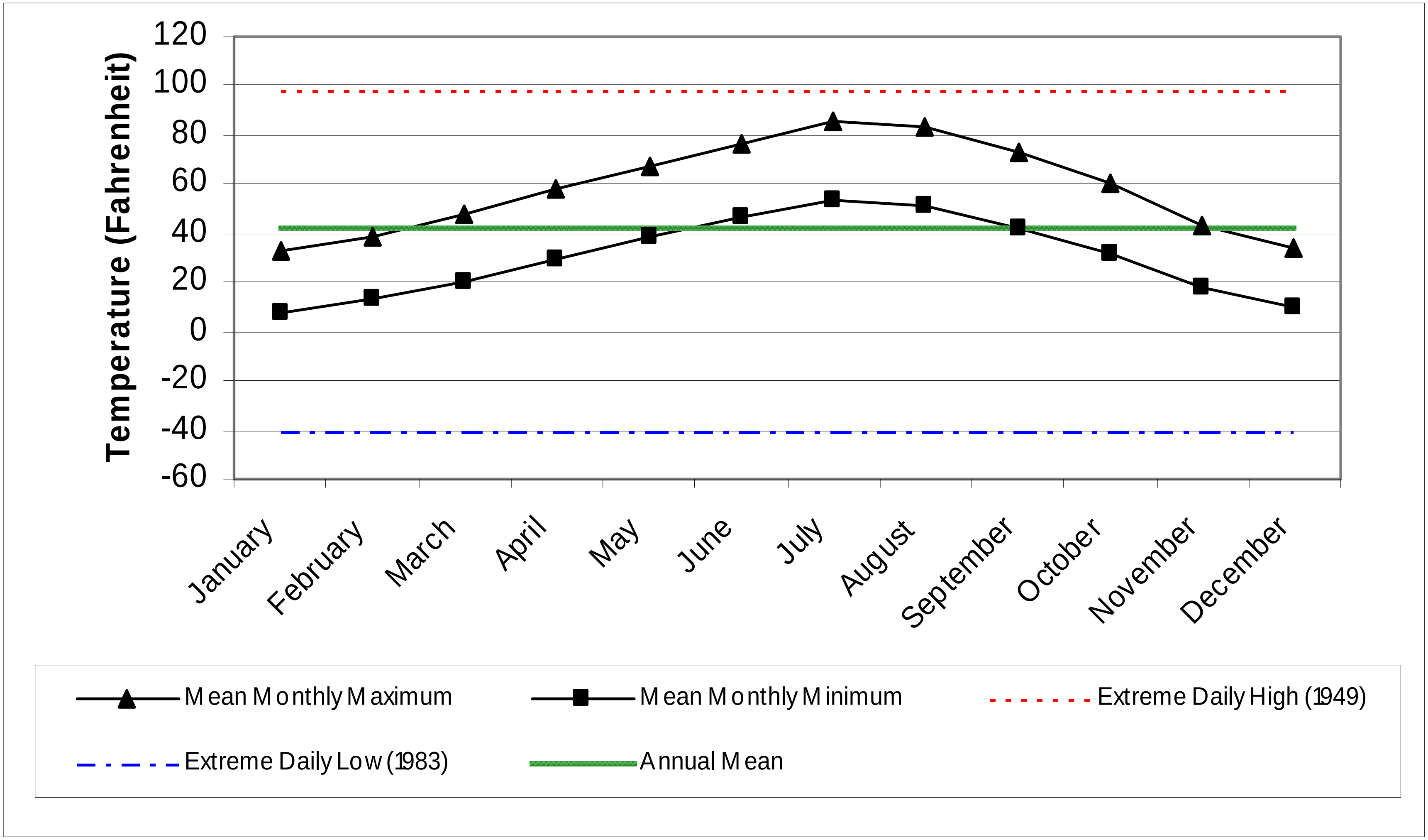


Figure 3.4-1. Annual Mean, Monthly Mean, and Daily Extreme Temperatures at Pavillion, Wyoming (1948 – 2002).

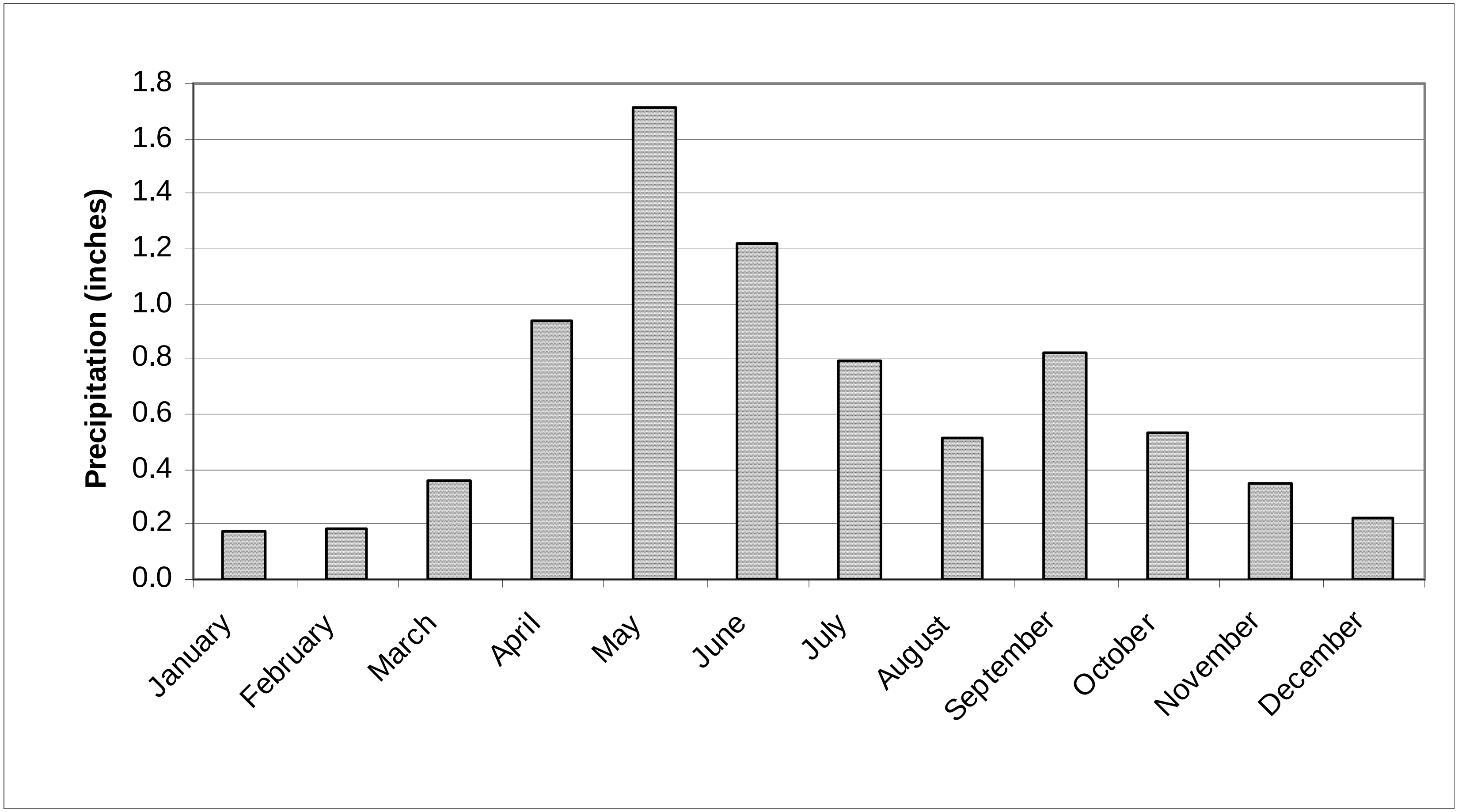


Figure 3.4-2. Average Monthly Precipitation at Pavillion, Wyoming (1948 – 2002).

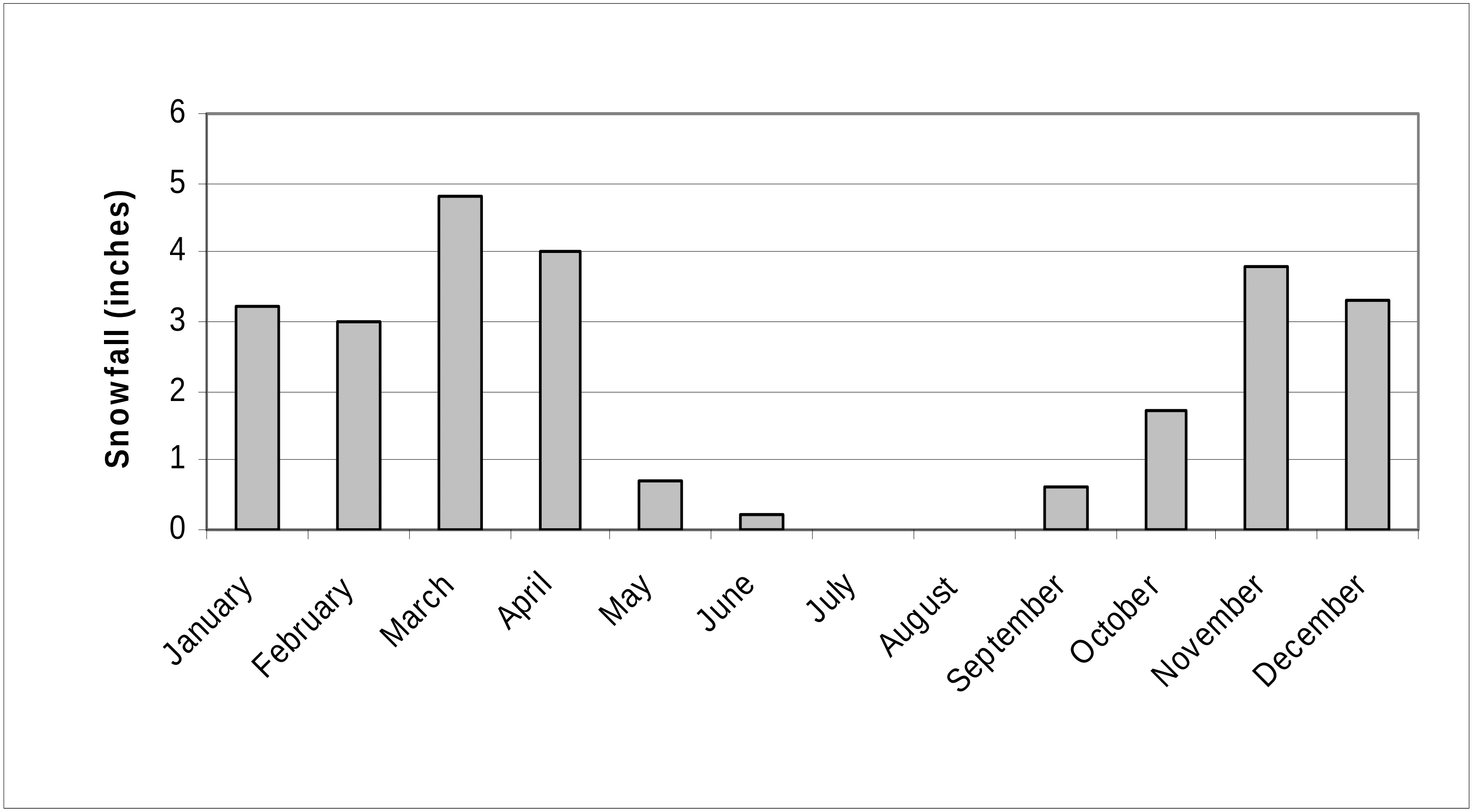


Figure 3.4-3. Average Monthly Snowfall at Pavillion, Wyoming (1948 - 2002).

3.4.2.2 Winds and Atmospheric Stability

Wind speed and direction, along with vertical profiles of heat and wind in the lower atmosphere, greatly affect the transport and dispersion of air pollutants. The potential for atmospheric dispersion is relatively high for the WRPA due to the frequency of strong winds. During warm spells in the winter, strong down slope winds which facilitate pollutant dispersion are common along the eastern slopes of the Wind River Range. However, calm periods and nighttime cooling may enhance air stability, thereby inhibiting air pollutant transport and dilution. The area experiences frequent temperature inversions in winter when cold stable air masses settle into the valleys and snow cover and shorter days inhibit ground-level warming. During periods of atmospheric stability, cold air tends to be trapped at the surface and vertical mixing of pollutants is limited. Temperature inversions are less common during the summer months when daytime ground-level heating rapidly leads to inversion break-up and increased vertical mixing.

The nearest comprehensive surface and corresponding upper air meteorological data are recorded about 35 miles south-southwest of the WRPA at the Lander/Hunt Field Station (EPA 2003). Atmospheric stability can be categorized by stability classes “A” through “F”, with “A” representing a high degree of atmospheric turbulence, and “F” representing a high degree of atmospheric stability. A “D” stability represents a neutral atmosphere. Table 3.4-3 present the frequency distribution of the atmospheric stability classes as recorded at the Lander/Hunt Field station for the years 1985, 1987, 1988, 1990, and 1991. As illustrated, neutral (Class D) atmospheric conditions occur the majority of the time (32.3%), followed by slightly stable conditions (21.3%) and slightly unstable stable conditions (14.6%).

Table 3.4-3. Atmospheric Stability Class Frequency of Occurrence.

Stability Class	Frequency of Occurrence
A – Strongly Unstable	1.2%
B – Moderately Unstable	11.1%
C – Slightly Unstable	14.6%
D – Neutral	32.3%
E – Slightly Stable	21.3%
F – Moderately Stable	19.5%
Total	100%

Source: EPA (2003). Wind data collected at Lander/Hunt field for years 1985, 1987, 1988, 1990, and 1991, available from the National Climatic Data Center (NCDC).

Wind direction and speed data as measured at the Lander/Hunt Field are tabulated in Tables 3.4-4 and 3.4-5. Figure 3.4-4 presents a wind rose illustrating wind speed and direction for the Lander data. Note that the data represent the direction from which the wind is blowing (Wind Direction Origin). As shown, the winds predominately originate from the west to southwest 26.9 percent of the time, with an average wind speed of 7.8 miles per hour (3.47 meters/second).

Table 3.4-4. Wind Direction Frequency of Occurrence.

Direction of Wind Origin	Frequency Of Occurrence	Direction of Wind Origin	Frequency Of Occurrence
North	4.0%	South	3.6%
North Northeast	2.9%	South Southwest	3.7%
Northeast	4.0%	Southwest	10.4%
East Northeast	2.7%	West Southwest	10.7%
East	2.8%	West	5.8%
East Southeast	5.2%	West Northwest	5.8%
Southeast	6.7%	Northwest	5.5%
South Southeast	4.1%	North Northwest	4.4%
Calm (No Direction)	17.6%	Total	100%

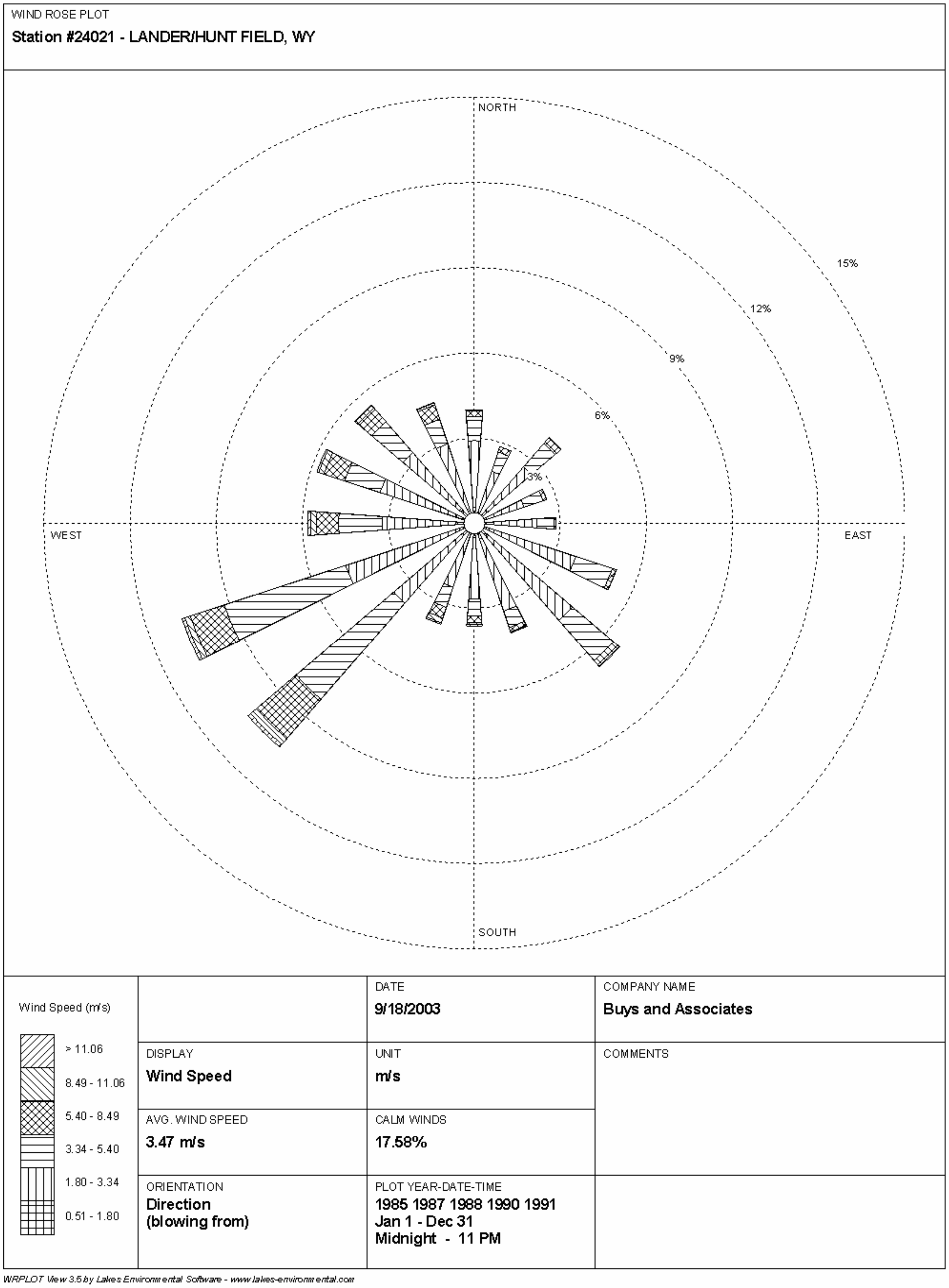
Source: EPA (2003). Wind data collected at Lander/Hunt field for years 1985, 1987, 1988, 1990, and 1991, available from the National Climatic Data Center (NCDC).

Table 3.4-5. Wind Speed Frequency of Occurrence.

Wind Speed Category (miles per hour)	Frequency Of Occurrence
Calm to 4.0	25.7%
4.0 to 7.5	41.3%
7.5 to 12.1	23.2%
12.1 to 19.0	7.9%
19.0 to 24.7	1.4%

Source: EPA (2003). Wind data collected at Lander/Hunt field for years 1985, 1987, 1988, 1990, and 1991, available from the National Climatic Data Center (NCDC).

Figure 3.4-4. Lander, Wyoming Wind Rose.


WIND ROSE PLOT
Station #24021 - LANDER/HUNT FIELD, WY
NORTH
SOUTH
WEST
EAST
3%
6%
9%
12%
15%
Wind Speed (m/s)
> 11.06
8.49 - 11.06
5.40 - 8.49
3.34 - 5.40
1.80 - 3.34
0.51 - 1.80
DATE
9/18/2003
COMPANY NAME
Buys and Associates
DISPLAY
Wind Speed
UNIT
m/s
COMMENTS
AVG. WIND SPEED
3.47 m/s
CALM WINDS
17.58%
ORIENTATION
Direction
(blowing from)
PLOT YEAR-DATE-TIME
1985 1987 1988 1990 1991
Jan 1 - Dec 31
Midnight - 11 PM
WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

3.4.3 Air Quality

3.4.3.1 Regulatory Environment

In general, the Environmental Protection Agency (EPA) has primary regulatory authority for implementing various air quality control statutes established by Congress. However, EPA has granted this authority to states, pending EPA's approval of state implementation plans (SIPs). Indian tribes may implement environmental programs and assume enforcement authority for these environmental statutes on tribal lands. However, when tribes do not assume that authority, the EPA, rather than the state, retains primary enforcement authority.

Jurisdiction over lands within an Indian reservation generally depends on the nature and history of land ownership. However, even where the land ownership and history are clear, some controversy still exists as to which government agency has jurisdiction. The WRPA resides within the Wind River Indian Reservation (WRIR), which contains federal lands, federal lands held in trust for the tribes, Indian private lands, and non-Indian private lands. Therefore, several federal, state, and local authorities could have jurisdiction over the Proposed Action.

For most areas within the WRIR the EPA is the primary agency for implementing the Federal Clean Air Act (CAA) and the permitting of air emission sources. However, there are some areas of the WRIR that the State of Wyoming classifies as "non-reservation" lands and are therefore subject to State of Wyoming air standards and regulations. Therefore, it is possible that over the life of the project, air emission sources within the WRPA could be regulated by the EPA, the Wyoming Department of Environmental Quality (WDEQ), or Wind River Tribal regulatory authorities.

Ambient Air Quality Standards

National and Wyoming Ambient Air Quality Standards (NAAQS and WAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. The CAA established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Pollutants for which standards have been set include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter ($PM_{2.5}$).

Comprehensive air quality monitoring has not been conducted within the WRPA. However, air quality in and surrounding the area is expected to be relatively good due to the limited number of large industrial emission sources and predominately favorable atmospheric dispersion conditions. Background values recorded in the region are below the NAAQS and WAAQS. Measured regional background concentrations are presented in Table 3.4.6 with the applicable ambient air quality standards

Prevention of Significant Deterioration (PSD) Increments

Under the Prevention of Significant Deterioration (PSD) provisions, incremental increases of specific pollutant concentrations are limited above a legally defined baseline level. Many national parks and wilderness areas are designated as PSD Class I. The PSD program protects air quality within Class I areas by allowing only slight incremental increases in pollutant concentrations. Areas of the state not designated as PSD Class I are classified as Class II. For Class II areas, greater incremental increases in ambient pollutant concentrations are allowed. The PSD increments for both Class I and II areas are presented in Table 3.4-6.

The WRPA and surrounding region is federally designated as a PSD Class II. The two nearest PSD Class I areas are Bridger and Fitzpatrick Wilderness areas located directly west of the WRPA in the Wind River Mountain Range. Contiguous with Bridger Wilderness are Popo Agie Wilderness and the Wind River Roadless Area, both designated as PSD Class II. Nearby tribal areas of special concern include Wind River Canyon (PSD Class II) located northeast of the WRPA, and Phlox Mountain, located in the Owl Creek range (PSD Class II) just north of the WRPA. The Wind River Canyon and the Owl Creek Range are both located within the Wind River Indian Reservation boundary. More distant Class I areas include Grand Teton and Yellowstone National Parks, and Washakie, Teton, and North Absaroka Wilderness areas. Cloud Peaks Wilderness is designated as PSD Class II. Figure 3.4-5 presents a regional map indicating the location of the WRPA and the areas of special concern.

Hazardous Air Pollutants

Hazardous air pollutants (HAPs) are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental impacts. The EPA has classified 189 air pollutants as HAPs. Examples of classified HAPs include formaldehyde (CH_2O), BTEX compounds (benzene, toluene, ethylbenzene, and isomers of xylene) and normal-hexane (*n*-hexane).

The CAA requires the EPA to regulate emissions of toxic air pollutants from a published list of industrial sources referred to as "source categories." As required under the CAA, EPA has developed a list of source categories that must meet control technology requirements for these toxic air pollutants. Under section 112(d) of the CAA, the EPA is required to develop regulations establishing national emission standards for hazardous air pollutants (NESHAP) for all industries that emit one or more of the pollutants in major source quantities. These standards are established to reflect the maximum degree of reduction in HAP emissions through application of maximum achievable control technology (MACT). Source categories for which MACT standards have been implemented include Oil and Natural Gas Production and Natural Gas Transmission and Storage.

Table 3.4-6. Air Pollutant Background Concentrations, National and State Ambient Air Quality Standards, and PSD Increments.

Pollutant And Averaging Time	Measured Background Concentration ($\mu g/m^3$)	National and Wyoming Ambient Air Quality Standard ($\mu g/m^3$)	PSD Class I Increment ($\mu g/m^3$)	PSD Class II Increment ($\mu g/m^3$)
Carbon Monoxide (CO)				
1-hour	3,336 a	40,000	n/a	n/a
8-hour	1,381 a	10,000	n/a	n/a
Nitrogen Dioxide (NO_2)				
Annual	3.4 b	100	2.5	25
Ozone (O_3)				
1-hour	169 c	235	n/a	n/a
8-hour	147 c	157	n/a	n/a
Particulate Matter (PM_{10})				
24-hour	61 d	150	8	30
Annual	22 d	50	4	17
Particulate Matter ($PM_{2.5}$)				
24-hour	35 d	65	n/a	n/a
Annual	10 d	15	n/a	n/a
Sulfur Dioxide (SO_2)				
3-hour	132 e	1,300	25	512
24-hour (National)	n/a	365	5	91
24-hour (Wyoming)	43 e	260	5	91
Annual (National)	n/a	80	2	20
Annual (Wyoming)	9 e	60	2	20

Note: The U.S. Supreme Court upheld the proposed 8-hour ozone and PM2.5 standards on February 27, 2001. The state of Wyoming will not enforce compliance with these standards until an implementation rule is issued by the EPA. (Cara Casten, WDEQ, personal communication, February 2004.)

Measured background ozone concentration value represents the top tenth percentile maximum 1-hour value. Other short-term background concentrations are second-maximum values.

n/a: Not Applicable.

Wyoming Ambient Air Quality Standards from: Wyoming Air Quality Standards and Regulations, Chapter 2 - Ambient Standards.

National Ambient Air Quality Standards from: 40 CFR part 50 National Primary and Secondary Air Quality Standards.

PSD Increments from: 40 CFR part 51.166 Prevention of Significant Deterioration of Air Quality.

Sources of Measured Background Concentrations

a Data collected by Amoco at Ryckman Creek for an 8 month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).

b Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period January-December 2001. (ARS 2002)

c Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period June 10, 1998 through December 31, 2001 (ARS 2001).

d Data collected from the Lander, Wyoming monitors for the year 2002 (WDEQ).

e Data collected at LaBarge Study Area at the Northwest Pipeline Craven Creek site, 1982-1983 (WDEQ).

Figure 3.4-5. WRPA with Nearest PSD Class I and Class II Areas and Sensitive Lakes.

Insert revised figure with marker for lakes in legend and revised reservation boundaries.

3.4.3.2 Pollutant Sources and Characteristics

Sources of Air Pollution

- Existing sources of air pollution within the WRPA and surrounding region include the following:
- Exhaust emissions, primarily CO, oxides of nitrogen (NO_x), and formaldehyde (CH_2O) from existing natural gas fired compressor engines used in the production of natural gas;
- Natural gas dehydrator still-vent emissions including volatile organic compounds (VOC), BTEX and *n*-hexane;
- Power plant SO_2, CO, NO_x and particulate emissions;
- Gasoline- and diesel-fueled vehicle tailpipe emissions consisting of VOC, NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$;
- Fugitive dust (PM_{10} and $PM_{2.5}$) from vehicle traffic on unpaved roads, wind erosion in areas of soil disturbance, road sanding during winter months, and from coal mines; and
- Long-range transport of pollutants from distant sources.

Criteria Air Pollutant Characteristics

The term NO_X is used to describe mixtures of nitrogen oxide compounds including nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrate (NO_3) and other nitrogen species including dinitrogen oxide (N_2O). The National Ambient Air Quality Standard refers only to NO_2, rather than all species of NO_X. Nitrogen oxides are by-products from the combustion of fossil fuels and the primary sources of anthropogenic NO_X include automobiles and power plants. Furnaces and gas stoves also contribute to NO_X emissions. Most NO_X emissions are emitted in the form of NO, which is not stable in the atmosphere and is eventually converted to NO_2. Nitrogen dioxide is a toxic, reddish-brown gas that is reactive in the atmosphere and plays a role in the formation of smog. Short-term human exposures (e.g. less than 3 hours) to elevated levels of NO_2 may lead to changes in airway responsiveness and lung function in individuals with pre-existing respiratory illness. Long-term human exposure to NO_2 may lead to increased susceptibility to respiratory infection and may cause alterations in the lung. Nitrogen oxides also contribute to the formation of acid rain and to visibility impairment.

Carbon monoxide is formed when fossil fuels are not burned completely. Nation-wide, the primary source of CO is automobile emissions. Other sources of CO include industrial processes, non-transportation fuel combustion and forest fires. Carbon monoxide is a colorless, odorless gas that is poisonous in high concentrations. When humans are exposed to CO, the gas enters the bloodstream through the lungs and reduces oxygen delivery to the body's organs and tissues. Reduced work capacity, reduced manual dexterity, poor learning capacity and difficulty in performing complex tasks are associated with exposure to elevated levels of CO.

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases (SO_x). These gases are highly soluble in water. Sulfur is prevalent in many raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gasses are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metal is extracted from ore. SO_2 dissolves in water vapor to form an acid, and interacts with other gases and particles in the air to form sulfates and other compounds that can be harmful to people and the environment. The health effects of SO_2 exposure range from short-term difficultly with breathing to longer-term respiratory illness. SO_2 also contributes to the formation of acid rain and to visibility impairment.

Ground-level ozone (O_3) is a gas created through chemical reactions of NO_X and VOCs in the presence of heat and sunlight. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC that help to form ozone. Sunlight and hot weather expedite the formation of ground-level ozone. As a result, ozone is generally known as a summertime air pollutant. Ozone can be transported great distances and therefore contributes to air pollution issues on a regional scale. Primary health effects from O_3 exposure range from breathing difficulty to permanent lung damage. Ground-level ozone also contributes to plant and ecosystem damage.

Particulate matter, or PM**,** is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particulate matter is frequently classified by size and typical categories include total suspended particulates (TSP), particulate matter less than 10 microns in diameter (PM_{10}) and PM less than 2.5 microns in diameter ($PM_{2.5}$). Particulate matter may be emitted directly to the atmosphere from mobile and stationary sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and wood burning. Additionally, PM may be generated from secondary chemical reactions in the atmosphere involving oxides of nitrogen and sulfur. The primary health hazard stems from inhalation of fine particulate matter or $PM_{2.5}$. Many health studies have correlated increased $PM_{2.5}$ exposure with increases in premature death as well as a range of serious respiratory and cardiovascular effects. Environmentally, particulate matter in the form of atmospheric sulfates and nitrates, organics, and elemental carbon (soot), represents the primary source of visibility impairment and contributes to acid deposition.

Hazardous Air Pollutant Characteristics

Formaldehyde, a recognized irritant to humans, may be released from consumer products such as particle board and carpet, or may be formed as a byproduct during the combustion of natural gas. Acute (short-term) and chronic (long-term) exposures can result in eye, nose and throat irritation and respiratory symptoms including coughing, wheezing and bronchitis. The Environmental Protection Agency (EPA) has classified formaldehyde as a Group A, probable human carcinogen of medium carcinogenic hazard (EPA 1994). The highest levels of airborne formaldehyde have been found in indoor air, where it is released from various consumer products (EPA 2002). One survey (EPA 1988) reports measured formaldehyde levels in homes ranging from 0.10 to 3.68 parts per million (ppm), or 122 to 4,520 $\mu g/m^3$. The smoking of tobacco products also represents a critical source of human formaldehyde exposure.

Benzene emissions typically result from coal and oil combustion, volatilization from gasoline service stations, and motor vehicle exhaust. Acute inhalation exposure to benzene may cause drowsiness, dizziness and headaches, as well as eye, skin, and respiratory tract irritation. Exposure to high concentrations of benzene may cause unconsciousness. Chronic inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia. Adverse reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidences of leukemia (cancer of the tissues that form white blood cells) have been observed in humans occupationally exposed to benzene. EPA has classified benzene as a Group A, human carcinogen (EPA 1994).

Additional BTEX compounds including toluene, ethylbenzene, and xylene, as well as *n*-hexane, are of concern for both acute and chronic health effects. EPA has classified these compounds as a Group D, not classifiable as to human carcinogenicity (EPA 1994). These compounds are released to the atmosphere through a variety of pathways, including volatilization through their use as solvents, as fugitive emissions from industrial sources, and through automobile exhaust.

3.4.3.3 Air Quality Related Values

Areas of special concern, including National Parks and some Class I and II wilderness areas are monitored for Air Quality Related Value (AQRV) impacts. These AQRVs include terrestrial and aquatic deposition of acidic pollutants and visibility impairment.

Atmospheric Deposition

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems. Deposition is frequently reported as the mass of material deposited on an area (kilograms per hectare or kg ha^{-1}) or as a flux (kilograms per hectare per year or kg ha^{-1} $year^{-1}$). Air pollutants are deposited by wet deposition (precipitation) and by dry deposition (gravitational settling of particles and adherence of gaseous pollutants).

Total deposition refers to the sum of airborne material transferred to the Earth's surface by both wet and dry deposition. Total terrestrial deposition Levels of Concern (LOC) have been estimated for several areas, including the Bridger Wilderness in Wyoming (Fox et al. 1989). Estimated total terrestrial deposition LOC include the "red line" (defined as the total deposition that the area can tolerate) and the "green line" (defined as the acceptable level of total deposition). Total deposition LOC for Bridger are "red lines" set at 10 kg/ha/year for nitrogen and 20 kg/ha/year for sulfur. The Bridger Wilderness "green lines" are currently 3-5 kg/ha/year for nitrogen and 5 kg/ha/year for sulfur, although these values may be reduced in the future.

Incremental project-level Deposition Analysis Thresholds (DATs) for Class I areas have also been established jointly through the National Park Service (NPS) and U.S. Fish and Wildlife Service (USFWS). DATs are incremental amounts of deposition that trigger management concerns. However, deposition rates in excess of the DATs do not necessarily constitute an adverse impact to the environment. Both the NPS and the USFWS utilize a case-by-case approach to permit review and National Environmental Policy Act (NEPA) related proposals. Adverse impact determinations are considered on a case-by-case basis for predicted deposition values that are higher than the DAT. The DAT for sulfur and nitrogen deposition in Western Class I areas, developed as a function of natural background deposition, has been set at 0.005 kg/ha/yr for nitrogen (N) and sulfur (S) species (National Park Service 2003).

In order to characterize the current deposition rates at Bridger Wilderness, dry and wet deposition monitoring data measured at Pinedale, Wyoming (as recommended in the FLAG

[2000] Phase I report) were evaluated. Wet deposition data for the Pinedale station are available through the National Atmospheric Deposition Program (NADP) for the period 1982 through 2002. The NADP assesses wet deposition by measuring the chemical composition of precipitation (rain and snow). Similarly, the Clean Air Status and Trends Network (CASTNet) measures the dry deposition rates of nitrogen and sulfur compounds. Data from the Pinedale, Wyoming CASTNet station are available from 1989 through 2001.

Tables 3.4-7 and 3.4-8 summarize the annual average wet and dry components of total nitrogen and sulfur deposition at Pinedale. Figures 3.4-6 and 3.4-7 present graphical representations of the Pinedale total deposition data, along with comparisons to the Bridger "Red Line" and lower "Green Line." Note that wet deposition data are available from 1982 through 2002, while dry deposition data are available only from 1989 through 2001.

As the data illustrate, total deposition of nitrogen and sulfur are below the Bridger thresholds. Total nitrogen deposition of 1.3 kg N ha^{-1} yr^{-1} is approximately 60% below the "green line", while total sulfur deposition of 1.1 kg S ha^{-1} yr^{-1} is about 80% below the "green line". Both nitrogen and sulfur deposition are substantially below the "red line" thresholds. Additionally, the average annual pH of precipitation as measured at Pinedale from 1982 through 2002 was 5.1, and ranged from 4.9 to 5.5 over the period. The natural acidity of precipitation is considered to range from 5.0 to 5.6 pH (Seinfeld 1986); therefore the pH of precipitation at Pinedale is at the acidic end of the normal range.

Table 3.4-7. Nitrogen Deposition at Pinedale, Wyoming.

Chemical Species	Dry Deposition[1] (kg N ha^{-1} yr^{-1})	Wet Deposition[2] (kg N ha^{-1} yr^{-1})	Total Deposition (kg N ha^{-1} yr^{-1})
Ammonium (NH_4^+)	0.1	0.3	0.4
Nitrate (NO_3^-)	0.0	0.5	0.5
Nitric acid (HNO_3)	0.4	-	0.4
TOTAL	0.5	0.8	1.3

Table 3.4-8. Sulfur Deposition at Pinedale, Wyoming.

Chemical Species	Dry Deposition[1] (kg S ha^{-1} yr^{-1})	Wet Deposition[2] (kg S ha^{-1} yr^{-1})	Total Deposition (kg S ha^{-1} yr^{-1})
Sulfate (SO_4^{2-})	0.1	0.7	0.8
Sulfur dioxide (SO_2)	0.3	-	0.3
TOTAL	0.4	0.7	1.1

[1] Source: Dry deposition collected at Pinedale CASTNet site (PND165) from 1989-2000.
[2] Source: Wet deposition data collected at Pinedale NADP site (WY06) from 1982-2002.

Deposition data represent the annual average over each respective time period.

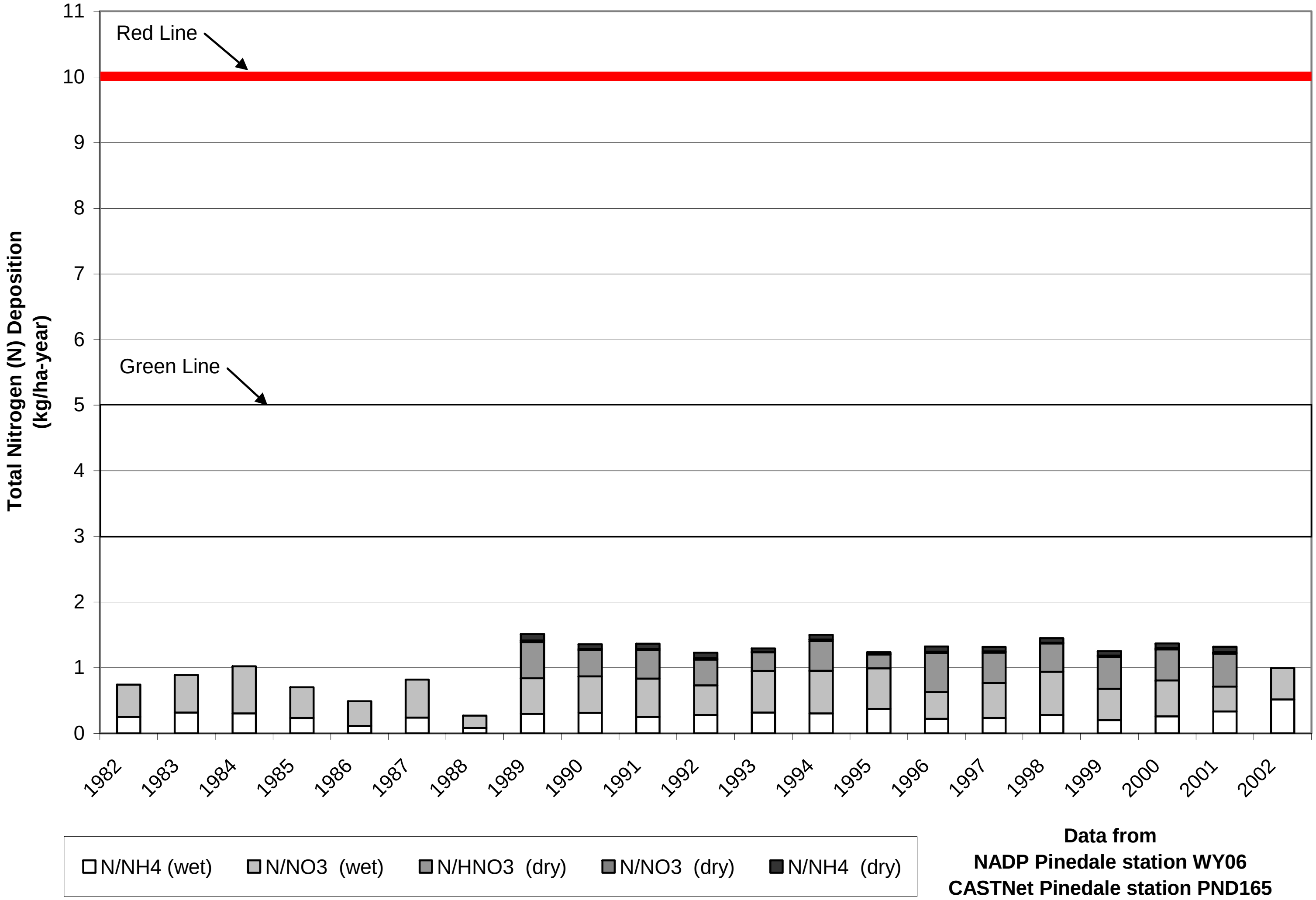


Figure 3.4-6. Total Nitrogen Deposition near Bridger Wilderness, Wyoming.

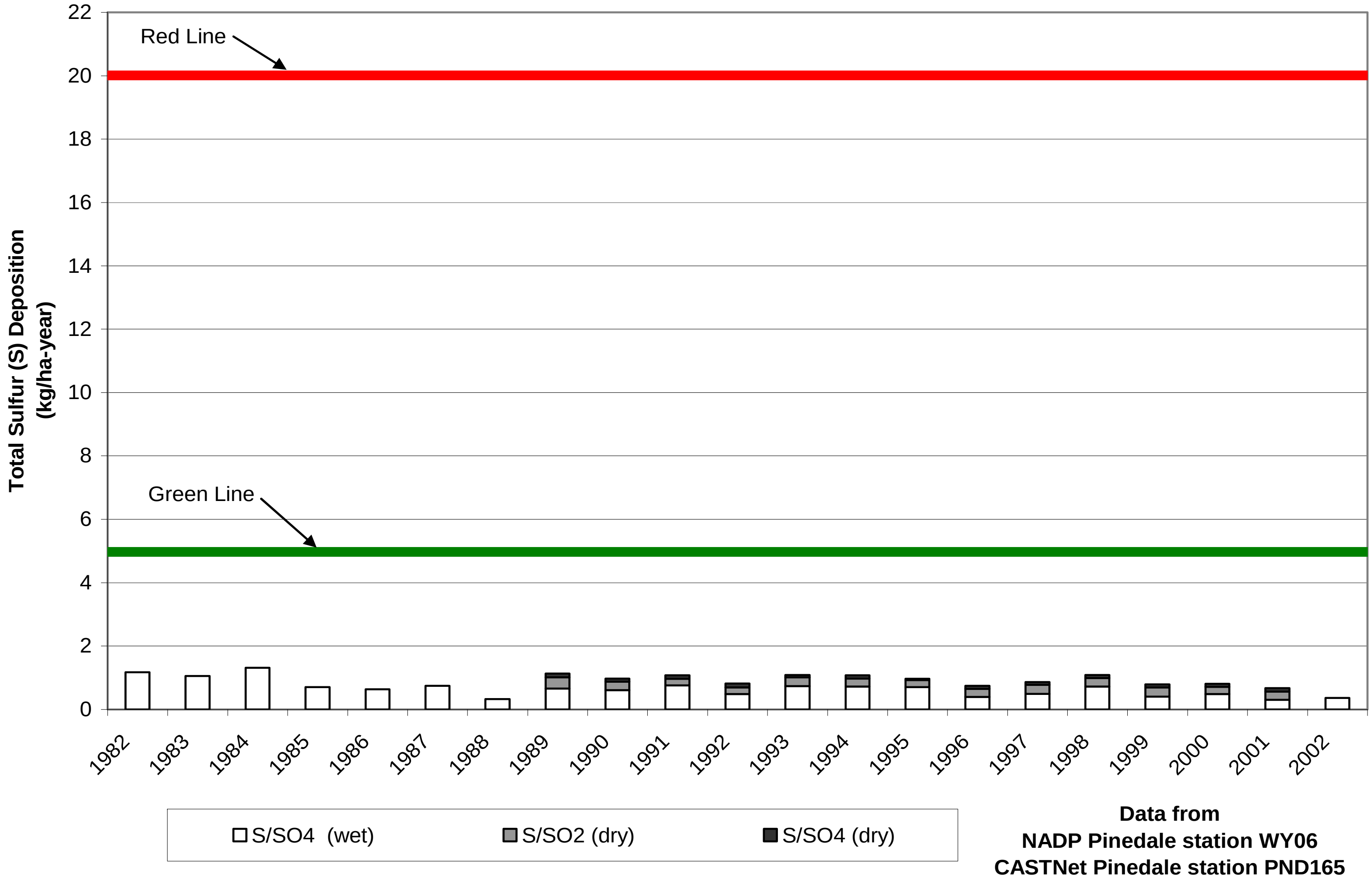


Figure 3.4-7. Total Sulfur Deposition near Bridger Wilderness, Wyoming.

Acid Neutralization Capacity

Aquatic bodies are important resources in most wilderness areas. Acid deposition resulting from industrial emissions of sulfur and nitrogen based compounds can have a direct effect on the acid neutralization capacity (ANC) of sensitive lake ecosystems. The following table (3.4-9) summarizes the existing ANC for selected lakes of special concern.

Table 3.4-9. Background Acid Neutralization Capacity for Sensitive Lakes in Wyoming.

Lake	Area Of Special Concern	10% Lowest ANC Recorded at Outlet (μeq/l)	Number Of Samples	Monitoring Period
Black Joe	Bridger Wilderness	67.0	61	1984 – 2003
Deep	Bridger Wilderness	59.9	58	1984 – 2003
Emerald Lake	Cloud Peak Wilderness	69.8	26	1993 – 2003
Florence Lake	Cloud Peak Wilderness	33.0	28	1993 – 2003
Hobbs	Bridger Wilderness	69.9	65	1984 – 2003
Lower Saddlebag	Popo Agie Wilderness	55.5	43	1989 – 2003
Ross	Fitzpatrick Wilderness	53.5	44	1988 – 2003
Stepping Stone	Absaroka-Beartooth	19.9	10	1993 – 2003
Twin Island	Absaroka-Beartooth	17.6	10	1993 – 2003
Upper Frozen	Bridger Wilderness	5.0	6	1997 – 2003

Source: U.S. Department of Agriculture, Forest Service 2003.

Visibility

Visitors to national parks and wilderness areas list the ability to view unobscured scenic vistas as an important part of a satisfying experience. Unfortunately, visibility impairment in the form of regional haze has been documented in many Class I areas. In the intermountain west, atmospheric sulfate, organics and elemental carbon are the main cause of regional haze and visibility impairment (FLAG 2000).

Visibility is usually characterized by two parameters, standard visual range (SVR) and the light-extinction coefficient (b_{ext}). The standard visual range parameter represents the greatest distance that a large dark object can be seen. The light extinction coefficient represents the attenuation of light per unit distance due to scattering and absorption by gases and particulate matter in the atmosphere. Under typical conditions, the visual range and b_{ext} parameters are inversely related to each other. Long visual ranges and low b_{ext} values represent good visibility conditions, while poor visibility conditions are represented by short visual ranges and high b_{ext} values. The dimension of visual range is length, and the parameter is usually expressed in kilometers (km). The dimension for b_{ext} is inverse length (1/length) and the coefficient is typically expressed as “inverse kilometers” (km^{-1}), or “inverse megameters” (Mm^{-1}), the reciprocal of 1 million meters.

Visibility impairment is frequently expressed in terms of deciview (dv). The deciview index was developed as a linear perceived visual change and increasing deciview values represent proportionately larger perceived visibility impairments. A change in visibility of 1.0

dv represents a "just noticeable change" by the average person under most circumstances. However, under ideal visibility conditions, changes in visibility of less than 1.0 dv may be noticeable. The U.S. Forest Service (USFS) has identified specific "Level of Acceptable Change" (LAC) values to evaluate potential air quality impacts within wilderness areas (USDA-FS 1993). The USFS utilizes visibility LAC thresholds of 1.0 and 0.5 deciviews.

Visibility related background data collected as part of the Interagency Monitoring of PROtected Visual Environments (IMPROVE) program are available for Bridger Wilderness, Yellowstone National Park, and North Absaroka Wilderness. Long-term (10 years or greater) data are available for Bridger Wilderness and Yellowstone National Park; however the available data for North Absaroka is limited to two years.

Figures 3.4-8 and 3.4-9 present long-term visibility conditions (as reconstructed from aerosol measurements) for the 20% cleanest, 20% haziest, and mid-range 40% to 60% days at Bridger Wilderness and Yellowstone National Park (IMPROVE 2004). As shown, monitored visibility conditions at Bridger Wilderness have been stable over time, neither improving nor degrading. Monitored conditions at Yellowstone National Park indicate visibility conditions have been improving slightly over time.

Seasonal visibility conditions can be reconstructed utilizing quarterly particle concentrations measured at the IMPROVE monitoring sites in conjunction with monthly relative humidity factors. Tables 3.4-10 through 3.4-12 summarize the seasonal visibility conditions at Yellowstone National Park, Bridger Wilderness and North Absaroka Wilderness. Figure 3.4-10 presents the Standard Visual Range for each of the IMPROVE monitoring areas. As shown, visibility is very good at all three areas with a Standard Visual Range of 192 to 307 km (119 to 190 miles). Bridger and North Absaroka Wilderness areas typically exhibit the clearest visibility conditions, while Yellowstone N.P. is consistently the haziest. Seasonal visibility conditions are typically the clearest during the fall and winter months (October through March) when particulate concentrations are at a minimum, while hazier conditions predominate during the spring and summer months (April through September) when particulates are at a maximum.

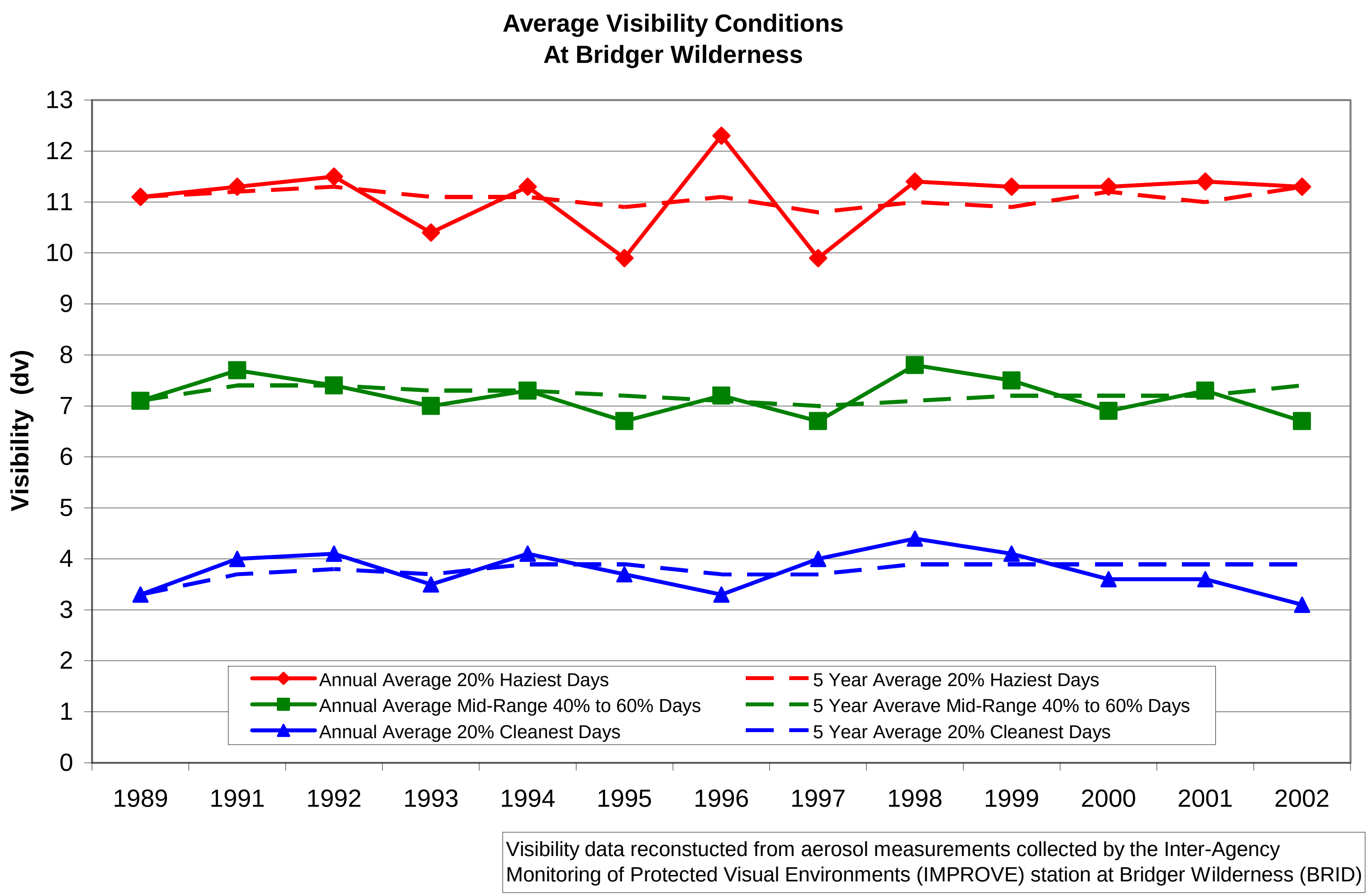


Figure 3.4-8. Visibility Conditions at Bridger Wilderness, Wyoming.

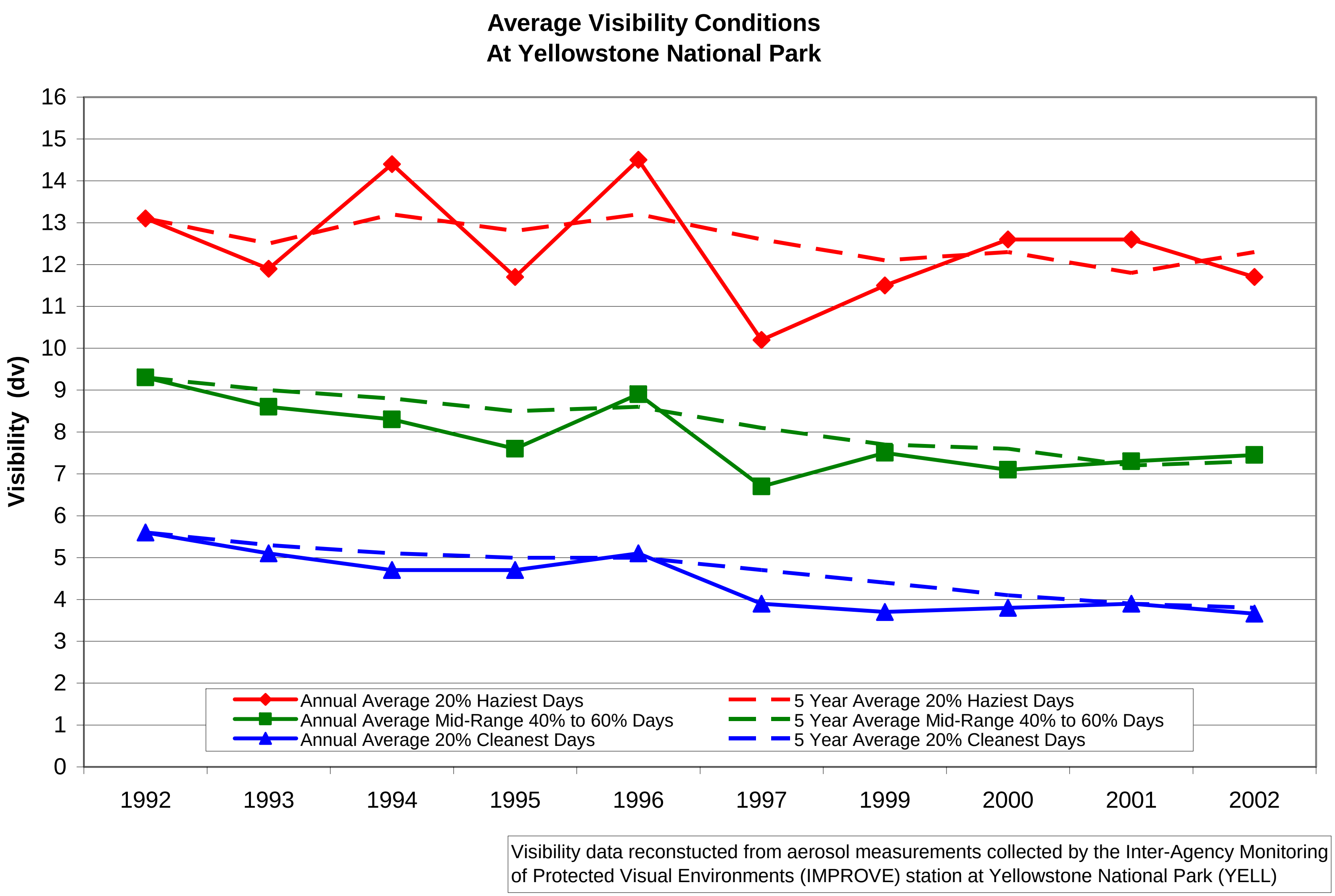


Figure 3.4-9. Visibility Conditions at Yellowstone National Park, Wyoming.

Table 3.4-10. Bridger Wilderness Reconstructed Visibility Conditions (20% Cleanest).

Month	Relative Humidity Factor [1] f(Rh) (unitless)	Dry Hygroscopic Extinction [2] (1/Mm)	Dry Non-Hygroscopic Extinction [2] (1/Mm)	Reconstructed Extinction (bext) (1/Mm)	Deciview (dv)	Standard Visual Range (km)
Jan	2.5	0.845	1.666	13.778	3.2	284
Feb	2.3	0.845	1.666	13.609	3.1	287
Mar	2.3	0.845	1.666	13.609	3.1	287
Apr	2.1	1.730	3.800	17.432	5.6	224
May	2.1	1.730	3.800	17.432	5.6	224
Jun	1.8	1.730	3.800	16.914	5.3	231
Jul	1.5	1.902	5.637	18.489	6.1	211
Aug	1.5	1.902	2.035	18.489	6.1	211
Sep	1.8	1.902	2.591	19.060	6.5	205
Oct	2.0	0.915	4.163	13.865	3.3	282
Nov	2.5	0.915	5.151	14.323	3.6	273
Dec	2.4	0.915	2.262	14.231	3.5	275

[1] Relative humidity factors [f(Rh)] from Table A-2, Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, September 2003.
[2] Quarterly particle extinction data provided by Scot Copeland, USFS, Washakie Ranger District, Lander, WY. October 2003.

Table 3.4-11. Yellowstone N. P. Reconstructed Visibility Conditions (20% Cleanest).

Month	Relative Humidity Factor [1] f(Rh) (unitless)	Dry Hygroscopic Extinction [2] (1/Mm)	Dry Non-Hygroscopic Extinction [2] (1/Mm)	Reconstructed Extinction (bext) (1/Mm)	Deciview (dv)	Standard Visual Range (km)
Jan	2.5	1.126	2.973	15.8	4.6	248
Feb	2.3	1.126	2.973	15.6	4.4	251
Mar	2.2	1.126	2.973	15.5	4.4	253
Apr	2.1	1.502	4.531	17.7	5.7	221
May	2.1	1.502	4.531	17.7	5.7	221
Jun	1.9	1.502	4.531	17.4	5.5	225
Jul	1.7	1.811	7.330	20.4	7.1	192
Aug	1.6	1.811	7.330	20.2	7.0	193
Sep	1.8	1.811	7.330	20.6	7.2	190
Oct	2.1	1.033	2.990	15.2	4.2	258
Nov	2.4	1.033	2.990	15.5	4.4	253
Dec	2.5	1.033	2.990	15.6	4.4	251

[1] Relative humidity factors [f(Rh)] from Table A-2, Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, September 2003.
[2] Quarterly particle extinction data provided by Scot Copeland, USFS, Washakie Ranger District, Lander, WY. October 2003.

Table 3.4-12. North Absaroka Reconstructed Visibility Conditions (20% Cleanest).

Month	Relative Humidity Factor [1] f(Rh) (unitless)	Dry Hygroscopic Extinction [2] (1/Mm)	Dry Non-Hygroscopic Extinction [2] (1/Mm)	Reconstructed Extinction (bext) (1/Mm)	Deciview (dv)	Standard Visual Range (km)
Jan	2.4	1.091	1.696	14.3	3.6	273
Feb	2.2	1.091	1.696	14.1	3.4	277
Mar	2.2	1.091	1.696	14.1	3.4	277
Apr	2.1	1.660	2.897	16.4	4.9	239
May	2.1	1.660	2.897	16.4	4.9	239
Jun	1.9	1.660	2.897	16.1	4.7	244
Jul	1.6	1.718	6.949	19.7	6.8	198
Aug	1.5	1.718	6.949	19.5	6.7	200
Sep	1.8	1.718	6.949	20.0	7.0	195
Oct	2.0	0.681	1.167	12.5	2.3	312
Nov	2.3	0.681	1.167	12.7	2.4	307
Dec	2.4	0.681	1.167	12.8	2.5	305

[1] Relative humidity factors [f(Rh)] from Table A-2, Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, September 2003.
[2] Quarterly particle extinction data provided by Scot Copeland, USFS, Washakie Ranger District, Lander, WY. October 2003.

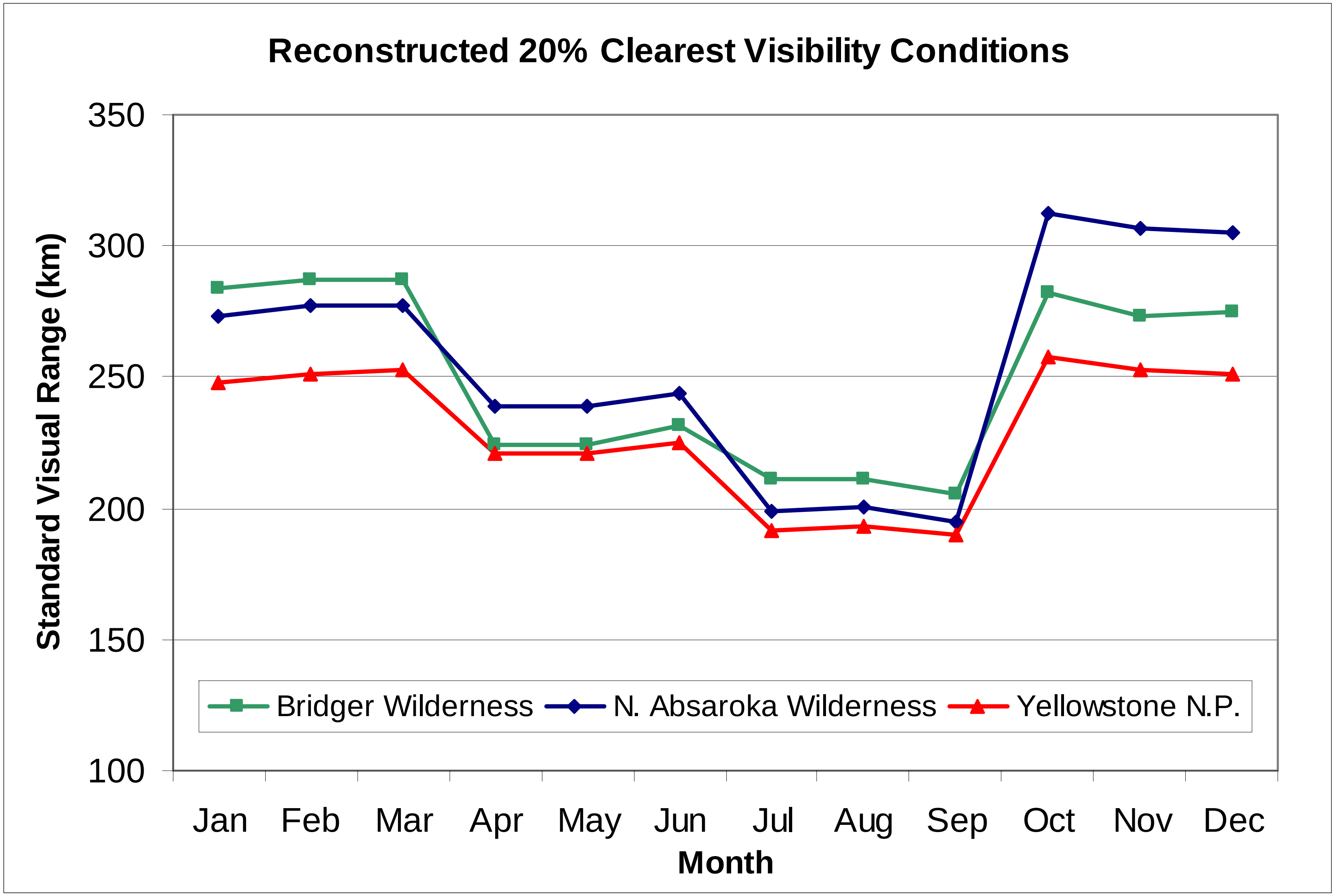


Figure 3.4-10. Reconstructed 20% Clearest Seasonal Visibility Condition

3.5 WATER RESOURCES

This section is based on numerous field studies and reports conducted in and near the WRPA. These studies have been completed for planning, designing, and managing water resources, both locally and regionally, and were implemented by the U.S. Geological Survey (USGS), Wyoming State Engineer, Shoshone and Arapaho Tribes, and others. Primary sources of information for this section are USGS reports including: "Water Resources of Fremont County, Wyoming" (Plafcan et al. 1995); "Water Resources of The Wind River Indian Reservation, Wyoming" (Daddow, R. L. 1996); and "Ground-water Resources of the Wind River Indian Reservation, Wyoming" (McGreevy et al. 1969). Other data and information were derived from numerous sources presented in the list of references. In addition, topographic maps and stream gauging data were used to describe the hydrology of the WRPA.

Water resources within the Wind River Project Area (WRPA) consist of both surface water and groundwater. Groundwater beneath the WRPA is contained primarily in unconsolidated Quaternary deposits of sand and gravel in the Wind River Formation. Other water-bearing units occur within the deeper Mesozoic, Paleozoic, and Precambrian rocks.

3.5.1 Surface Water

The major surface water drainages within the WRPA include Fivemile Creek, Muddy Creek, Cottonwood Creek and Cottonwood Drain. Cottonwood Drain connects Upper and Middle Reservoir to Lake Cameahwait. These waterways discharge into Boysen Reservoir, which is located on the Wind River. In addition, a large portion of the WRPA lies within the Riverton Reclamation Withdrawal Area, which consists of numerous irrigation canals, laterals, and drains. Other surface water bodies within the WRPA include Ocean Lake, Boysen Reservoir, Middle Depression Reservoir, and Upper Depression Reservoir.

3.5.1.1 Streams

The WRPA is drained by three principal streams, Fivemile Creek, Muddy Creek, and Cottonwood Creek, as shown in Figure 3.5-1. The watershed areas associated with these three creeks within the WRPA are shown in Figure 3.5-2. Fivemile Creek drains the southern portion of the WRPA; Muddy Creek drains the central portion; and Cottonwood Creek drains a small portion of the northern part of the WRPA. Each of these streams flows into Boysen Reservoir. The source of water for Fivemile Creek is the discharge from the Circle Ridge Oil Field (Maverick Springs Dome). Therefore this stream is an "effluent-dominated" stream in its upper reaches (i.e., Arapahoe Ranch Road)(D. Haire, WREQC, personal communication, April 27, 2004). The headwaters of Muddy and Cottonwood creeks are in the Owl Mountains to the north of the WRPA. Prior to reaching the WRPA, these creeks flow over a series of Paleozoic, Mesozoic, and Tertiary strata including limestone, sandstone, shale, and conglomerate. Within the WRPA, these streams flow over Quaternary deposits of unconsolidated sand and gravel and the Tertiary Wind River Formation, which consists primarily of siltstone and sandstone.

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Figure 3.5-1. Surface Water Drainages, USGS Gauging Stations, and other Water and Fish Sampling Locations within and near the WRPA.

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Figure 3.5-2. Sub-basins within the WRPA.

Basic geographical characteristics of each of the major streams within the WRPA are presented in Table 3.5-1. In general, Fivemile, Muddy and Cottonwood Creeks are relatively sinuous. Cottonwood Drain, the connecting stream between Upper and Middle Reservoir and Lake Cameahwait, is relatively straight. Fivemile and Muddy Creeks have relatively uniform widths with narrow point bars, are typically incised, and are considered to be relatively unstable. Sediment loading in the channel is relatively high and typical of streams in this part of Wyoming.

Table 3.5-1. Geomorphological Characteristics of WRPA Streams

Stream Name	Approx. Elevation at Project Boundaries (ft)		Relief (ft)	Approximate Length (mi)		Sinuosity	Approximate Watershed Area (mi^2)
	Enter	Exit		Valley	Channel		
Muddy Creek	5,326	4,751	575	12.74	21.97	1.19	332
Fivemile Creek	5,648	5,129	519	18.45	16.92	1.33	418
Cottonwood Creek	5,129	4,899	230	7.03	7.91	1.13	165
Cottonwood Drain	5,129	4,866	263	8.52	8.79	1.03	-

Streams within the WRPA are classified as ephemeral, intermittent, or perennial. In general, ephemeral streams are those streams that flow only in direct response to a rainfall or runoff event. Intermittent streams are streams that intercept the water table and flow at least part of the year. Perennial streams are streams that flow all year. Muddy and Fivemile Creeks are mainly perennial streams. However, they contain ephemeral and intermittent reaches, as well (D. Haire, WREQC, personal communication, April 27, 2004). Cottonwood Creek is an intermittent stream. Flows of each of the major streams within the WRPA are affected by irrigation diversions, storage structures, and drains within the WRPA. The affects of these irrigation features on flow and erosive characteristics will be discussed in more detail later in this section.

The USGS has maintained numerous surface water gauging stations in the direct vicinity of the WRPA, as shown in Table 3.5-2. Most of these stations are no longer monitored.

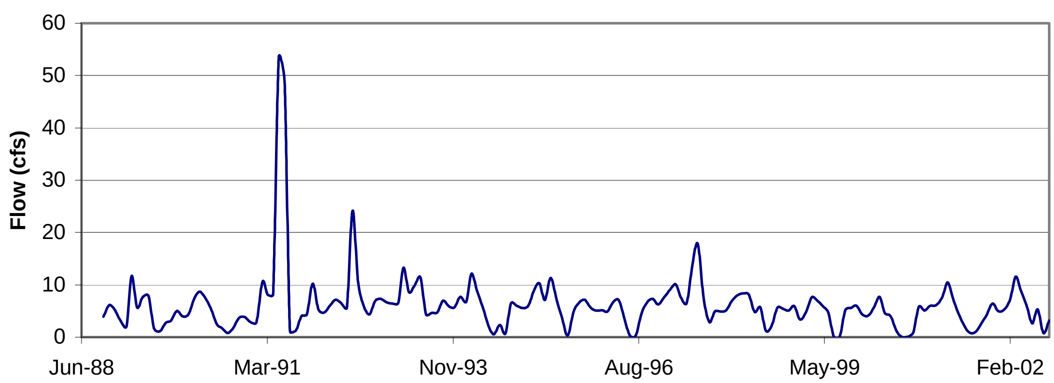
Table 3.5-2. Historic and Current USGS Gauging Stations in the Direct Vicinity of the WRPA

Station Name	Station Number	Drainage Area (mi^2)	Period of Record		
			Daily or monthly Discharge	Water Quality	Sediment
Fivemile Creek above Wyoming Canal, near Pavillion	06244500	118	1949-75; 1988-Present	1949-51; 1969; 1974-75; 1987 -92	1949-51;1960-61;1964-68;1970-75;1989-92;
Fivemile Creek near Pavillion	06245000	118	1948-49	-	-
Powerline Wasteway near Pavillion	06245500	-	1949-50	-	1950
Pavillion drain near Pavillion	06246000	-	1948-50	1988	1949-50;1988
Ocean Drain at Ocean Lake outlet, near Pavillion	06246500	-	1948-53; 1978-83.	1950-51; 1978-83; 1986;1988	1950-51
Ocean Drain near Midvale	06246800	-	1979-82	-	1979-82
Ocean Drain near Pavillion	06247000	-	1948-53	-	1949-50
Dudley Wasteway near Pavillion	06247500	-	1949-50	-	
Kellett Drain near Pavillion	06248000	-	1948-50	-	1950
Dewey Drain near Pavillion	06248500	-	1948-50	-	-
Fivemile 76 Drain near Riverton	06249000	-	1949-50	-	-
Sand Gulch Drain and Wasteway near Riverton	06249500	-	1949-50	-	-
Fivemile Creek near Riverton	06250000	356	1949-65	1950-51	1949-51;1959-61;1963-65
Lost Wells Butte Drain near Riverton	06250500	-	1949-50		
Coleman Drain near Shoshoni	06251000		1948-50		1950
Sand Gulch near Shoshoni	06251500	18.6	1948-53	1988	1949-50;1988
Eagle Drain near Shoshoni	06252000	-	1948-50		
Lateral P-34.9 Wasteway near Shoshoni	06252500	-	1949-50		
Fivemile Creek near Shoshoni	06253000	418	1941-42;1948-83;1988	1948-51; 1953; 1965-86; 1988.	1949-51;1959-61; 1963-68;1972; 1974-75;1978-85; 1988
Lateral P-36.8 Wasteway near Shoshoni	06253500	-	1949-50	-	-
Muddy Creek near Pavillion	06257500	267	1949-73	1949-51; 1988-92.	1949-51;1961; 1964-68;1970-72
Muddy Creek near Shoshoni	06258000	332	1949-68;1972-83	1953; 1982-84; 1986;1988	1949-51;1960-61;1964-68;1982-85;1988
Cottonwood Creek Drain near Shoshoni	06258010		1979-82		
Birdseye Creek near Shoshoni	06258400	13.2	1959-72		
Cottonwood Creek near Bonneville	06258500	165	1949-53	1949-50; 1976.	
Boysen Reservoir	06258900	7,700	1951-Present		

Source: Daddow 1996, Plafcan et al. 1995.

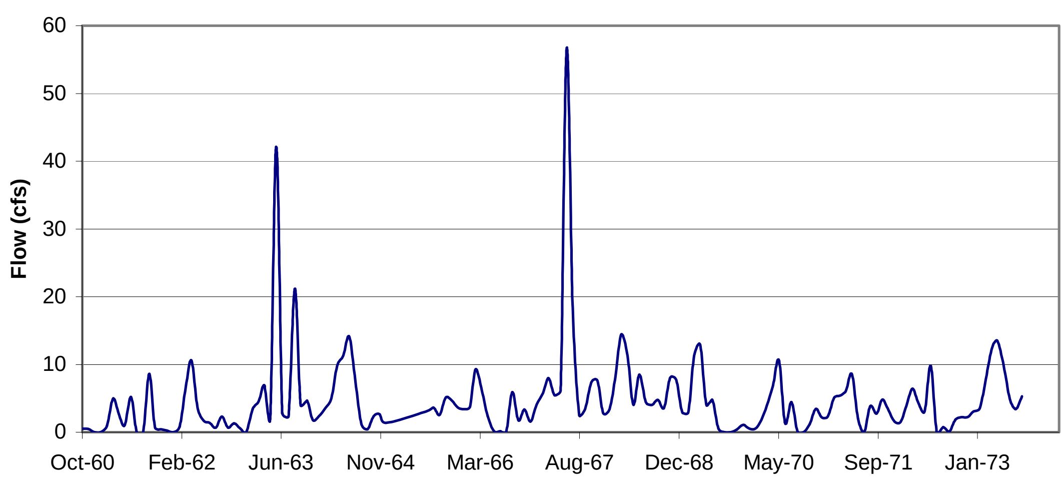
Review of stream gauging data indicates that peaks flows for streams such as Fivemile and Muddy creeks occur during May and June. Peak flows are the result of early season diversion flows from the Wind River through the Midvale Irrigation District delivery system. Localized snowmelt may result in higher flows in March and April, but most of these flows are diverted for irrigation above the WRPA. Figures 3.5-3 and 3.5-4 show hydrographs for Fivemile and Muddy creeks within the WRPA.

Figure 3.5-3: Hydrograph for Five Mile Creek above Wyoming Canal, near Pavillon (USGS 06244500) Water Years 1988 - 2001



Source: USGS 2003a.

Figure 3.5-4: Hydrograph for Muddy Creek near Pavillion (USGS 06257500) Water Years 1961 - 1973



Source: USGS 2003a.

There are also numerous ephemeral streams within the WRPA, which, for the most part, originate in the low-lying areas. These streams have not been gauged in the WRPA for any continuous length of time; however, the hydrographs of similar streams in the area indicate that peak flows occur during summer months in direct response to high intensity, short duration thunderstorm events.

Within the WRPA, both Muddy and Fivemile Creeks gain flow in the downstream direction. Tables 3.5-3 and 3.5-4 present flow data for two gauging stations on Fivemile Creek for the Water Year 2000. These data show that the flow in Fivemile Creek increases from 3.79 cubic feet per second (cfs) near Pavillion, upstream from the WRPA, to 162 cfs near Shoshoni downstream from the WRPA. The increase in flow is primarily due to irrigation return flows entering the creek from the complex irrigation system supplied by the Midvale Irrigation District – Riverton Unit.

Table 3.5-3. Summary Flow Statistics For Water Years 1950 – 2001 at USGS Gauging Station 06244500, Fivemile Creek Above Wyoming Canal, Near Pavillion, WY.[1, 2]

	W.Y. 2000	W.Y. 2001	1950 - 2001
Annual Total	1,386.27	1,817.70	--
Annual Mean	3.79	4.98	3.58
Highest Annual Mean	--	--	12.4 (1991)
Lowest Annual Mean	--	--	0.25 (1955)
Highest Daily Mean	9.6 (Mar 8)	15 (Mar 16)	273 (Sept. 20, 1950)
Lowest Daily Mean	0.02 (Jul 18)	0.07 (Aug 1,2)	No flow for several days most years
Annual Seven-Day Minimum	0.02 (Aug 4)	0.08 (Jul 31)	No flow for several days most years
Maximum Peak Flow	--	24 (Mar 16)	1750 (Sep 6, 1951)
Annual Runoff (Ac-Ft)	2,750	3,610	2,590

[1]Station is located at Lat 43°18'05", Long 108°42'08", in SE1/4 SW1/4 SE14 sec.24, T4N, R1E, Fremont County, Hydrologic Unit 10080005, on left bank 1,700 ft upstream from Wyoming Canal siphon and 4.0 mi north of Pavillion. Drainage Area: 118 mi^2.
Period of Record: October 1949 to September 1975, October 1988 to current year.
[2]All units in cubic feet/second.
Source: Plafcan et al 1995; Daddow 1996.

Table 3.5-4. Summary Flow Statistics For Water Years 1950 – 2001 at USGS Gauging Station 06243000, Fivemile Creek Near Shoshoni, WY[1, 2]

	W.Y. 2000	W.Y. 2001	W.Y. 1950 - 2001
Annual Total	59317	43,145	--
Annual Mean	162	118	163
Highest Annual Mean	--	--	253 (1999)
Lowest Annual Mean	--	--	54.8 (1942)
Highest Daily Mean	350 (Jul 20)	230 (Jul 5)	964 (Sept 11,1973)
Lowest Daily Mean	41 (Apr 10)	46 (Feb 10)	1 (Jan 4, 1942)
Annual Seven-Day Minimum	44 (Apr 5)	49 (Feb 8)	1.4 (Jan 1, 1942)
Maximum Peak Flow	--	257 (Oct 3)	3390, (June 15, 1962)
Annual Runoff (Ac-Ft)	117,700	85,580	1,118,300

[1]Station is located at Lat 43°13'20", Long 108°13'06", in NW1/4 SW1/4 SE 19, T3N4, R6E., Fremont County, Hydrologic Unit 10080005. Drainage Area: 418 mi^2 of which 133 mi^2 not contributing. Period of Record: May 1941 – September 1942, August 1948 – September 1983, October 1988 – Current Year
[2]All units in cubic feet/second.
Source: Plafcan et al 1995; Daddow 1996.

3.5.1.2 Midvale Irrigation District Canals

The Midvale Irrigation District, Riverton Unit consists of two main canals. The Wyoming Canal is 62.4 miles long and has a design capacity of 2,200 cubic feet per second; and the Pilot Canal is 38.2 miles long with a design capacity of 1,000 cubic feet per second. The lateral system totals 300 miles in length, of which 177 miles of the channels are unlined, 104 miles are lined, and 19 miles are pipeline. The drainage system comprises 335 miles, of which 141 miles are closed pipelines. Sources of water for the system, which are located upstream from the WRPA, include Bull Lake Dam and Reservoir, Wind River Diversion Dam, and Pilot Butte Dam and Reservoir.

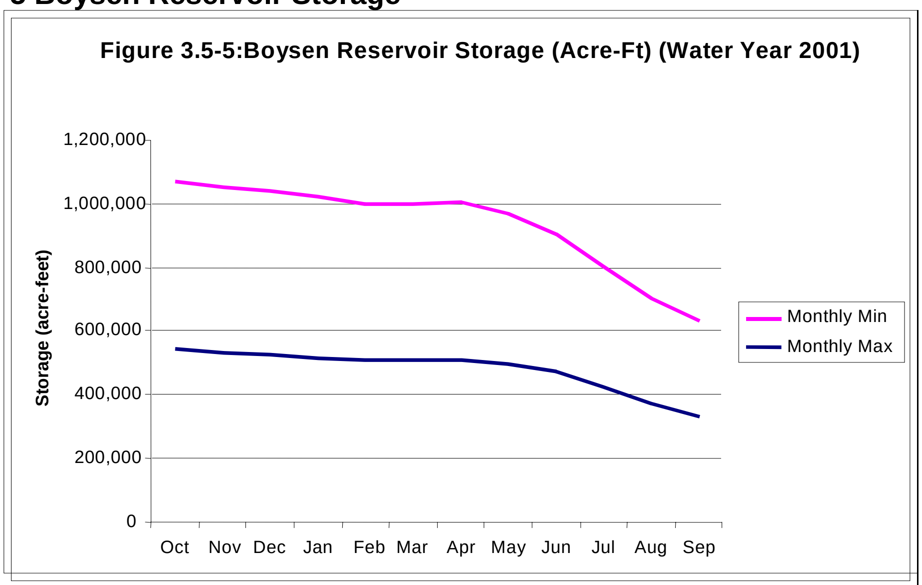
Bull Lake Dam, located in the foothills of the Wind River Range, is an earthen-filled dam 81 feet high. Bull Lake Dam creates a reservoir on Bull Lake Creek with a capacity of 152,000 acre-feet, in addition to the existing 70,000 acre-foot capacity of the natural lake. This water is delivered to the WRPA via the Wyoming Canal. The Wind River Diversion Dam, located 34 miles northwest of Riverton, Wyoming, consists of a concrete weir with earthen dikes, at a height of 19 feet, and diverts water into the Wyoming Canal. Pilot Butte Reservoir is located 10 miles below the Wind River Diversion Dam. Three earthen-filled embankments constitute the Pilot Butte Dam and form a reservoir, which has an active capacity of 31,600 acre-feet. Water from this reservoir is delivered to the WRPA via the Pilot Butte Canal.

3.5.1.3 Other Surface Water Bodies

Adjacent to the WRPA, there are two major surface water bodies, Ocean Lake and Boysen Reservoir. Ocean Lake is a natural lake and lies entirely within the Fivemile Creek watershed. It has a surface area of approximately 6,440 acres and is bounded on the east side by a State Wildlife Management Area. It receives water from runoff and irrigation drains, and discharges into Fivemile Creek through the Ocean Drain (Figure 3.5-2). In addition, there are two small reservoirs termed Upper Depression and Middle Depression Reservoirs within the WRPA on Cottonwood Drain. Both of these reservoirs discharge into Lake Cameahwait, which discharges into Boysen Reservoir.

Boysen Reservoir was formed by the damming of the Wind River. It receives discharges from all streams draining the WRPA. In total, approximately 7,700 square miles drain into the reservoir. A rockfill dam constructed by the BOR in 1951 formed the reservoir. Boysen Reservoir has a storage capacity of 802,000 acre-ft with a dead storage of 59,880 acre-ft below an elevation of 4,657 ft. The dam was originally constructed for irrigation, flood control, and power generation. Figure 3.5-5 illustrates monthly reservoir storage fluctuations in the lake level for Water Year 2001. This data indicate, that for Water Year 2001, which was particularly dry, the maximum reservoir storage was 542,000 acre-ft in October, 2000, and the minimum storage was 304,000 acre-ft in September, 2001. For Water Year 2001, water withdrawals exceeded inflow.

Figure 3.5-5 Boysen Reservoir Storage



Source: BOR 2003.

3.5.2 Surface Water Quality

The water quality characteristics of the surface waters in the WRPA reflect the chemical nature of precipitation, irrigation water, and the geologic strata over which the water flows. The following section presents an overview of the water quality of these waters, and is divided into three parts. The first part presents the overall chemical characteristics of the surface waters within the WRPA. The second part presents the results of a qualitative habitat quality assessment, which was used to classify the surface waters based on Wyoming Department of Environmental Quality Standards (WDEQ 2001a). Based on the results of these studies, potential beneficial uses of these waters are evaluated.

It is important to note that WDEQ water quality standards were used for this EIS, since water quality standards for the WRIR are not currently available. However, WREQC is in the process of developing water quality standards for the WRIR. While the basic framework of the WDEQ classification is being adopted by WREQC, there may be significant differences in classification of the Fivemile and Muddy Creek watersheds. Since upper Fivemile Creek is completely dependent on NPDES discharges, it would likely be classified as 4C by WREQC, rather than 2AB. In addition, the peak water temperatures and low dissolved oxygen measurements recorded in the Muddy Creek mainstem above the Riverton Reclamation Withdrawal Area preclude the survival and propagation of game fish. As a result, WREQC has made a preliminary determination that Muddy Creek will be classified as a non-game fishery (i.e., 2C, rather than 2AB) (D. Haire, WREQC, April 27, 2004).

3.5.2.1 Water Quality Characteristics

According to Daddow (1996), the water quality of streams in the vicinity of the WRPA is variable because of changes in stream flow conditions, and the influx of waters containing a mixture of runoff water, irrigation water, and groundwater. However, data from WREQC indicate that annual peak flows are a result of irrigation system diversion operations by the Midvale Irrigation District (D. Haire, WREQC, personal communication, April 27, 2004).

Daddow (1996) evaluated water chemistry data for numerous streams within the Wind River Indian Reservation (WRIR). Of particular interest to this EIS are water samples collected on Fivemile Creek near the Wyoming Canal Crossing, corresponding with USGS Gauging Station 06244500 (G-50 on Figure 3.5-1), which is directly upstream from the WRPA. A location of interest is on the Wind River below Boysen Reservoir at USGS Gauging Station 006259000 (G50a on Figure 3.5-1). Water quality samples collected at seven stations within the WRPA in August 2001 were used for a habitat evaluation study by the WDEQ (Eddy 2003).

Water quality samples have also been collected monthly or quarterly by the Wind River Environmental Commission (WREQC) at six stations for more than two years. Three of these stations are located on Fivemile Creek and three are on Muddy Creek. The report of the results of the water quality sampling and analysis (WREQC 2003) is provided in Appendix G-4.

Table 3.5-5 provides a summary of the water quality for Fivemile Creek near the Wyoming Canal Crossing for samples collected between 1949 and 1990. Water chemistry data for Fivemile Creek evaluated by Daddow (1996) indicates that the stream's water chemistry is affected by the quantity of stream flow. Fivemile Creek is predominantly a perennial stream, with a few intermittent reaches during periods of extreme drought. Based on 63 samples, the median concentration of total dissolved solids (TDS) in Fivemile Creek is 3,360 mg/L, with a range of 2,320 mg/L to 5,080 mg/L. Major ion concentrations indicate that the waters are dominated by sodium, calcium, and sulfate. Nitrate ranged from non-detect to 0.18 mg/L, with a median of 0.02 mg/L, based on 28 samples. During one sampling event, the boron concentration at this site was 0.81 mg/L. This value exceeds the Wyoming Water Quality standard of 0.75 mg/L boron for agricultural use (Appendix G-1). Another parameter of note is selenium, which based on 15 samples ranged between <0.01 and 4.0 µg/L. These values are below the Wyoming Stream Standards for aquatic life (acute value), Human Health, and Drinking Water as presented in Appendix G-1.

Table 3.5-5. Water Quality Summary for Fivemile Creek above Wyoming Canal Crossing near Pavillion, Wyoming, USGS Gauging Station 06244500, 1949-1990.[1]

Constituent	Sample Size	Maximum	Minimum	Median
Specific conductance (µS/cm)	63	5,750	2,370	4,000
pH (units)	37	8.4	7.1	7.7
Water temperature (^{o}C)	88	28	0.0	10
Turbidity (NTU)	18	200	0.0	2.5
Hardness, total as $CaCO_3$	51	2,100	1,000	1,800
Calcium, dissolved	51	690	310	460
Magnesium, dissolved	51	240	18	140
Sodium, dissolved	67	820	220	360
Potassium, dissolved	48	21	0.50	11
Alkalinity, total as $CaCO_3$	69	240	89	170
Sulfate, dissolved	70	3,500	1,300	2,400
Chloride, dissolved	70	92	18	65
Fluoride, dissolved	50	1.8	0.60	1.2
Silica, dissolved as SiO_2	50	22	4.8	8.9
Total Dissolved Solids (sum of constituents)	47	5,080	2,320	3,360
Nitrate, dissolved as N	28	0.18	0.0	0.02
Nitrite plus nitrate, dissolved as N	19	0.30	<0.01	0.06
Phosphorus, total as P	46	0.17	<0.01	0.006
Selenium, dissolved (µg/L)	15	4.0	<1.0	--

Source: Daddow 1996.

[1]All units are in mg/L, unless otherwise noted.

Table 3.5-6 presents a summary of water quality analyses taken near the outlet for Boysen Reservoir at USGS Gauging Station 006259000. These analyses reflect the character of water flowing into the reservoir, which includes irrigation withdrawals conducted by the Midvale Irrigation District. The median TDS concentration of water samples collected for this site is 443 mg/L. Water from this site is dominated by a mixture of sodium, calcium, and sulfate. Concentrations of trace metals, including arsenic, mercury, and chromium, are low and within acceptable Wyoming Water Quality standards for all uses (Appendix G-1). Maximum concentrations for nutrients such as nitrate and phosphorous are slightly higher than in samples collected at USGS Gauging Station 06244500 (Fivemile Creek near the Wyoming Canal Crossing), reflecting contributions of nitrate and phosphorous from irrigation return water.

Table 3.5-6. Water Quality Summary for USGS Gauging Station 0625900, Wind River below Boysen Reservoir, 1953 –1990.[1]

Constituent	Sample Size	Maximum	Minimum	Median
Specific conductance (µS/cm)	462	1,460	322	697
pH (units)	399	8.8	6.3	7.9
Water temperature (^{o}C)	224	24	0.0	10
Turbidity (NTU)	79	100	1.0	2.0
Hardness, total as $CaCO_3$)	469	480	120	210
Calcium, dissolved	455	120	30	57
Magnesium, dissolved	455	47	7.3	18
Sodium, dissolved	468	160	32	65
Potassium, dissolved	439	5.0	0.10	2.6
Alkalinity, total as $CaCO_3$	452	210	82	140
Sulfate, dissolved	450	560	94	200
Chloride, dissolved	441	66	0.10	8.1
Fluoride, dissolved	440	4.0	0.0	0.40
Silica, dissolved as SiO_2	455	17	3.7	8.8
Total Dissolved Solids (sum of constituents)	437	1,050	246	443
Nitrate, dissolved as N	87	0.54	0.0	0.14
Nitrite plus nitrate, dissolved as N	83	2.3	<0.10	0.14[2]
Phosphorus, total as P	151	0.27	<0.01	0.02[2]
Arsenic, dissolved (µg/L)	46	4.0	1.0	2.0
Barium, dissolved (µg/L)	45	200	<100	63[2]
Boron, dissolved (µg/L)	271	270	10	70
Cadmium	498	3.0	<1.0	0.31[2]
Chromium, dissolved (µg/L)	49	20	<1.0	0.40[2]
Iron, dissolved (µg/L)	75	290	<10	20[2]
Manganese, dissolved (µg/L)	49	240	<1.0	6.0[2]
Mercury, dissolved (µg/L)	46	9.0	<0.10	0.01[2]
Selenium, dissolved (µg/L)	48	2.0	<1.0	1.0[2]
Gross Alpha, dissolved as U-natural (µg/L)	13	19	<7.8	12[2]
Gross Beta, dissolved as Sr/Yt-90 (pCi/L)	13	8.0	<3.4	5.5[2]
Radium 226, dissolved (pCi/L)	13	0.19	0.07	0.11
Uranium, natural (µg/L)	13	11	5.2	9.3

[1]Units in mg/L, except where indicated
Source: Daddow 1996.
[2] Estimated based on regression analysis

Within the WRPA, an evaluation of surface waters in Fivemile Creek and Muddy Creek was conducted as part of a qualitative habitat quality assessment (Eddy 2003). For this study, water quality samples were collected at eight stations. The locations of these eight stations are described in Table 3.5-7, and analytical results from these stations are presented in Table 3.5-8.

Figure 3.5-6 shows basic trends of sulfate (anions), hardness (cations) and TDS (a surrogate for conductivity) on Fivemile Creek as the creek flows through the WRPA. Data for this figure were collected at five of the eight sampling stations described above. This diagram illustrates that, for this day in August 2001, there was a general decrease in the concentration of anions, cations, and TDS from Station 1 to Station 5. These data suggest that increases in flow of Fivemile Creek within the WRPA effectively dilute the water in the creek. Figure 3.5-7 provides the data for Muddy Creek. For Muddy Creek, flows are not affected by irrigation water to the same degree as for Fivemile Creek. Muddy Creek gains flow between Stations 6 and 7 and loses flow between Stations 7 and 8. However, as shown in Figure 3.5-7, cations, anions, and TDS increase as Muddy Creek flows through the WRPA.

Table 3.5-7. Water Quality Station Locations for Habitat Assessment within the WRPA.

Station Number	Stream Name	Section	Township	Range	Elevation (ft)
1	Fivemile Creek, Wyoming Canal Crossing	NE, NE Section 24	4N	1E	5515
2	Fivemile Creek, S7T3R3	SE,SE Section 7	3N	3E	5280
3 (water quality only)	Fivemile Creek Midvale	SW,SE Section 24	3N	3E	5250
4	Fivemile Creek, Lost Wells Butte	NE Section 35	3N	4E	5100
5	Fivemile Creek, Boysen Reservoir	NW, NW Section 25	38N	5E	4800
6	Muddy Creek, Wyoming Canal Crossing	SE, SE Section 35	5N	2E	5365
7	Muddy Creek, Below CR 431 Crossing	NE,NW Section 32	4N	4E	5052
8	Muddy Creek, Boysen Reservoir	SE, NE Section 33	39N	5E	4790

Source: Eddie (2003)

Table 3.5-8. Water Chemistry Results for Habitat Assessment for Water Quality Stations within or near the WRPA in August, 2001.

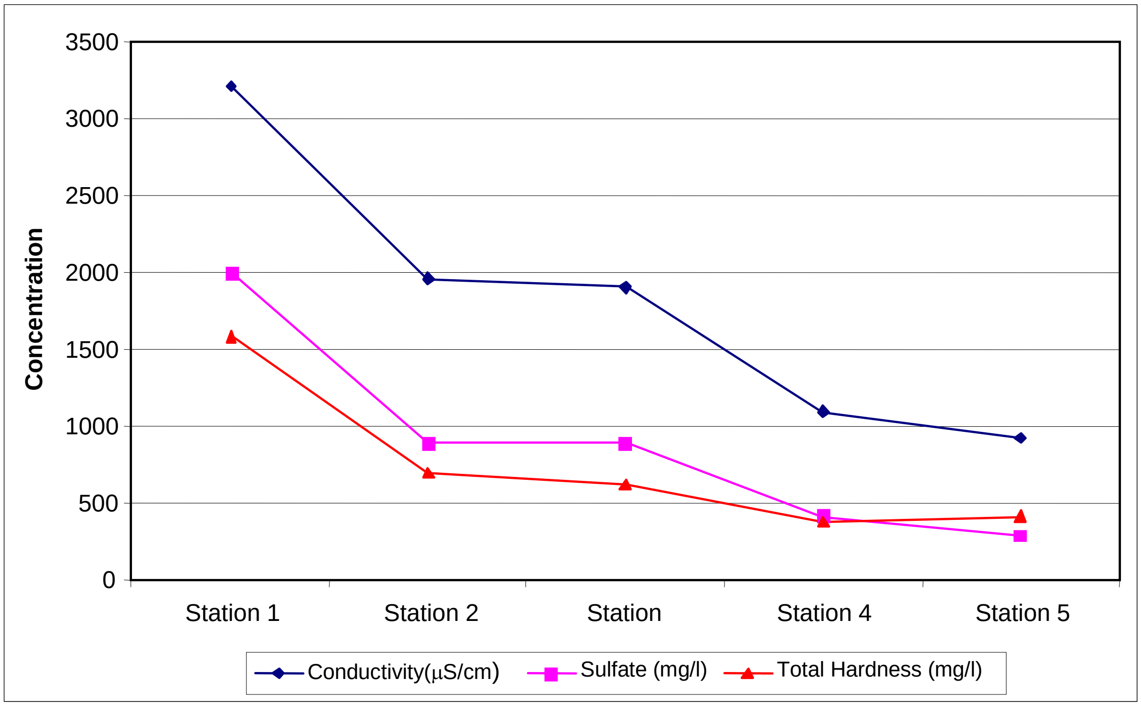
Parameter (units)	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Statio n 7	Station 8
Temperature (ΕC)	25.1	17.9	17.9	17.1	15.5	22.4	23.8	24.3
pH (Standard Units)	8.13	8.29	8.48	8.42	8.27	8.91	8.62	8.56
Conductivity (ΦS/cm)	3200	1950	1895	1090	926	231	824	832
Dissolved Oxygen (mg/L)	8.29	8.01	8.67	7.92	7.96	7.72	8.1	7.85
Turbidity (NTU)	0.83	5.24	6.38	23.6	41.5	2.36	10.18	33.4
Total Suspended Solids (mg/L)	ND	11	6	53	44	ND	32	54
Alkalinity (mg/L)	200	210	180	180	415	180	Invalid[1]	145
Chloride (mg/L)	58	20	19	12	9	ND	6	7
Sulfate (mg/L)	1993	885	885	406	284	35	278	287
Total Hardness (mg/L)	1582	694	614	375	404	96	272	272
Total Phosphorus (mg/L)	ND	ND	ND	0.2	0.2	ND	ND	ND
Nitrate Nitrogen (mg/L)	ND	1.82	0.215	0.57	1.19	ND	0.2	ND
Flow (cfs)	0.71	15.36	not measured	85.34	154.24	18.72	31.32	21.4

[1]The alkalinity sample was outside the RPD value for a duplicate sample, as governed by the sampling plan for these analyses.

ND indicates non-detect for the given parameter

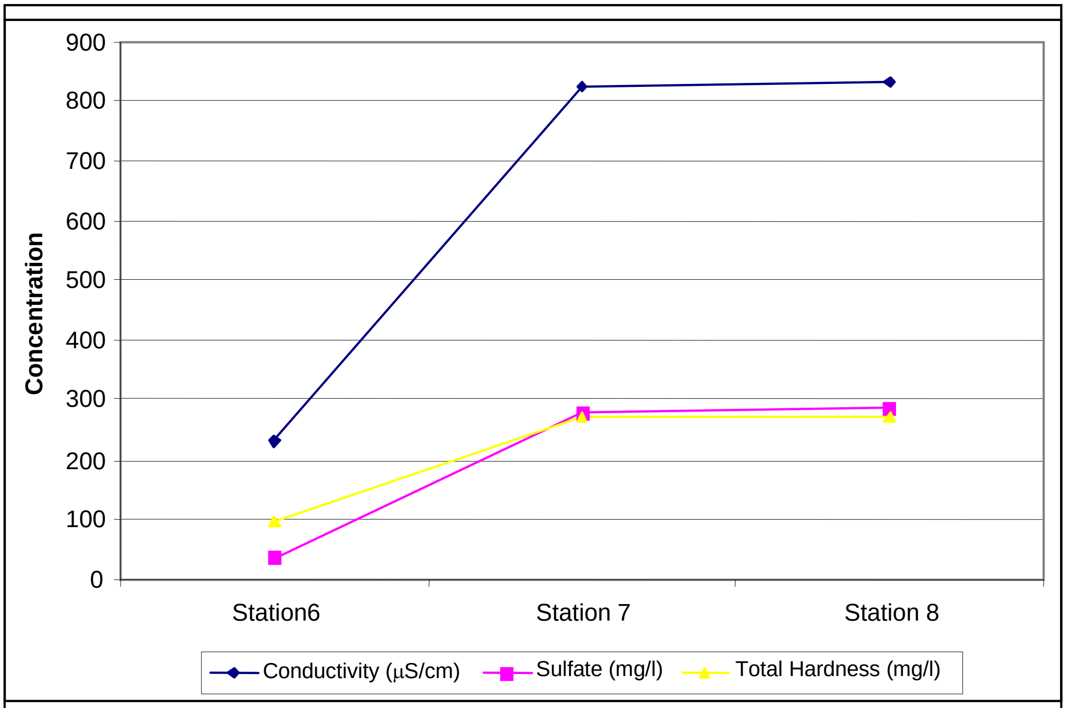
Source: Eddy 2003

Figure 3.5-6. Water Chemistry Trend for Fivemile Creek within the WRPA in August 2001.



Source: Eddy 2003

Figure 3.5-7. Water Chemistry Trend for Muddy Creek within the WRPA in August 2001.



Source: Eddy 2003

In addition to the data presented above, the WREQC collected water quality data on Fivemile Creek and Muddy Creek between 1998 and 2001. A total of six stations were monitored on a monthly or quarterly basis for more than two years. For Fivemile Creek, the stations are identified as G50, G50b, and G50a, and for Muddy Creek, the stations are labeled as G52, G52a, and G52b (see Figure 3.5-1 for locations of these stations). Water quality in the creeks was monitored for a variety of parameters, including temperature, dissolved oxygen, salinity, nitrates, and others. The results of these analyses are presented in Appendix G-2. Tables 3.5-9 and 3.5-10 summarize the results of these analyses. In general, the results indicate that waters in Fivemile Creek are relatively saturated with dissolved oxygen, with the percentage of dissolved oxygen saturation ranging between a low of 8.49 percent at Station G50b in the middle reach within the WRPA to a high of 144 percent at the lower end. For Muddy Creek, the percentage of dissolved oxygen saturation ranged from 24.6 percent at Station G52 to 132 percent, also at Station G52. Of concern are the relatively high values of total dissolved solids for both streams. TDS ranges from 492 mg/L to over 2,800 mg/L at Station G50 on Fivemile Creek, and between 102 mg/L and 2,600 mg/L at Station G52 on Muddy Creek. Long-term averages of TDS at most stations within the WRPA range from 800 mg/L to 1,000 mg/L. These values limit each creek's use for irrigation.

Table 3.5-9. Summary of Water Quality Data for Fivemile Creek in the WRPA (data from WREQC 2003).

	MIN	MAX	AVG	MEDIAN	Number of samples
STATION: G50	**LAT.: 43° 18' 11'' LONG.: 108° 42' 13''**			**Sampling Dates: 2/97 - 5/02**	
Temperature (°C)	32	78.08	51.48	51.44	33
Specific Conductance (µS/cm)	288	4410	2698	3000	33
TDS (mg/L)	492	2870	2085	2090	18
Salinity (mg/L)	0.2	2.4	1.49	1.6	24
Dissolved oxygen (%Sat.)	46.2	122.2	98.17	97.9	29
Dissolved oxygen (mg/L)	1.7	13.79	9.6	9.98	31
pH (units)	6.94	8.96	8.19	8.22	33
Ammonia (mg/L)	0.0	2.77	1.03	1.03	18
Nitrate (mg/L)	0.2	36.7	4.80	1.36	18
Chloride (mg/L)	8.41	160.7	75.26	65.9	17
Turbidity (NTU)	0.0	272	25.1	4.0	33
STATION: G 50b	**LAT.: 43° 12' 48'' LONG.: 108° 27' 38''**			**Sampling Dates: 6/99 - 1/02**	
Temperature (°C)	35.22	67.96	53.77	58.5	10
Specific conductance (µS/cm)	565	3198	1710	1048	10
TDS (mg/L)	367	2080	1110	680	10
Salinity (mg/L)	0.27	1.7	0.89	0.55	10
Dissolved oxygen (%Sat.)	8.49	125.3	98.37	109.6	10
Dissolved oxygen (mg/L)	8.88	92.1	19.96	11.93	10
pH (units)	7.53	8.75	8.37	8.44	10
Ammonia (mg/L)	0.0	2.0	0.63	0.33	10
Nitrate (mg/L)	1.0	9.6	5.19	5.05	10
Chloride (mg/L)	7.2	65.4	26.26	21.76	9
Turbidity (NTU)	26.2	205	98.92	96.6	10
STATION: G 50a	**LAT.: 43° 13' 35'' LONG.: 108° 13' 08''**			**Sampling dates: 9/98 - 12/01**	
Temperature (°C)	32.07	71.55	49.44	46.04	33
Specific conductance (µS/cm)	492	2907	1320	856	32
TDS (mg/L)	125.2	1890	859	735	32

Table 3.5.9 (continued).

Salinity (mg/L)	0.2	1.5	0.66	0.41	37
Dissolved oxygen (%Sat.)	94.7	144.3	113.11	108.3	32
Dissolved oxygen (mg/L)	7.36	20.77	12.37	11.95	33
pH (units)	8.09	9.34	8.54	8.55	35
Ammonia (mg/L)	0.0	1.1	0.46	0.29	35
Nitrate (mg/L)	1.8	153.1	22.42	6.11	33
Chloride (mg/L)	4.7	47.29	21.54	21.90	31
Turbidity (NTU)	11	174.70	62.82	43.50	33

Source: WREQC 2003.

Table 3.5-10. Summary of Water Quality Data for Muddy Creek in the WRPA (data from WREQC 2003).

	MIN	MAX	AVG	MEDIAN	NUMBER of SAMPLES
STATION: G50	**LAT.: 43° 18' 11'' LONG.: 108° 42' 13''**			**Sampling dates: 2/97 - 5/02**	
Temperature (°C)	32.9	73.1	52.55	53.24	27
Specific conductance (µS/cm)	245	3995	1962	1972	27
TDS (mg/L)	102.4	2600	1401	1202	12
Salinity (mg/L)	0.4	2.1	1.05	0.95	18
Dissolved oxygen (%Sat.)	24.6	132.3	96.95	98.2	25
Dissolved oxygen (mg/L)	5.09	13.74	9.72	9.89	25
pH (units)	6.80	9.37	8.27	8.25	27
Ammonia (mg/L)	0.0	1.32	0.6	0.56	12
Nitrate (mg/L)	0.22	31.37	3.95	1.44	12
Chloride (mg/L)	9.70	130	36.82	16.87	11
Turbidity (NTU)	0.0	184	17.31	10.0	27
STATION: G 52b	**LAT.: 43° 17' 36'' LONG.: 108° 27' 38''**			**Sampling dates: 6/99 - 1/02**	
Temperature (°C)	33	71.70	54.60	58.50	10
Specific conductance (µS/cm)	657	2900	1472	1095	10
TDS (mg/L)	427	1900	959	714	10
Salinity (mg/L)	0.32	1.5	0.75	0.57	10
Dissolved oxygen (%Sat.)	93.3	127.8	108.97	110.25	10
Dissolved oxygen (mg/L)	8.4	16.5	11.79	11.5	10
PH (units)	7.93	8.82	8.44	8.48	10

Ammonia (mg/L)	0.0	1.2	0.59	0.6	10
Nitrate (mg/L)	0.2	144.5	16.87	3.3	10
Chloride (mg/L)	4.5	39	18.75	12.63	8
Turbidity (NTU)	8.6	128.3	58.34	43.75	10
STATION: G 52a	**LAT.: 43° 17' 19'' LONG.: 108° 16' 59''**			**Sampling dates: 9/98 - 1/02**	
Temperature (°C)	32	75.51	53.15	51.6	14
Specific conductance (µS/cm)	637	2781	1374	945	14
TDS (mg/L)	160	1810	816	606	12
Salinity (mg/L)	0.3	1.4	0.63	0.46	14
Dissolved oxygen (%Sat.)	81.8	130.5	106.25	103.85	14
Dissolved oxygen (mg/L)	8.12	14.77	10.89	10.59	14
PH (units)	7.96	8.8	8.54	8.6	14
Ammonia (mg/L)	0.0	1.5	0.47	0.34	12
Nitrate (mg/L)	0.4	3631	309.09	3.98	12
Chloride (mg/L)	4.4	92.63	27.69	16.18	10
Turbidity (NTU)	2.0	1000.00	170.43	70.80	14

Source: WREQC 2003.

3.5.2.2 Stream Classification

The Wyoming Department of Environmental Quality (WDEQ) classifies Wyoming surface water resources according to quality and degree of protection (WDEQ 2001b). Four classes have been identified as follows:

Class 1

Those surface waters in which no further water quality degradation by point source discharges other than from dams are allowed. Nonpoint sources of pollution are to be controlled through implementation of appropriate Best Management Practices (BMPs). Factors considered during the designation of these waters include water quality, aesthetic/scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, and archaeological values, and fish and wildlife, as well as the presence of significant quantities of developable water and other values of present and future benefit to the people.

Class 2

Class 2 waters are those waters, other than Class 1, that are known to support fish or drinking water supplies, or where those uses are attainable. Class 2 waters may be perennial, intermittent, or ephemeral and are protected for the uses in each subcategory as follows: Class 2AB are those waters known to support game fish populations or spawning and nursery areas, at least seasonally, and all their perennial tributaries and adjacent wetlands; and where a game fishery or drinking water use are otherwise attainable. Class

2A are those waters that are not known nor have the potential to support game fish but are used for public or domestic drinking water supplies. Class 2B waters are those waters known to support or have the potential to support game fish populations or spawning and nursery areas, at least seasonally; and where it has been shown that drinking water uses are not attainable. Class 2C waters are those that are known to support or have the potential to support only non-game fish populations or spawning and nursery areas, at least seasonally, including their perennial tributaries and adjacent wetlands.

Class 3

Class 3 waters are those surface waters, other than those classified as Class 1, that are intermittent, ephemeral, or isolated waters, and because of natural habitat conditions do not support, nor have the potential to support, fish populations or spawning; and certain perennial waters which lack the natural water quality to support fish. Class 3 waters provide support for invertebrates, amphibians, or other flora and fauna, which inhabit Waters of the State at some stage of their life cycle.

Class 4

Class 4 waters, other than those classified as Class 1, are those waters where it has been determined that aquatic life uses are not attainable. Subcategories include Class 4A, which are artificial canals and ditches; Class 4B, which are intermittent and ephemeral stream channels that have been determined to lack the hydrologic potential to normally support and sustain aquatic life; and Class 4C, which are all waters that have been determined to lack the potential to normally support and sustain aquatic life.

3.5.2.3 Habitat Quality Assessment

WDEQ Study

As mentioned, a qualitative habitat quality assessment was conducted for the Fivemile and Muddy Creeks within the WRPA by Eddy (2003). The study followed the procedures presented in the (WDEQ) Beneficial Use Reconnaissance Project – Wadeable Stream Monitoring Methodology (WDEQ 1999a), documented in King (1993). The study took place at seven of the eight stations presented in Table 3.5-8 (Station 3 was sampled for water quality only). The reach length for each individual station was determined by multiplying the bankfull width by 20, or at a minimum, a 360 foot-reach length was used. Thirteen parameters (5 primary parameters, 4 secondary parameters, and 4 tertiary parameters) were evaluated. Evaluation of these parameters allow for a total habitat score ranging from zero to 200 points. High total point scores equate to high quality habitat. These results of this study are presented in Table 3.5-11. It should be noted that no information is available at this time for Cottonwood Creek or Cottonwood Drain within the WRPA.

Table 3.5-11. Habitat Assessment Results for Muddy Creek and Fivemile Creek (from Eddy 2003).

Station Number	1	2	4	5	6	7	8
Habitat Parameters (maximum score)							
Bottom Substrate- Percent Fines (20)	15	11	8	17	19	15	8
Embeddedness (20)	9	20	12	18	17	19	17
Instream Cover for Fish (20)	9	10	11	5	18	10	7
Velocity/Depth (20)	16	16	12	6	18	17	11
Channel Flow Status (20)	16	19	18	18	19	17	16
Channel Shape at Bankfull (15)	8	11	12	7	12	12	10
Pool/Riffle Ratio (15)	12	6	3	3	12	4	3
Channelization/Alteration (15)	7	12	15	15	11	14	15
Width/Depth Ratio (15)	6	12	9	4	8	6	2
Bank Vegetation Protection at Bankfull (10)	5	9	8.5	3	9	9	5.5
Bank Stability at Bankfull (10)	6	8.5	8.5	3	9	8	5
Disruptive Pressures (Riparian Zone) (10)	8	9	9	3.5	9	9	5
Riparian Vegetative Zone Width (10)	8	5	9	4	8	9	5
HABITAT ASSESSMENT TOTAL (200 possible)	125	148.5	135	106.5	169	149	109.5
HABITAT ASSESSMENT (Percent of maximum score)	63	74	68	53	85	75	55
Biological Indicators[1] (ocular estimate along reach)							
Periphyton	1	2	2	0	2	2	1
Filamentous algae	1	3	2	2	2	2	2
Rooted Macrophytes	2	1	1	1	0	1	2
Floating Macrophytes	1	0	1	0	1	0	0
Fish	4	2	2	0	3	2	2
Slimes	0	0	0	0	0	0	0

[1] 0-absent, 1-rare, 2-common, 3-abundant, 4-dominant
Source: Eddy 2003.

The results of the WDEQ Habitat Assessment Study indicate that Fivemile Creek, Muddy Creek, and perhaps Cottonwood Creek and Cottonwood Drain within the WRPA can support fish populations. The current classifications of the streams listed below are based on input from DiRienzo (WDEQ, personal communication, January 2004).

Wind River - 2AB
Boysen Reservoir - 2AB
Cottonwood Creek - 3B
Muddy Creek - 2AB
Fivemile Creek - 2AB
Wyoming Canal - 4A

WREQC Study

A water quality and habitat quality assessment study of Fivemile Creek and Muddy Creek stream segments within and adjacent to the WRPA was conducted by WREQC (see Appendix G-4). Six stream segments were analyzed and ranked for severity of impact to water quality by reviewing data from long-term monitoring stations and other available reports. These data were used to determine the level of impact (minor, moderate, severe) for each stream segment evaluated. The ranking of the stream segments was based on three criteria which included potential impacts to fish and wildlife and humans, proposed tribal water quality standards, and best professional judgment of the WREQC scientists. The results of the habitat assessment and ranking are presented in Table 3.5-12.

Table 3.5-12. Water Quality Evaluation of Stream Segments in Fivemile and Muddy Creeks (from WREQC 2003).

Stream Segment	Dominant Use	Physical/ Chemical	Biological	Severity Rating	Tentative Rosgen Classification
Upper Fivemile-above G50 (5MCI)	Produced water discharge from upstream	High chlorides, conductivity, TDS, temperature exceedances, low or intermittent flow	Amphibians, non-game fish observed	Severe	G4 – G5
Middle Fivemile-between G50 and G50b (5MC2)	Livestock grazing	High TCS, nitrates, low flow	Fish observed	Moderate	G4 – G5
Lower Fivemile-between G50b and G50a (5MC3)	Livestock grazing, agriculture, augmented flows from Ocean Lake drain	High TDS, nitrates, conductivity	No fish observed	Severe	B2 – B3
Upper Muddy	Livestock	Exceedances	Fish	Severe	C4 – C5

Creek-headwaters to G52 (MuC1)	grazing, some produced water from upstream	of temperature, conductivity, pH, nitrate, TDS	observed		
Middle Muddy Creek- G52 to G52b (MuC2)	Less livestock grazing, decreased effect from produced water upstream	Exceedances of temperature, TDS, conductivity, nitrates	Beaver populations	Moderate	C4 – C5
Lower Muddy Creek- G52b to G52a (MuC3)	Livestock grazing, augmented flows from Wyoming Canal	Exceedances of temperature, conductivity, pH, nitrate, TDS	No fish observed	Severe	G4 – G5

Based on the water quality evaluation of the Fivemile and Muddy Creek drainages by WREQC (2003), upper Fivemile Creek is completely dependent on NPDES discharges (see Appendix G-3 for location of NPDES permitted discharges) and would likely be classified as 4C by WREQC. The peak water temperatures and low dissolved oxygen measurements recorded in the Muddy Creek mainstem above the Riverton Reclamation Withdrawal Area by WREQC, during the two-year water sampling and analysis study, would preclude the survival and propagation of game fish in that reach. As a result, WREQC has made a preliminary determination that Muddy Creek will be classified as 2C, (i.e., non-game fishery) (D. Haire, WREQC, April 27, 2004).

3.5.3 Surface Water Use

Waters within the WRPA are, for the most part, suitable for agricultural and industrial usage.

3.5.3.1 Salinity and Sodium Hazards

Salinity and sodium hazard classes developed by the US National Salinity Laboratory (1954) are presented in Tables 3.5-13 and 3.5-14. Water from Fivemile Creek has a high to very high salinity hazard to agriculture, and low to medium sodium hazard, with occasional high boron levels. These chemical characteristics make waters from Fivemile Creek moderately suitable to unsuitable for agricultural use. Muddy Creek has a somewhat lower salinity hazard ranging from low to high.

Table 3.5-13. Salinity Hazard Classes.

Salinity Hazard Class	Specific conductance (µS/cm at 25^{o} C)	Characteristics
Low	0-250	Low salinity water can be used for irrigation on most soil with minimal likelihood that soil salinity will develop.
Medium	251-750	Medium salinity water can be used for irrigation if a moderate amount of drainage occurs.
High	751 – 2,250	High salinity water is not suitable for use on soil with restricted drainage. Even with adequate drainage, special management for salinity control may be required.
Very High	> 2,250	Very high salinity water is not suitable for irrigation under normal conditions

Source: U.S. National Salinity Laboratory 1954.

Table 3.5-14. Sodium Hazard Classes.

Sodium Hazard Class	Characteristics
Low	Low sodium water can be used for irrigation on most soil with minimal danger of harmful levels of exchangeable sodium.
Medium	Medium sodium water will present an appreciable sodium hazard in fine textured soil having high cation exchange capacity.
High	High sodium water may produce harmful levels of exchangeable sodium in most soils.
Very High	Very high sodium water is generally unsatisfactory for irrigation purposes.

Source: U.S. National Salinity Laboratory 1954.

High sodium concentration and its effect on soil permeability and water infiltration is also a concern in the WRPA. Sodium contributes directly to the total salinity of the water and may be toxic to sensitive crops, such as fruit trees. The sodium hazard of irrigation water is estimated by the sodium adsorption ratio (SAR). This is the proportion of sodium to calcium plus magnesium in the water. Water with an SAR greater than 9 should not be used for irrigation, even if the total salt content is relatively low. Continued use of water having a high SAR leads to a breakdown in the physical structure of the soil. The sodium replaces calcium and magnesium adsorbed on the soil clays and causes dispersion of soil particles. This dispersion results in breakdown of soil aggregates and causes the soil to become hard and compact when dry and increasingly impervious to water penetration. The permeability of sandy soils may not deteriorate as readily as heavier soils, when irrigated with high SAR water, but a potential problem does exist for these soils as well.

Waters with SARs in the range 0 to 6 can generally be used on all soils with little problem of a sodium buildup. When SAR's range from 6 to 9, chances for soil permeability problems increase (Herbert et al. 1997). SAR is calculated using the formula:

$$SAR = Na^{+} / [(Ca^{+2} + Mg^{+2})/2]^{1/2} \text{ (ions reported in milliequivalents)}$$

Table 3.5-15 presents the calculated SARs for Fivemile Creek and the Wind River below Boysen Reservoir. SAR values range from 17 and 38 for Fivemile Creek, and from 7 and 18 for the Wind River. Accordingly, care should be used when using this water for irrigation.

Table 3.5-15. Calculated Sodium Adsorption Ratios (SAR) for Waters from Fivemile Creek and the Wind River near the WRPA.

Fivemile Creek above Wyoming Canal near Pavillion				
	No.	**Max**	**Min**	**Median**
Ca (mg/L)	51	690	310	460
Mg (mg/L)	51	240	18	140
Na (mg/L)	51	820	220	360
SAR		38	17	21
Wind River Below Boysen Reservoir				
Ca (mg/L)	455	120	30	57
Mg (mg/L)	455	47	703	18
Na (mg/L)	455	160	32	65
SAR		18	7	11

Source: Plafcan et al. 1995.

3.5.3.2 Wastewater Discharges

Evaluation of the WDEQ (2003) and tribal database for National Pollution Discharge Elimination System (NPDES) permits indicates that there are six (6) permits that have been issued in the Fivemile Creek drainage basin, but no permit is current. Table 3.5-16 presents a summary of the NPDES permits in the Fivemile Creek basin. There are no NPDES permits issued for the Muddy Creek Basin. Discharge permits in the immediate vicinity of the WRPA are presented in Appendix F.

Table 3.5-16. WDEQ NPDES Permits in the Fivemile Creek Basin.

Permit Number	Sec	T	R	Facility	RWAT Description	Exp Date
WY0000469	26	06N	02W	Maverick Springs Field	Blue Draw (4)	3/31/2002
WY0000779	22	06N	02W	Maverick Springs Field	Maverick Springs Draw (4)	3/31/2002
WY0000922	16	06N	02W	Maverick Springs Chatterton	Fivemile Creek (2)	3/31/2002
WY0031984	NA	NA	NA	Maverick Springs #15-13	Fivemile Creek (2)	5/31/1991
WY0000621	NA	NA	NA	Tribal A-1x Lease	Fivemile Creek (2)	12/31/1991
WY0020222	NA	01N	03E	Pavillion Wastewater Lagoon	Ocean Lake #6 Drain (3)	9/30/2003

Source: WDEQ 2003.

3.5.3.3 Waters of the United States

The US Army Corps of Engineers (COE) regulates the discharge of dredged or fill material into Waters of the United States (referred to as Waters in this section) under Section 404 of the Clean Water Act (33 U.S.C. 1251-1376). Waters are defined and regulated in a final rule, 33 CFR Parts 320 through 330 (1986), with six corrections as of August 1993. Waters are broadly defined as territorial seas, tidal waters, or non-tidal waters. Non-tidal waters include intermittent watercourses and their tributaries, with no stated limits on the order of tributaries. The COE jurisdiction on non-tidal waters extends to the "ordinary high water mark" (OHWM) in the absence of wetlands; or beyond the OHWM to the limits of the adjacent wetlands; or to the limits of wetlands when only wetlands are present. Wetlands are a subset of Waters and are regulated. The lateral limits of isolated Waters of the United States include intermittent streams (without adjacent wetlands) to the OHWM. The term OHWM is defined as:

> ".that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." [33 CFR 328.3(e)]

The channel that contains the normal water flow is a good indication of the approximate lateral limits of Waters. The upstream limit of Waters is that point where the channel or OHWM is not visible. In the WRPA, all waters are classified as either as Waters or wetlands. Waters are evident as channels in the streams, and wetlands occur along the streams and as isolated areas in the central portion of the drainages.

3.5.4 Groundwater

Groundwater beneath the WRPA is recharged through direct infiltration of precipitation or through seepage of surface water including irrigation ditches, lakes, and streams, as well as leakage from other geologic units. In the WRPA, groundwater occurs in pore spaces between grains, in fractures, or in solution openings (McGreevy et al. 1969). According to Plafcan et al. (1995), wells and springs obtain groundwater from 35 different geologic units in Fremont County.

Regionally within the Wind River Structural Basin, there are 61 water-bearing units dating from Precambrian to Recent in age (Plafcan et al. 1995). In general, recharge of the deeper water-bearing units occurs where these rocks outcrop in the mountainous areas adjacent to the basin. Groundwater within the deeper water-bearing units is generally confined. The groundwater generally moves from the recharge areas adjacent to the basin and discharges into the major rivers and streams in the basin.

3.5.4.1 Nature, Yield, and Extent of Aquifers

Within the WRPA, the major water-bearing units are unconsolidated deposits of Quaternary age, the Tertiary Wind River Formation, and to a lesser extent, the underlying Mesozoic, Paleozoic, and Precambrian rocks. Table 3.5-17 provides descriptions of the aquifers beneath the WRPA. The following sections present brief descriptions of the water-bearing characteristics of these units. These descriptions are based on the work done by McGreevy et al (1969), Plafcan et al (1995), and Daddow (1996).

Precambrian Aquifers

Precambrian-aged rocks within the Wind River Basin consist of metamorphic and igneous rocks that are exposed in the Wind River, Washakie, and Owl Creek Mountains. Wells completed in fractures in these rocks have been known to yield up to 30 gpm with water containing low concentrations of dissolved solids near outcrops and greater concentrations of dissolved solids at depth.

Paleozoic Aquifers

Many of the Paleozoic rock units have a high potential of being significant aquifers. Water yields of more than 1,000 gpm have been reported from wells completed in the Bighorn Dolomite, Darby Formation, Madison Limestone, and Tensleep Sandstone. In the nearby Big Horn Basin, wells completed in Paleozoic rocks have been known to produce up to 2,500 gpm. Primary permeabilities of the limestones and dolomites are generally quite low. However, where fractures and solution cavities exist, there can be significant secondary permeability. Where the Paleozoic rocks are under water table conditions or where pressures are low, as near outcrops, yields are usually low, except where the rocks are fractured or are cavernous. Water in Paleozoic rocks often contains gas and oil. Dissolved solids in the Paleozoic groundwater generally ranges between 300 to 3,000 mg/L, but Permian rocks have been known to have groundwater with dissolved solids over 10,000 mg/L.

Mesozoic Aquifers

Moderate to high yields of groundwater may be available from some of the Lower Mesozoic rocks. High yields up to several hundred gpm may be possible for the Nugget Sandstone. Wells completed in the Sundance Formation and Crow Mountain Sandstone most likely would yield less than 20 gpm. Most other formations in the Lower Mesozoic would produce smaller amounts of groundwater. For the most part, groundwater from Lower Mesozoic rocks contains high concentrations of dissolved solids, but near outcrops dissolved solid concentrations have been found to be around 1,000 mg/L. Some oil field waters have dissolved solids of more than 20,000 mg/L.

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Table 3.5-17. Hydrogeologic Description of Aquifers in the WRPA.

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Wells completed in upper Mesozoic rocks may produce moderate to high yields, but the yields from most wells are low. Well yields up to several hundred gpm may be available from the Cloverly, Morrison, Mesaverde, and Lance Formations. Other formations, such as the Frontier and the Meeteetse Formations, and the sandstone beds from the Mowry, Thermopolis, and Cody Shales, may produce up to 50 gpm.

Dissolved solids in groundwater from upper Mesozoic rocks generally range between 1,000 and 5,000 mg/L, but could be much higher when associated with oil fields. The underground injection well used by Tom Brown Inc. is completed in the Lance Formation, whose waters are high in dissolved solids.

Cenozoic Aquifers

Fort Union Formation

Few water wells are completed in the Fort Union Formation. Generally, these wells have yields of less than 10 gpm with water containing dissolved solids of around 1,000 mg/L. Existing wells located near outcrops have better quality water than those completed toward the center of the basin, which have dissolved solids ranging between 1,000 and 5,000 mg/L.

Indian Meadows Formation

Although the Indian Meadows Formation is a potential aquifer, few wells are completed in this formation. Well yields up to 50 gpm may be expected.

Wind River Formation

The Wind River Formation is the major aquifer underlying the WRPA. The Wind River Formation consists of three sequences of sedimentary rocks. The lowest unit consists mainly of fine-grained siltstone and shale with a small amount of sandstone. The main, or middle sequence consists of coarse-grained arkosic sandstones about 1,000 feet thick. The upper sequence consists of fine-grained siltstone, shale and sandstone. In general, the Wind River formation has a large potential for groundwater development. Water of quantity and quality suitable for livestock use is available from the formation in most areas, although well depths of 500 feet or more may be required.

Most wells in the Wind River Formation are completed in the sandstones of the upper unit. Yields can be as great as 50 gpm, but most are considerably less. The most productive wells are completed in the coarse-grained middle unit. These wells have reported yields of over 500 gpm. The Riverton well field south of the WRPA produces water from this unit. Few, if any, wells are completed in other parts of this formation.

The Wind River Formation contains groundwater with dissolved solids that range between 200 and 5,000 mg/L. Most of the groundwater found in the upper unit contains dissolved solids of more than 1,500 mg/L.

Quaternary Aquifers

Quaternary deposits within the WRPA consist of floodplain alluvium, alluvial terrace deposits, slope wash, and colluvium. Floodplain alluvium generally consists of unconsolidated sands, silts, clays and gravels deposited along Muddy, Fivemile, and other creeks in the WRPA. The water-yielding characteristics of these deposits are quite variable depending on the degree of saturation and the nature of the material. Where there is sufficient saturation, large well yields have been reported. The alluvial aquifer is generally under unconfined conditions.

Within the WRIR, water levels in wells completed in floodplain alluvial deposits range from the land surface to 42 feet below ground surface (bgs) with a median value of 8.3 feet bgs. Seasonal recharge from irrigation ditches often raises the water table considerably. Near the major streams, the water table is near the surface most of the year with the streams acting as points of discharge for the groundwater.

Terrace deposits are similar to floodplain alluvial deposits and consist of silt, sand, gravel, cobbles, and boulders and usually appear as bench features up to 50 feet thick (Daddow 1996). In the WRPA, one well completed in Quaternary terrace deposits has been inventoried. This well is located in Section 23, T4N, R4E. It was completed to a depth of 23 feet bgs with a water level of 10 feet bgs (Plafcan et al. 1995).

3.5.4.2 Depth to Groundwater and Recharge Rates

The following information is based on maps developed by the State of Wyoming and available through the University of Wyoming (2003) Groundwater Vulnerability Clearinghouse - http://www.sdvc.uwyo.edu/clearinghouse/gw_vuln.html.

Figure 3.5-8 shows the depth to groundwater within the WRPA. In general, the depth to groundwater ranges from less than 5 feet to 100 feet bgs (Hamerlinck and Arneson 1998). Net annual recharge of surficial aquifers from natural sources is presented in Figure 3.5-9. Recharge appears to be relatively low for the WRPA, with the majority of the area having around 0.04 inches of recharge a year.

Figure 3.5-8. Depth to Groundwater within and Adjacent to the WRPA.

Figure 3.5-9. Groundwater Recharge Rates within and adjacent to the WRPA.

3.5.5 Groundwater Quality

Groundwater quality is affected by a variety of factors, including the geochemical composition of the aquifer materials, retention time in the aquifer, and the quality of recharge water. Numerous studies have been completed on water quality characteristics of the aquifers in the immediate vicinity of the WRPA. These include those by Daddow (1996), Plafcan et al. (1995), and McGreevy et al (1969). In addition, the results of suitability studies, including aquifer vulnerability (Munn and Arneson 1998) are available. The following presents a general overview of the water quality characteristics of the two main aquifers which underlie the WRPA: the Tertiary aquifer in the Wind River Formation and the unconsolidated deposits of Quaternary age. Water quality for deep aquifers was described briefly in the previous section in terms of dissolved solid concentrations and will not be discussed in more detail here.

3.5.5.1 Wind River Formation

The water chemistry of the Wind River Formation is quite variable due to its variable lithology, permeability, and recharge conditions. The water chemistry of the Wind River Formation within the WRIR was evaluated by Daddow (1996) on the basis of chemical analyses of over 125 water quality samples and over 200 specific conductance measurements. For these samples, dissolved solids ranged between 211 to 5,110 mg/L with a median value of 490 mg/L. Seventy-three of the 154 samples exceeded the State Maximum Concentration Limits (SMCL) for dissolved solids (i.e., 500 mg/L), and 62 of 154 samples exceeded the SMCL for sulfate (i.e., 250 mg/L). Several samples exceeded the SMCL of 4.0 mg/L for fluoride. Salinity hazard class was mostly medium to high with some samples being very high.

In the Wind River Basin, the groundwater water type generally varies with the total dissolved solid concentration (Daddow 1996). Groundwater with less than 325 mg/L of total dissolved solids is dominated by calcium, sodium, and bicarbonate. Groundwater with dissolved solids concentrations between 325 and 500 mg/L are dominated by sodium, bicarbonate, and sulfate. Groundwater with dissolved solids greater than 500 mg/L is typically dominated by sodium and sulfate with a lesser amount of bicarbonate.

Water quality data for the Wind River Formation is presented in Table 3.5-18 (Plafcan et al. 1995). These data indicate that the water quality within this unit is quite variable, with total dissolved solids ranging between 166.4 mg/L and 3,182 mg/L. High dissolved solid concentrations indicate generally low permeability and high retention time within the aquifer.

Table 3.5-18. Concentrations of Major Ions in Groundwater from the Wind River Formation in the WRPA.[1]

	3N-2E-02cdc01	3N-2E-14aad01	3N-3E-26aba02	3N-4E-29dcc02	3N-4E-36cad01	4N-4E-13dbd01	3N-5E-33dcc01
Parameter							
Sodium	210	38	330	170	580	560	740
Potassium	4.2	2.3	4	1	1	1	3.2
Calcium	160	45	27	34	87	28	210
Magnesium	48	8.5	0.1	4.8	1	0.3	41
Chloride	77	5.6	59	5.3	57	110	58
Bicarbonate	0	0	23	0	0	0	330
Carbonate	0	0	0	0	0	0	0
Sulfate	290	67	660	82	1500	1100	1800
TDS	789.2	166.4	1,103	2,226	3,182	1,799	169.3

Source: Plafcan et al 1995.
[1]All units are in mg/L

3.5.5.2 Quaternary Deposits

Plafcan et al. (1995) collected groundwater samples from 47 wells completed in Quaternary deposits throughout Fremont County. Thirty-three wells are completed in alluvium and colluvium and 10 are completed in terrace deposits. The remaining four wells are completed in glacial, landslide, and dune sand deposits. The results of this study indicated that groundwater from alluvial and colluvial deposits has total dissolved solids ranging from 141 to 1,430 mg/L. Water withdrawn from the alluvium generally contains a predominance of sodium, calcium, carbonate, and sulfate ions.

One well (number 4N4E-23acd01) was sampled within the WRPA during this study. This well is completed in a terrace deposit. Table 3.5-19 presents analytical results from this well. Data in dissolved solids and other parameters are not available from this well, making it difficult to make comparisons with other wells in the WRPA.

Table 3.5-19. Water Quality Summary for Well Number 4N-4E-23acd01.

Parameter	Concentration[1]
Hardness, total as $CaCO_3$	68
Sodium, dissolved	170
Bicarbonate	330
Carbonate	7
Sulfate, dissolved	120
Chloride, dissolved	17
Fluoride, dissolved	1.2

[1] All parameters are in mg/L
Source: Plafcan et al 1995.

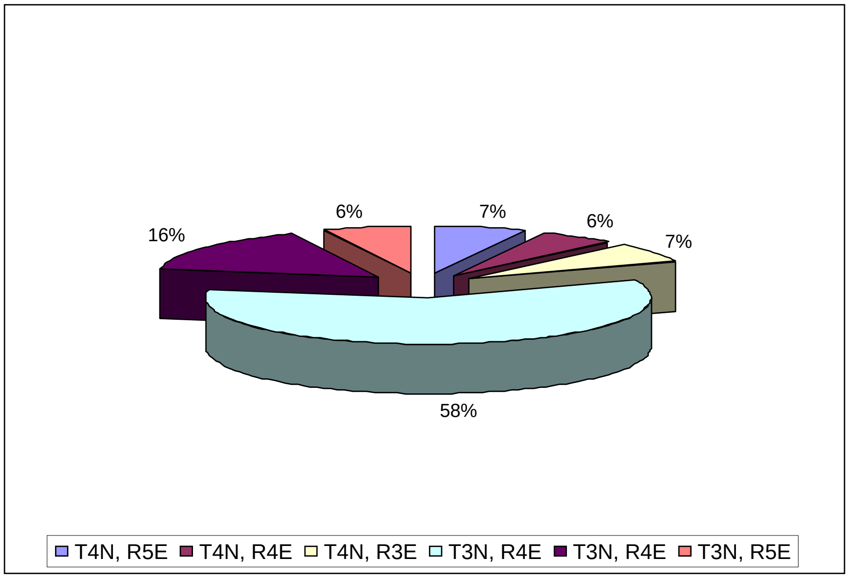
3.5.6 Water Rights and Groundwater Use

The Yellowstone River Compact of 1950 allocated 80 percent of the Bighorn River flow to Wyoming. Pre-1950 water rights are guaranteed by the compact and Indian reserved rights are excluded from the compact. This arrangement indicates that there is significant available water for new consumptive uses in Wyoming, given that the Bighorn River discharges 3.9

million acre-feet of flow from Wyoming in an average year. However, federally reserved water rights must also be considered. These include water rights for the WRIR as well as federal land agencies. In 1977, the State of Wyoming filed suit in federal court to settle the adjudication of the Bighorn River. The Tribes have since been awarded over 500,000 acre-feet of reserved water rights. The adjudication is complicated and ongoing with many determinations still unsettled. The administration of state and reserved water rights will continue to be a concern, given the diversity of water rights' holders in the basin. When the 1950 compact was negotiated, the Little Bighorn allocation was not agreed upon among the states that were party to the compact. While general provisions of the compact are interpreted to cover the Bighorn River, no specific allocations of Little Bighorn flows were made in the Yellowstone River Compact (USGS 1985).

Evaluation of Wyoming State Engineer's records indicates that the majority of the water rights are for ditches and reservoirs for domestic use, stock, and irrigation purposes. At least one water right was issued for industrial purposes. There have been approximately 285 water well permits issued within the WRPA. As illustrated in Figure 3.5-10, the majority of these wells (58 percent) are located in T3N, R3E. In general, over 90 percent of these wells are for domestic use, while a few are used for irrigation, monitoring, and miscellaneous purposes. All of the well permits within the WRPA were reviewed for this EIS.

Figure 3.5-10. Well Permits within the WRPA by Township and Range.



3.6 VEGETATION AND WETLANDS

3.6.1 Introduction

The Wind River Basin contains five zones of floral and faunal communities. These zones range from the colder alpine zone on the highest mountains to the north and west of the basin to the lower, warmer elevation zones south and east of the basin (USDA NRCS 1974). Environmental factors, dynamic processes, and the biotic attributes that are required for their existence influence the spatial scale and distribution of each vegetative cover type. Two of the five zones (the *Upper Sonoran* and the *Transition Life)* occur within the WRPA.

The Wind River Basin is home to more than 200 plant species and nine primary vegetative cover-types. Vegetative communities within these cover types form the ecological systems that characterize the Wind River Basin landscape. The vegetation defined in this section is described at a landscape scale. The character and existing "functionality" of this landscape is derived from the composition, structure, and function of each component within the vegetative community. Environmental factors affect the species composition, morphology, and distribution of these vegetative communities (Fox and Dolton 1995; Reid et al. 2002).

The Big Sagebrush steppe sub-region is the most extensive semi-desert vegetation type of the Western U.S. The existing sage steppe ecosystem within the WRPA is an ecological sub-region within the Wind River Basin characterized by several species of sagebrush and many species of grasses. The area is dominated by wide-open spaces and a desert landscape characterized by a shrub-dominant overstory with an understory of perennial grasses and forbs. More than 25 percent of the vegetation cover in the Big Sagebrush steppe consists of the Wyoming big sagebrush shrubland, which is a floristic alliance, comprised of plant associations that share one or more dominant community (Reid et al. 2002).

The Wyoming Big Sagebrush shrub cover type is widespread and extends from the western Great Plains short-grass prairie on the north to British Columbia to the west, and south as far as northern Nevada. Sagebrush of this type occupies loamy soils derived from a variety of parent materials, on middle and lower slopes and in draws. The Wyoming big sagebrush cover type contributes the most cover to the shrub layer and is often the only shrub present throughout the Wind River Basin (Fox and Dolton 1995; Reid et al. 2002; World Wildlife Organization, no date).

3.6.2 Vegetation

The Wind River Project Area (WRPA) consists of a relatively level, gently sloping valley, with low lying, hilly terrain at elevations that range from 5,500 feet to less than 3,000 feet within the lower elevations of the Cottonwood Creek, Muddy Creek and Fivemile Creek drainages. The majority of the land is open development area that is currently used for agriculture, cattle grazing, and oil and gas fields.

Nine of the 41 land cover types identified by the WGFD's Land Cover Classification (GAP) system for the State of Wyoming have been identified in the WRPA. The eight primary vegetative cover types present in the WRPA are shown in Figure 3.6-1 and are summarized in Table 3.6-1. The secondary vegetative cover types are shown in Figure 3.6-2 and are summarized in Table 3.6-2.

Table 3.6-1. Acreages of Primary Vegetation Cover by Field within the WRPA[1].

Vegetation Cover	Pavillion	Muddy Ridge	Coastal Extension	Sand Mesa	Sand Mesa South	Remaining Area	Total Acres
Wyoming big sagebrush	507.6	1789.56	0	2366.28	2537.76	13132.8	24096
Desert shrub	422.28	2731.32	3989.52	2215.08	565.92	16819.9	31696.6
Dry land crops	0	0	0	0	0	0	0
Greasewood fans/ flats	0	0	0	4.32	0.54	833.76	993.92
Irrigated cropland	9622.8	2516.4	1185.84	3656.88	0	19105.2	42769.9
Mixed grass prairie	1261.44	0	0	1355.4	0	629.64	3847.68
Saltbush fans and flats	0	0	45.36	0	0	70.2	136.96
Shrub riparian	0	524.8	0	9.72	732.24	2972.16	5011.2
Total Acres	**11814.1**	**7551.36**	**5220.72**	**956.88**	**3833.46**	**53563.7**	**91591.2**
% Cover	**14**	**9**	**6**	**6**	**4**	**61**	**100**

[1] Values are estimated based on WYNDD land cover data. Error is less than 1%.

Table 3.6-2. Acreages of Secondary Vegetation Cover by Field and Within the WRPA[1].

Vegetation Cover	Pavillion	Muddy Ridge	Coastal Extension	Sand Mesa	Sand Mesa South	Remaining Project Area	Total Acres
Desert shrub	1678	2670	1993	2213	564	16686	25804
Greasewood fans/ flats	0	509	2029	9	730	4264	7541
Mixed grass prairie	413	52	0	2358	1501	2751	7075
Open water	0	0	0	1351	0	0	1351
No secondary cover	9684	4295	1182	3644	1026	29686	49517
Total	**11775**	**7526**	**5204**	**9575**	**3821**	**53387**	**91288**

[1] Values are estimated based on WYNDD land cover data. Error is less than 1%.

Figure 3.6-1 Primary Land Cover Types Within and Adjacent to the Wind River Project Area.

Figure 3.6-2. Secondary Land Cover Types Within and Adjacent to the Wind River Project Area.

Irrigated cropland is dominant within the WRPA. The southwestern portions of the WRPA are comprised of Wyoming big sagebrush steppe and mixed-grass prairie interspersed with irrigated crops. In the north, the vegetation is a mixture of the desert shrub and Wyoming big sagebrush steppe cover types totaling 51 percent of the site, as shown in Table 3.6-3. Small patches of mixed-grass prairie adjacent to cropland or stands of Wyoming big sagebrush are found to the east and southwest. Common secondary cover includes greasewood shrubs along Muddy Creek, its tributaries, and various irrigation drainages. The plant species and distribution associated with these vegetative cover types within the three watersheds are described in further detail below.

Table 3.6-3. Distribution of Primary Vegetation Cover by Subshed for the Three Watersheds within the WRPA

Vegetation Cover	Muddy Creek	Cottonwood Creek	Fivemile Creek	Total Acres	% Cover
Wyoming Big Sagebrush	9176	0	11156	20332	22
Desert Shrub	13926	10680	2135	26741	29
Dry Land Crops	96	0	0	96	<1
Greasewood Fans and Flats	695	0	148	843	1
Irrigated Cropland	14208	1317	20485	36010	39
Mixed Grass Prairie	1364	0	1885	3249	4
Saltbrush Fans and Flats	0	114	0	114	<1
Shrub Riparian	4162	0	92	4254	5
Total Acres	**43627**	**12111**	**35901**	**91639**	**100**

[1] Values are estimated based on WYNDD land cover data. Error is less than 1%.

Wyoming Big Sagebrush

The Wyoming big sagebrush (*Attemisia tridentate wyomingensis*) shrubland alliance occupies relatively dry, low-elevation sites, whereas silver sagebrush (*Artemisia cana)* occupies the deep alluvial soils of drainage bottoms at low elevation. The vegetation included in this alliance is characterized by a moderately sparse to moderately dense (20-70 percent cover) shrub layer that is dominated by Wyoming big sagebrush. The herbaceous layer is relatively sparse and often dominated by perennial graminoids (<20 percent cover) that occupy patches in the shrub matrix (WYNDD 2003; Reid et al. 2002).

Plant associations within this alliance that may occur within the WRPA Include:

Wyoming Big Sagebrush / Bluebunch Wheatgrass Shrubland.

Wyoming Big Sagebrush / Threadleaf Sedge Shrubland.

Basin Big Sagebrush/Foothill Big Sagebrush Shrub Herbaceous.

Desert Shrub

The desert shrub association covers 31,697 acres (35 percent) of the WRPA, primarily in the north-central portion of the area. The desert shrub association is composed of a mix of black greasewood (*Sarcobatus vermiculatus*), shadscale saltbrush (*Atriplex confertifolia*), and Nuttall's or Gardner's saltbush (*Atriplex gardneri*), interspersed with a variety of grasses and forbs. The vegetation type consists of a mixture of dry, saline-adapted shrubs dominated by shadscale saltbush (*Atriplex confertifolia*) and often intermixed with greasewood (*Sacobaus vermiculatus*), Gardner's saltbush (*Atriplex gardneri*), and several grasses and forbs. This type may include some cushion plants, but the shrub cover typically exceeds more than 25 percent and is usually located in flats and fans in Wyoming's central basins (WYNDD 2003; Reid et al. 2002; World Wildlife Organization, no date).

Greasewood Fans and Flats

Greasewood (*Sarcobatus vermiculatus*) dominates this shrub cover type and represents more than 75 percent of the total shrub cover in places where total shrub cover is at least 25 percent. This association covers less than 994 acres (1 percent) of the WRPA. This shrub cover is found along riparian areas and often mixed with grasses. The shrub riparian cover is often delineated as a secondary type within the greasewood fans and flats. The distribution of this association is along streams at low to medium elevations, but it can be found on saline upland areas and basin fans/flats (WYNDD 2003; Reid et al. 2002).

Irrigated Crops

By far the most abundant cover type, irrigated crops represent 42,770 acres (47 percent) of the cover within the WRPA. The irrigated area includes many row crops, irrigated pastureland, and hayfields associated with farm or ranching activities. Crops planted include corn, beans, potatoes, beets, sunflower, alfalfa, and hay, often grown throughout the alluvial plains and riparian areas in elevations that range from 3,200 to 9,600 feet (WYNDD 2003).

Mixed-grass Prairie

About 3,848 acres (4 percent) of the WRPA are characterized as mixed-grass prairie. Mixed-grass prairie consists of grasslands comprised of short and tall grass prairie species that are often interspersed with *Atemisia* shrubs, typically silver sagebrush (*Artemisia cana*). Grass patches need to occupy more than 50 percent of the vegetation cover to be classified as a primary cover type, even though silver sagebrush may be dominant. This cover type is found at elevations ranging from 3,200 to 10,300 feet. Common plant species within this cover type include blue grama (*Bouteloua gracilis*), western wheatgrass (*Elymus smithii*), thickspike wheatgrass (*Elymus lanceolatus*), needle-and-thread (*Hesperostipa comata*), threadleaf sedge (*Carex filifolia*), and needle-leaf sedge (*Carex duriuscula*) (WYNDD 2003).

Saltbrush Fans and Flats

Gardner's saltbush (*Atriplex gardneri*) is the dominant shrub that characterizes the saltbrush fans and flats cover type, which represents about 137 acres (less than 1 percent) of the WRPA. Generally these areas contain few or no other grass or shrub species on exposed soil on saline flats or fans at elevations of 6,200 to 7,200 within the Wind River Basin (WYNDD 2003).

Shrub Riparian

Riparian shrub lands cover approximately 5,011 acres (5 percent) of the WRPA. Riparian shrub lands typically contain more than 25 percent shrub cover with few to no trees. Shrub species include willow (*Salix* sp), greasewood, shrubby cinquefoil, alder, birch, and tamarisk interspersed with several *Artemisia* species (WYNDD 2003; Reid et al. 2002). The riparian shrub type is found throughout Wyoming. These riparian shrub lands are described in more detail in Section 3.6.4.

Open Water

The open water cover type is defined as any area of open water greater than 100 acres, and is represented by Muddy, Cottonwood and Fivemile Creeks. The Middle Depression Reservoir is located within the WRPA but it is less than 100 acres in size and therefore it is not included as a primary cover type in the WGFD's Land Cover Classification (GAP). Open-water covers about 1,351 acres (1.5 percent) of the secondary cover type within the WRPA (Table 3.6-2). Open water occurs throughout the state at elevations ranging from 3,000 to 12,500 feet (WYNDD 2003).

3.6.3 Existing Disturbance to Vegetation Cover

Disturbance densities are higher and vegetation is more fragmented along the southeastern and central portion of Wyoming where historical land uses have included grazing, agriculture and oil and gas development. Primary sources of historic disturbance to vegetation cover in the WRPA have resulted from oil and gas development, ranching, agriculture, and road construction.

Oil and gas exploration and production, agriculture, and livestock grazing have occurred over most areas been of the WRPA. Conversion of sagebrush habitats to croplands has taken place in areas where the climate will support crop production. The combined effects of livestock grazing, crop production, and fire suppression have also altered the structure and composition of some areas of the Wind River Basin. Heavy grazing removes potential grass fuels, thus minimizing the likelihood of periodic fires.

Fragmentation of the native vegetation cover has occurred through localized conversion or degradation. Overgrazing by domestic livestock, fire suppression, and conversion of sagebrush communities to grasslands has encouraged the spread of invasive grasses and noxious weeds.

Ecological interactions between fire regimes, grazing history, and climate patterns result in equally complex patterns of species composition in the Wyoming big sagebrush cover type due to the long-standing agricultural and human settlement. Extensive grazing of the native grasses increases the shrub densities.

Muddy Creek and several of its tributaries traverse the middle of the WRPA. These tributaries and streams and their floodplains have been modified for irrigation purposes, but continue to support riparian and wetland habitats.

Occasional bare-ground and highly-disturbed areas include lands with exposed soil resulting from past disturbance or periodic flooding. These areas are often dominated by exotics, such as poverty-weed (*Iva axillaris*), Russian thistle (*Salsola kali*) and verbena (*Verbena bracteata*). Invasion by non-native annual grasses (e.g., *Bromus tectorum* or *Bromus japonicus*) may increase fire frequency sufficiently to change species composition. Excessive grazing may decrease fire frequency due to consumption of herbaceous forage, resulting in increased shrub density. Conversely, invasion by non-native annual grasses (e.g., *Bromus tectorum*) may increase fire frequency sufficiently to eliminate the shrubs from the stands.

3.6.4 Wetlands and Riparian Areas

Wetlands are found throughout the WRPA, and consist of irrigation channels, ditches, streams, tributaries, reservoirs, and ponds. The U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps indicate about 2,467 acres (76 percent) of the wetlands within the WRPA are Palustrine wetlands. There are also two perennial streams (riverine systems), several intermittent tributaries and streams, and several lakes (lacusterine systems) located in the south, central, and east portions of the WRPA.

The riverine wetland systems are located along the Wyoming Canal and Muddy Creek, and to a lesser extent along Fivemile Creek and total approximately 107 acres of wetlands. This area is about 3 percent of the total and area of the WRPA   In addition one reservoir and several ponds total about 1,351 acres of open water within the WRPA (Table 3.6-2), and three stream systems total over 36 linear miles of Waters of the U.S. Wetlands identified in the WRPA are classified as Palustrine Emergent (PEM), Palustrine Shrub Scrub (PSS), Palustrine unconsolidated shore (PUS), and intermittent or perennial riverine (RI, RP) and are either sub-classified as intermittently or seasonally flooded. The distribution of the perennial, lacustrine, and riverine wetlands are shown in Figure 3.6-3 and summarized in Table 3.6-4. The wetland classification inventory for each of these wetland systems present within the WRPA is provided in Appendix H.

Figure 3.6-3. Wetland Types within and near the Wind River Project Area

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Table 3.6-4. Distribution Acreages of Wetland Communities and Waters of the U.S. by field within the WRPA[1]

Wetlands	Pavillion	Muddy Ridge	Coastal Extension	Sand Mesa	Sand Mesa South	Remaining Project Area	Total	%
Lacustrine, limnetic	513	0	0	129	0	38	680	21
Palustrine	0	228	332	268	42	1597	2467	76
Riverine perennial	0	43	0	0	0	64	107	3
Riverine intermittent	0	0	0	0	0	0	0	0
Total	**513**	**271**	**332**	**397**	**42**	**1699**	**3254**	**100**

[1] Values are estimated based on WYNDD land cover data. Error is less than 1%.

Two perennial creek systems (Muddy and Fivemile creeks), including several tributaries and intermittent channels flowing into them, drain the WRPA. Muddy Creek and Fivemile Creek flow from the west through the Wind River Indian Reservation and pass through the WRPA and enter Boysen Reservoir. To the north Cottonwood Creek, an ephemeral channel, drains through the Coastal Extension field in a northeasterly direction, where it exits the WRPA and eventually enters Boysen Reservoir.

The common wetlands within the WRPA are palustrine emergent (PEM) wetlands along irrigation canals and drainages (Cowardin et al. 1979). These wetlands contain primarily emergent hydrophytic plant species. Wetland vegetation is dominated by common cattail (*Typha latifolia*), various sedges (*Carex* sp.), and rushes (*Scirpus* sp.). Shallow waters with submerged plant species such as pondweed (*Potamogeton* sp) are also present. The rivering perennialRP wetlands are widespread along natural drainages. Most are inter-connected or feed into the lacustrine wetlands of Boysen Reservoir and/or small ponds to the east. The main source of water for these wetland types also includes seasonal stream over-bank flow and groundwater seeps. The majority of these wetlands are underlain by loamy soils and are commonly located on floodplains. Soils in this group are typically subject to flooding.

Table 3.6-5. Distribution of Wetland Communities and Waters of the U.S. for the Three Watersheds within the WRPA[1].

Wetlands	Muddy Creek	Cottonwood Creek	Fivemile Creek	Total	% Cover
Lacustrine, limnetic	680	0	0	680	21
Palustrine emergent	1086	419	962	2467	76
Riverine perennial	40	5	62	107	3
Riverine intermittent	0	0	0	0	0
Total	**1806**	**424**	**1024**	**3254**	**100**

[1] Values are estimated based on WYNDD land cover data. Error is less than 1%.

The riparian wetland habitats, which represent 79 percent of all wetlands within the WRPA (Table 3.6-5) consist of the riparian shrub association. Shrubs cover about 25 percent of the riparian complex with very few trees. Riparian shrub cover may include one or more of the following species: willow (*Salix* sp), greasewood, and shrubby cinquefoil, with young alder, birch, or tamarisk saplings (a noxious weed) interspersed amongst several types of *Artemisia* species. The riparian shrub cover type is commonly found in low-lying drainages throughout Wyoming. This cover type provides shade and cover for fish and wildlife, reduces erosion and sedimentation, and maintains the water budgets for wetland systems. These habitats support more wildlife variety than any other habitat type (USFWS 2002a).

3.6.5 Sensitive Species

The Wyoming Natural Diversity Database (WYNDD) maintains a list of Wyoming Plant and Animal Species of Special Concern (Fertig et al., no date). The WGFD's Habitat Protection Program produces a Species Watch List using state, federal and University of Wyoming Cooperative Fish and Wildlife Research Unit personnel to develop a list of 150 species that may need management attention. These combined sources of data helped to formulate the BLM's Wyoming Sensitive Species List (BLM 2002a) (Table 3.6-6).

BLM's Wyoming Sensitive Species List does not include those species already designated by the USFWS as federally endangered, threatened or proposed (BLM 2002a). However, any de-listed threatened or endangered species is automatically designated on this list as BLM sensitive. The USFWS letter, dated October 31, 2002, does not identify the presence of any federally listed threatened or endangered plant species within the WRPA.

One of the 38 sensitive plant species on the BLM's Wyoming Sensitive Species (i.e., Nelson's milkvetch) list is known to occur in Fremont County. This species is a regional endemic plant and is classified as a state and BLM sensitive species (BLM 2002a; WYNDD 2003). It occupies alkaline, often seleniferous, clay flats, shale bluffs and gullies, pebbly slopes, and volcanic cinders within sparse sagebrush and cushion plant communities. There is known suitable Nelson's milkvetch habitat present within the WRPA.

Two occurrences of the state-sensitive longleaf pondweed (*Potamogeton nodosus)* have been identified in Fremont County. This aquatic species roots in mud along shallow edges of slow to fast-moving rivers. There are no known occurrences of longleaf pondweed within the WRPA.

Table 3.6-6. BLM Wyoming Sensitive Species List

Common Name	Scientific Name
Meadow Pussytoes	*Antennaria arcuata*
Laramie Columbine	*Aquilegia laramiensis*
Small Rock Cress	*Arabis pusilla*
Mystery Wormwood	*Artemisia biennis* var. *diffusa*
Porter's Sagebrush	*Artemisia porteri*
Dubois Milkvetch	*Astragalusgilviflorus* var.*purpureus*
Hyattville Milkvetch	*Astragalus jejunus* var *articulatus*
Nelson's Milkvetch	*Astragalus nelsonianus -or- Astragalus pectinatus* var. *platyphyllus*
Precocious Milkvetch	*Astragalus proimanthus*
Trelease's Milkvetch	*Astragalus racemosus* var *treleasei*
Cedar Rim Thistle	*Cirsium aridum*
Ownbey's Thistle	*Cirsium ownbeyi*
Many-stemmed Spider-flower	*Cleome multicaulis*
Owl Creek Miner's Candle	*Cryptantha subcapitata*
Evert's Wafer- Parsnip	*Cymopterus evertii*
Williams' Wafer- Parsnip	*Cymopterus williamsii*
Wyoming Tansymustard	*Descurainia torulosa*
Weber's Scarlet- Gilia	*Ipomopsis aggregata* ssp. *weberi*
Entire-leaved Peppergrass	*Lepidium integrifolium* var. *integrifolium*
Sidesaddle Bladderpod	*Lesquerella arenosa* var. *agrillosa*
Fremont Bladderpod	*Lesquerella fremontii*
Large-fruited Bladderpod	*Lesquerella macrocarpa*
Western Bladderpod	*Lesquerella multiceps*
Prostrate Bladderpod	*Lesquerella prostrata*
Absaroka Beardstongue	*Penstemon absarokensis*
Stemless Beardstongue	*Penstemon acaulis* var. *acaulis*
Gibbens' Beardstongue	*Penstemon gibbensii*
Beaver Rim Phlox	*Phlox pungens*
Tufted Twinpod	*Physaria condensata*
Dorn's Twinpod	*Physaria dornii*
Rocky Mountain Twinpod	*Physaria saximontana* var. *saximontana*
Persistent Sepal Yellowcress	*Rorippa calycina*
Shoshonea	*Shoshonea pulvinata*
Laramie False Sagebrush	*Sphaeromeria simplex*
Green River Greenthread	*Thelesperma caespitosum*
Uinta Greenthread	*Thelesperma pubescens*
Cedar Mtn. Easter Daisy	*Townsendia microcephala*
Barneby's Clover	*Trifolium barnebyi*
Total Species	**38 Species**

Source: BLM 2002a.

3.6.6 Invasive and Noxious Weeds

Nearly 250,000 acres of Fremont County contain noxious weed species, which include Canada thistle (*Cirsium arvense*), Russian knapweed (*Centaurea repens*), hoary cress (C*ardria draba*), leafy spurge (*Euhorbia esula*), musk thistle (*Carduus nutans*), perennial pepperweed (*Lepidium latifolium*), dalmatian toadflax (*Linaria dalmatica*), spotted knapweed (*Centaurea maculosa*), and diffuse knapweed (*Centaurea diffusa*), saltcedar (*Tamarix* spp.) St. Johnswort (*Hypericum perforatum*) and Common Tansy (*Tanacetum vulgare*). The Fremont County Weed and Pest Control District (FCWPCD) contracts with the BIA to control weeds on 350 miles of tribal roads and 450 miles of irrigation canals (Baker 2003).

There are 24 non-native plant species designated as noxious weeds by the State of Wyoming, as provided under Title 11, Chapter 5, Section 102.a.xi, (Wyoming State Statutes 1973). Table 3.6-7 provides a list of these species. Once established, non-native species often become invasive and out-compete the native plant species. As such, these species are a detriment to the native vegetation. Noxious weeds are weeds, seeds or other plant parts that are considered detrimental, destructive, injurious, or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within the state, and are on the designated list.

The 1992 Special Weed Management Act replaced the Leafy Spurge Act and allowed establishment of a cost-sharing program for integrated pest management and increased the use of biological control methods. Biological control agents have become the largest effort for reducing the spread of leafy spurge. Nearly seven species of biological control microorganisms are released to aid in the control of this noxious weed. Data are then collected at many sites annually throughout the county to monitor the success of the weed control program.

Table 3.6-7. Wyoming Weed & Pest Control Act Designated List

Common Name	Scientific Name
Field bindweed	*Convolvulus arvensis*
Canada thistle	*Cirsium arvense*
Leafy spurge	*Euphorbia esula*
Perennial sowthistle	*Sonchus arvensis*
Quackgrass	*Agropyron repens*
Hoary cress	*Cardaria draba*
Perennial pepperweed	*Lepidium latifolium*
Ox-eye daisy	*Chrysanthemum leucanthemum*
Skeletonleaf bursage	*Franseria discolor*
Russian knapweed	*Centaurea repens*
Yellow toadflax	*Linaria dalmatica*
Dalmatian toadflax	*Linaria dalmatica*
Scotch thistle	*Onopordum acanthium*
Musk thistle	*Carduus nutant*
Common burdock	*Arctium minus*
Plumeless thistle	*Carduus acanthoides*
Dyers woad	*Isatis tinctoria*
Houndstongue	*Cynoglossum officinale*
Spotted knapweed	*Centaurea maculosa*
Diffuse knapweed	*Centaurea diffusa*
Purple loosestrife	*Lythrum salicaria*
Saltcedar	*Tamarix* spp.
Common St. Johnswort	*Hypericum perforatum*
Common Tansy	*Tanacetum vulgare*

Source: Baker 2003.

The distribution and density of noxious weeds, which occur throughout the WRPA, are influenced by various factors such as site disturbance, soils, climate, and district controls. The Russian and diffuse knapweeds are far more widespread than Leafy spurge. More than 81,121 acres (88 percent) contain Russian knapweed with another 4321 acres (5 percent) of the WRPA affected by diffuse knapweed.

Figure 3.6-4. shows the distribution of leafy spurge, Russian knapweed, and diffuse knapweed and Table 3.6-8 summarizes the percent distribution of these noxious weeds throughout the WRPA. Although precise areas of the occurrence of invasive noxious weeds are not known, the presence of these species is being monitored by the FCWPCD.

Table 3.6-8. Extent (in acres) of Russian Knapweed and Diffuse Knapweed within the WRPA[1].

Noxious Weeds	Pavillion	Muddy Ridge	Coastal Extension	Sand Mesa	Sand Mesa South
Russian knapweed	11775	7525	2014	6991	3820
Diffuse knapweed	0	0	0	80	1242
Total Area of Field	11775	7525	5203	9577	3820

[1] Mapped areas of Russian knapweed overlap with mapped areas of diffuse knapweed in portions of the WRPA.

Figure 3.6-4. Areas Within and Adjacent to the Wind River Project Area Where Invasive Plant Species Have Been Observed

3.7 LAND USE

3.7.1 Introduction

The Wind River Project Area (WRPA) encompasses approximately 91,337 acres, and is comprised of federal, state, tribal, and private land. These lands are owned or managed by several entities including the Wind River Indian Reservation (WRIR), the Wyoming Game & Fish Department (WGFD), the U.S. Bureau of Reclamation (BOR), Wyoming State Parks and Historic Sites (WSP), and private land owners. Approximately 49.4 percent of the land within the WRPA is in private ownership, 33.6 percent is under Federal management, 16.4 percent is Tribal land, and less than 1 percent is under State management (See Table 3.7-1).

Table 3.7-1. Land Ownership within the WRPA.

Land Ownership	Land Area in Acres[1]	% of WRPA
Private Land	45,143	49.4%
Bureau of Reclamation	30,717	33.6%
Wind River Reservation/ Tribal Lands	14,966	16.4%
Wyoming State Parks	262	0.3%
Wyoming Game & Fish Department	239	0.3%
Open Water (Federal, Tribal)	10	0.01%
Total Area:	**91,337**	**100%**

[1]Acreage was generated by a GIS evaluation of the “own31s” shapefile, which displays ownership within and adjacent to the WRPA. These quantities may or may not coincide with other land area estimates in this EIS. Margin of error is assumed to be less than 1%.

Six primary land uses exist within the WRPA. These land uses are livestock grazing, agriculture, residential, recreational, wildlife habitat management, and resource extraction. The majority of the land within the WRPA has been modified from its natural state. Throughout the WRPA, resource extraction activities occur in conjunction with most land uses, with the exceptions being State Park lands and land owned by the Town of Pavillion.

There are 328 individual property parcels within the WRPA, including private, federal, state, municipal, and tribal lands. The majority of these lands contain separate surface and mineral ownership, meaning one individual or entity may own the surface rights to the land, while another may own the rights to minerals beneath the surface. This form of ownership is known as a “split estate.” Split estates allow holders of mineral rights to pursue resource extraction operations on land where the surface may be owned or managed by other individuals or agencies. These lands may contain various surface uses, such as agriculture, livestock range, wildlife habitat, or residential uses.

The following sections are organized by surface ownership, with sections describing the land uses that are related to each form of ownership.

3.7.2 Private Land

Within the WRPA there are 292 individual privately-owned land parcels, comprising 45,143 acres (Fremont County 2002). Private ownership accounts for 49.4 percent of the total surface area within the WRPA and is the largest single form of surface ownership within the WRPA. Private lands are typically held in split estate.

3.7.2.1 Agricultural Resources

The majority of the private land within the WRPA is in agricultural production. Agricultural crops include corn, alfalfa, wheat, and vegetables. Most of the agricultural lands are under some type of irrigation, typically overhead pivot systems. There are several irrigation ditches that traverse the WRPA, the largest of which is the Wyoming Canal, which traverses west-east through the northern portion of the WRPA. Residential farmhouses and other structures are an integral part of the agricultural resources on private lands. These structures may include barns, grain storage structures, silos, outbuildings, pivot irrigation systems, utility poles, fences, corrals, access roads, and other farm-related items. Throughout the agricultural lands there are large groupings of hay bales, typically organized in a rectangular block. These blocks are usually located within or near other agricultural structures. Agricultural lands within the WRPA typically contain resource extraction facilities in the form of gas wells and associated production facilities. Some croplands have existing natural gas facilities located directly in the development areas, while in other areas the facilities are “off-site”, with well heads located in the development area and the remainder of the production facilities located adjacent to the development area. Both of these arrangements typically displace some agricultural production by occupying arable lands either on the side, or within agricultural development areas.

3.7.2.2 Range Resources

Some of the private land within the WRPA is used as livestock range. These rangelands are typically non-irrigated, arid land characterized by sagebrush and grasses. Due to the arid nature of the rangelands, the livestock population density is relatively low. Rangelands are typically fenced from roadways and other land uses, although there are areas of open range in the WRPA. Throughout the WRPA, the rangelands generally co-exist with the irrigated agricultural lands, with the rangelands standing in distinct contrast to the more lush croplands. Natural gas production facilities and access roads are common on these rangelands.

3.7.2.3 Residential Areas

There are approximately 219 private landowners that own 292 individual land parcels. Many of these landowners live on their property, and have residences that exist in conjunction with agricultural lands. Consequently, there are no distinct residential neighborhoods within the WRPA. Many of these residences are part of larger agricultural compounds that may also include barns, outbuildings, silos and farm equipment. Some natural gas production facilities are located in close proximity to these residences, in addition to being located in other areas on private lands.

3.7.2.4 Recreation Resources

Recreational opportunities on private lands within the WRPA are limited, but include hunting and fishing by residents and acquaintances by permission from the landowner. For a more detailed description of recreational opportunities on private lands, refer to Section 3.10.

3.7.2.5 Resource Extraction

Resource extraction facilities, in the form of natural gas wells and associated facilities, exist in conjunction with other land uses on privately-owned lands in the WRPA. There are currently 117 existing producing wells on private lands within the WRPA. There are also a number of dry holes or wells that have been abandoned. Gas facilities on these lands include wellheads, capped wells, storage tanks, production units, meters, pipelines, evaporation ponds, well pads, and access roads.

3.7.3 U.S. Bureau of Reclamation

The BOR is the surface owner of approximately 30,717 acres of land within the WRPA, which constitutes the second largest form of surface management (Fremont County 2002). Within the BOR lands approximately 10,751 acres, are managed as Wildlife Habitat Management Areas (WHMA) by the Wyoming Game and Fish Department (WGFD). Most of the hunting activity within the WRPA occurs on these WHMA lands. The remaining 19,966 acres of BOR lands are managed primarily as rangelands.

The majority of the 10,751 acres managed as WHMA lands are associated with riparian corridors or wetland areas within the WRPA. The largest of these habitat areas consists of land associated with Muddy Creek, which traverses west-east through the north-central portion of the WRPA. The other land and water features included in the WHMA system are Upper Reservoir, Middle Reservoir, and their connecting ditch, a stock pond area in the western portion of the WRPA, and the Fivemile Creek corridor through the WRPA.

3.7.3.1 Range Resources

There are 19,996 acres of BOR land that are not part of the Sand Mesa WHMA. This land mostly consists of arid sagebrush plains and is primarily privately leased and managed as rangeland.

3.7.3.2 Recreation Resources

The majority of recreation that occurs on BOR administered lands within the WRPA is managed by the WGFD. The recreation in these areas consists of big-game hunting, with some small-game hunting, waterfowl and upland bird hunting, and fishing.

Big game in this area consist of mule deer and antelope which are hunted by local and regional hunters. Waterfowl hunting is pursued around Middle Reservoir and Upper Reservoir. These reservoirs are stocked, and as a result, fishing is a popular activity that occurs in these water bodies. Rabbit and upland bird hunting is mainly a pursuit of local residents (For a more detailed description of the recreational resources on public land throughout the WRPA, refer to Section 3.10).

3.7.3.3 Resource Extraction

Resource extraction facilities, in the form of natural gas wells and associated facilities, exist in conjunction with other land uses on BOR administered lands in the WRPA. There are currently 41 existing producing wells on BOR lands. There are also a number of dry holes or wells that have been abandoned. These gas facilities include wellpads, capped wells, storage tanks, production units, meters, pipelines, evaporation ponds, access roads, and compressor stations.

3.7.4 Wind River Indian Reservation/Tribal Lands

Tribal lands account for three parcels totaling approximately 14,966 acres within the WRPA (Fremont County 2002). This constitutes the third largest form of surface management within the WRPA. The majority of the tribal lands are undeveloped arid lands containing some resource extraction facilities.

3.7.4.1 Agricultural Resources

A small portion of the tribal lands has been developed for agriculture. The majority of the agricultural development within the tribal managed lands is contained within small portions of Shoshone tribal lands. This agricultural land is a small percentage of the total agricultural land within the WRPA.

3.7.4.2 Range Resources

The majority of tribal land within the WRPA is rangeland. These rangelands consist of one large parcel that overlaps the WRPA in three separate places. One portion of this parcel is located on the northern border of the WRPA and consists of a lower, dryer area comprising a portion of the Cottonwood Creek watershed. A smaller portion of the parcel forms the northeast corner of the Muddy Ridge Field. This corner consists of low-lying, arid rangelands. Another large portion of this parcel forms the northwestern corner of the WRPA and consists of sagebrush plains along and near Muddy Ridge.

3.7.4.3 Residential Areas

There are no residential land uses on tribal lands within the WRPA.

3.7.4.4 Recreation Resources

Recreational activities on tribal lands within the WRPA typically consist of hunting, trapping, and fishing by tribal members. For more information regarding recreational activities on tribal lands, please refer to Section 3.10.

3.7.4.5 Resource Extraction

Resource extraction facilities, in the form of natural gas wells and associated facilities, exist in conjunction with other land uses on tribal lands in the WRPA. There are 20 existing producing wells on tribal lands. There are also a number of dry holes or wells that have been abandoned. These gas facilities include capped wells, storage tanks, production units, meters, pipelines, evaporation ponds, well pads, and access roads.

3.7.5 Wyoming State Parks

Wyoming State Parks and Historic Sites (WSP) manages approximately 262 acres within the WRPA as part of Boysen State Park (Fremont County 2002). This comprises the fourth largest share of surface management in the WRPA, and is a relatively small portion of Boysen State Park. The WSP-managed acreage is comprised of 2 separate units: a 19-acre parcel in the northeast corner of the WRPA, and a 243-acre parcel in the southeast corner of the WRPA.

Boysen State Park comprises 40,000 acres and is accessed primarily from US Hwy 26/ WYO 789 and US Hwy 20. The main access to the west side of Boysen State Park is Bass Lake Road, which is located within the WRPA. Cottonwood Bay and Lake Cameahwait (also known as Bass Lake) are located here and are the primary attractions on the west side of the park, which is adjacent to and partly within the WRPA. The main attraction at Boysen State Park is the 19,000 acre Boysen Reservoir, formed by the damming of the Wind River near the top of Wind River Canyon, 6.5 miles to the northeast of the WRPA.

3.7.5.1 Wildlife Habitat Resources

Boysen State Park is managed partly for wildlife and fisheries habitat. People are attracted to the Park in part by the quality of fishing in Boysen Reservoir. The reservoir provides habitat for sport-fishing species including walleye, sauger, perch, crappie, ling, rainbow, cutthroat and brown trout. The reservoir also provides habitat for other game fish such as largemouth bass, bluegill, stonecat, black bullhead, mountain whitefish, lake trout, brook trout, and splake. Non-game fish species include carp, fathead minnow, plains killifish, golden and sand shiners; flathead, lake, and creek chubs; white, longnose, and northern redhorse suckers; and the river carpsucker. The lands surrounding the reservoir are mostly open, rolling sagebrush plains, and provide habitat for many species of wildlife (WSP & Historic Sites 2003).

3.7.5.2 Recreation Resources

Boysen State Park is also managed for recreational uses. The park has 11 developed campgrounds and several developed day-use areas providing access and/or facilities for camping, boating, swimming, water skiing, fishing, ice fishing, picnicking, wildlife watching, hiking, and ORV use (WSP & Historic Sites 2003). Boysen State Park receives 143,259 annual visits, based on a five-year average (Sims W., BOR personal communication, July-August 2003), (See Section 3.10 for more on Recreation on WSP-managed lands).

3.7.5.3 Resource Extraction

There are no existing producing wells on WSP-managed land within the WRPA.

3.7.6 Wyoming Game & Fish Department

There is one parcel of WGFD land within the WRPA (Fremont County 2002). This 239 acre parcel is located in the southwestern portion of the WRPA, and is managed as part of the Ocean Lake WHMA. This comprises the fifth largest share of surface management in the WRPA. The Sand Mesa WHMA, which runs through the WRPA, is also managed by the WGFD. These two WHMAs are discussed below.

3.7.6.1 Wildlife Habitat Resources

The Ocean Lake WHMA is managed by the WGFD primarily for wildlife habitat. There is one satellite parcel of this WHMA located within the WRPA. Various existing features on this parcel include an irrigation canal and several areas of vegetated shelterbelts. There are no water bodies on this parcel, however Ocean Lake is located south of WYO 134, adjacent to the southern portion of the WRPA. Ocean Lake contains the majority of the waterfowl habitat within this WHMA.

WGFD manages Sand Mesa WHMA through a cooperative agreement with the U.S. Bureau of Reclamation (BOR 2003b). The area contains 17,949 acres in five separate units. US Highway/134, US 26, and the Bass Lake Road are the principal roads to the Sand Mesa WHMA. Sand Mesa WHMA contains croplands managed for wildlife habitat and 350 acres of wetland ponds managed for waterfowl production. Areas used by waterfowl include Middle Depression Reservoir, Cottonwood Drain, Fivemile Creek, and Muddy Creek. Other waterbodies just outside of the WRPA include Lake Cameahwait, Muddy Ridge Reservoir (in T3N, R3E, Section 1) and the Sand Mesa Ponds (also known as the Lower Depression Ponds) west of Boysen Reservoir (WGFD 2002a). The remainder of the WHMA is sagebrush grassland that supports game and non-game species, including pheasant, mule deer and white-tailed deer.

3.7.6.2 Recreation Resources

Recreation in the Ocean Lake WHMA within the WRPA is primarily in the form of seasonal hunting (WGFD 2002a).

3.7.6.3 Resource Extraction

There are no existing producing wells on WGFD-managed land within the WRPA.

3.7.7 Town of Pavillion

The Town of Pavillion owns one parcel within the WRPA that comprises approximately 10 acres (Fremont County 2002). This parcel contains a small rocky geologic formation located in the center of the parcel in a northwest-southeast orientation, and is surrounded primarily by agricultural lands. There are no existing producing wells on Town of Pavillion land within the WRPA.

3.7.8 Land Use Adjacent to the WRPA

Lands adjacent to the WRPA are owned and/or managed by several entities, including the Bureau of Reclamation, Wind River Indian Reservation, Wyoming State Parks, Wyoming Game & Fish Department, and several private landowners. Several different land uses exist adjacent to the WRPA, including agriculture, ranching/rangeland, a State Park, Wildlife Habitat Management Areas, towns, and residential areas. These land uses are typically also found within the WRPA, but some adjacent land uses may not be present within the WRPA.

There are three areas open to public recreation located adjacent to the eastern boundary of the WRPA. These areas include Boysen State Park, Cameahwait Lake, and Sand Mesa WHMA (for more detailed information on these recreation areas refer to Section 3.10). US Hwy 26/WYO 789 is the major route that connects to the access roads to these areas. Bass Lake Road, which is located within the WRPA, is one such access road. Bass Lake Road provides the primary access to Cameahwait Lake and the west side of Boysen State Park.

There are three primary land uses, adjacent to the southern boundary of the WRPA. Rangeland managed by the BOR comprises the majority of the land use here. Privately-owned agricultural lands comprise another large area adjacent to the WRPA. The third land use in this area is recreational use of the Ocean Lake WHMA, which abuts the WRPA, and a small portion of the Sand Mesa WHMA along Fivemile Creek. Primary access to Ocean Lake is from WYO 134.

Adjacent to the western boundary of the WRPA are four primary land use categories: private residential and agricultural lands, WRIR rangelands, BOR rangelands, and a small portion of the Sand Mesa WHMA along Fivemile Creek. Private lands include the town of Pavillion, with a population of 165 (U.S. Census Bureau 2000). Main access to this area is from WYO 133.

Adjacent to the northern boundary of the WRPA, there are four primary land use categories: WRIR rangelands, private residential and agricultural lands, BOR rangelands, and a small portion of Boysen State Park. The majority of the land along the northern boundary of the WRPA is in a more remote area of the Wind River Indian Reservation that is not served by any Federal or State roads or highways.

3.7.9 Land Use Plans

The land use plans and related documents that direct management of federal and tribal lands within the WRPA are summarized in the following sections.

3.7.9.1 Wind River Agency Land Management Activities

In 1984, the BIA released the document entitled "Environmental Assessment of the Land Management Activities Proposed by Land Operations, Wind River Agency" (BIA 1984a). This document addresses the potential effects of specific land management activities on the Wind River Indian Reservation. The document provided guidance for activities affecting natural resources on the WRIR. Land use activities addressed include:

- Forest Management
- Range Management
- Exploration, production, and marketing of oil, natural gas, and gravel
- Irrigation Projects
- Soil conservation and crop production

Of these five specific land use activity topics, only the Oil, Natural Gas, and Gravel section is pertinent to this EIS. The land use management objectives for oil and gas production are to endeavor to ensure a level of production in each area that:

- Generates the highest possible income to help support the needs of tribal government
- Makes the highest possible monetary payments to enrolled tribal members
- Protects long-term uses of the land
- Conserves the land base for future generations

3.7.9.2 Draft Wind River Land Use Development Plan

The Eastern Shoshone and Northern Arapaho Tribes zoning ordinance has encompassed the WRPA area since the 1970s. A land use plan to coordinate development on the Wind River Indian Reservation (WRIR) for the next 20 years is under development by the Eastern Shoshone Tribe with input from the New'e Development Corporation Board, Eastern Shoshone Tribal Council and the Northern Arapaho Tribal Council. The overall goal "is to develop long-range planning, policies, ordinances and management documents that will further the tribe's ability to provide a self-sufficient community and economy" (Cottenoir 2003). The preparation of the plan is expected to take two years.

The overall land use goals of the draft plan are:

- Residential
    - o Provide suitable housing areas that contain a cost-effective infrastructure.
    - o Provide tribal members with a development process.
- Agriculture
    - o Protect and preserve agricultural lands.
- Commercial
    - o Designate commercial land use for large and small businesses.
- Industrial
    - o Provide land for industrial opportunities for both tribes and surrounding municipalities.
- Public Use
    - o Improve public and recreational areas on the reservation.
- Economic Development
    - o Provide opportunities for employment on the reservation.

Strategic plan goals in the draft plan are:

- Environmental and Natural Resource
    - o Provide a plan to conserve and preserve future resources.
- Transportation
    - o Support regional transportation planning and decision-making.
- Zoning

- o Modify current tribal zoning laws, as necessary, to further protect property and encourage orderly development.

3.7.9.3 Fremont County Land Use Plan

The Fremont County Land Use Plan (Fremont County 1978) includes objectives and goals for public land coordination and management, economic development, growth management, environmental quality, and natural resources. Fremont County has no countywide zoning regulations (Price, R., Fremont County, personal communication, August 5, 2003). Individual towns and cities have zoning requirements, but the Proposed Action has no facilities in an incorporated town or city. County permits may be required for the crossing of county roads by roads, pipelines, and Rights-of-Way (ROW). Fremont County has also prepared a draft land use plan (Fremont County 2001). This plan will also be considered, as NEPA requires consideration of local land use plans in the preparation of environmental analyses. The Proposed Action and alternatives to the Proposed Action for the Wind River Natural Gas Development Project would occur entirely within Fremont County.

Based on the foregoing, the Wind River Natural Gas Field Development Project will be in conformance with applicable land use plans and tribal law.

3.7.9.4 Draft Fremont County Land Use Plan (2001)

Fremont County released the Draft Fremont County Land Use Plan in 2001. The Land Use Plan addresses several planning items that are relevant to land use in the WRPA. These items are listed below and followed by the specific goals that define the desired condition related to land use or the land-use planning process (Fremont County 2001). The planning items and their goals are:

Citizen Participation

- Conduct a land-use planning program in accordance with the will of a majority of Fremont County residents.

Economic Preservation and Development

- Preserve and develop Fremont County's customs and cultures.
- Expand Fremont County's current economic base.
- Stop or reverse the erosion of Fremont County's economic base due to increased restrictions and limitations on the use of public lands in Fremont County.

Growth

- Plan orderly growth.

Open Space

- Preserve open space.

Agricultural Lands

- Protect and preserve agriculturally productive land both public and private for continued agricultural purposes.

Environmental Quality

- Protect or improve the existing quality of air, water, and land resources.

Natural Resources

- Facilitate prudent development, use and conservation of natural and renewable resources in such a way as to ensure their continued availability for future generations.

- Reaffirm the State of Wyoming's right to allocate and prioritize water rights to those individuals providing historic beneficial use as described in the Wyoming Constitution, Article 8, Section II.

- Create the atmosphere to facilitate the prudent use and conservation of natural renewable/non-renewable resources.

Scenic Areas and Historic Sites

Preserve, protect, and enhance scenic areas, historic sites, and cultural sites as provided in the Fremont County Historic Preservation Resolution.

Wildlife

Manage wildlife through the protection of water and maintenance of public and private lands as defined in the Wyoming constitution.

Public Lands

- Protect the tax base by exercising stewardship and being civilly responsible by prioritizing land use at the local level.

- Preserve the economic and cultural foundation of the county, by developing regulations that will enable a healthy local economy and preserve and allow profit to commercial public land users.

- Promote historical and future access to and travel across public lands that do not injure private owners or lessees for multiple use purposes.

Recreation

- Support and create quality recreational opportunities for county residents and visitors.

3.7.9.5 Lander Resource Management Plan

The Final Resource Management Plan/EIS for the Lander Resource Area, Lander, Wyoming (BLM 1986) addresses the areas east, south, and west of the WRIR. Therefore, this land use plan is not applicable to the Proposed Action and alternatives.

3.8 WILDLIFE

3.8.1 Introduction

The Wind River Project Area (WRPA) provides habitat for many species of big game, birds, fish, reptiles, amphibians, and invertebrates. A total of 365 species of wildlife are known, or have the potential, to occur as residents or seasonal migrants within the WRPA and surrounding area (Appendix I). This species list is comprised of 73 mammals, 266 birds, 4 amphibians, 8 reptiles, and 14 fish species. This chapter addresses the species that are associated with the sagebrush, saltbush, greasewood, desert shrub, shrub-dominated riparian, mixed grass prairie, and cropland habitats that are typical throughout the Wind River Basin. Because these habitats tend to occur in a mosaic across the landscape, many wildlife species use more than one habitat. Vegetative cover types and wildlife habitat associations are closely related. Vegetative species composition within these habitats is discussed in Section 3.6.

The presence and distribution of these wildlife species was determined from published literature, unpublished data from state and federal agencies, databases from private organizations, data from tribal records, and on-site fish and wildlife surveys conducted by project biologists during 2003 (Buys & Associates 2003a, b; Baldes 2003). Appendix J provides the results of an aerial survey conducted to identify wildlife habitats in the WRPA, a prairie dog survey, a macroinvertebrate survey, and a survey of fish and wildlife species in the WRPA.

Wildlife habitats that could be affected by the Wind River Gas Development Project include areas that would be physically disturbed by the drilling and construction of well pads, access roads, pipelines, and production facilities, as well as zones of influence around activity areas. Zones of potential influence are defined as those areas surrounding, or adjacent to, project activities where impacts to a given species could occur. The shape and extent of such zones varies considerably with the species and the circumstance.

The following sections discuss the wildlife that are expected to occur in the WRPA.

3.8.2 Terrestrial Wildlife

3.8.2.1 Big Game Species

Big game species that are expected to occur in suitable habitats throughout the WRPA include pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervis elaphus*), and moose (*Alces alces*). The nomenclature used follows Jones et al. (1997). There are six range-types for big game species, including the crucial, summer or spring-summer-fall, winter, winter/yearlong, yearlong, and parturition area ranges (Jones et al. 1997; WGFD no date). Definitions for these six range types are provided in the glossary.

Pronghorn Antelope

Pronghorn antelope typically inhabit grasslands and semi-desert shrublands of the western and southwestern United States. This species is most abundant in short- and mixed-grass habitats between elevations of 4,000 and 6,000 feet. Pronghorn are typically less abundant in xeric (very arid) habitats, preferring areas that average 12-15 inches of precipitation per year. Home ranges for pronghorn can vary between 400 and 5,600 acres, according to factors including season, habitat quality, population characteristics, and local livestock occurrence. Typically, daily movements do not exceed 6 miles. Some pronghorn make seasonal migrations between summer and winter habitats, but these migrations are often triggered by the availability of succulent plants and not local weather conditions (Fitzgerald et al. 1994). Wyoming supports the largest population of pronghorn in North America (Clark and Stromberg 1987).

Pronghorn antelope occur throughout the WRPA, as shown on Figure 3.8-1. Yearlong ranges exist throughout much of the eastern portion of the WRPA, which is dominated by sagebrush. Although, pronghorn have been documented in the western portion of the WRPA, their occurrence there is limited.

Mule Deer

Mule deer occur throughout the mountains, forests, deserts, and brushlands of the western United States. Typical habitats include shortgrass and mixed-grass prairies, sagebrush and other shrublands, coniferous forests, and forested and shrubby riparian areas. In Wyoming, mule deer occur in mountains and associated foothills, broken hill country, and prairie grasslands and shrublands (Clark and Stromberg 1987). In mountainous areas, mule deer usually are migratory, spending the warmer months at higher elevations. During this time, mule deer prefer foraging on the succulent regrowth of forbs and the new twigs of trees and shrubs. As summer progresses and the herbaceous plants mature and dry, the diet shifts more toward woody browse. This diet then continues as the deer are driven down to foothill areas in winter (Wilson and Ruff 1999). Fawn mortality is typically due to predation or starvation. Adult mortality often occurs from hunting, winter starvation, and automobile collisions. Typical predators may include wolves, coyotes, bobcats, golden eagles, mountain lions, bears, and domestic dogs (Fitzgerald et al. 1994). Although yearlong mule deer habitat occurs within the WRPA, no mule deer herd units are contained within the WRPA boundary (Figure 3.8-2).

White-tailed Deer

White-tailed deer occur from southern Canada throughout much of the United States and as far south as northern South America. White-tailed deer occupy diverse habitats from north-temperate to tropical and from semi-arid to rainforest. They prefer forest edges and open woodlands in proximity to brushland, old-fields, and agricultural areas (Wilson and Ruff 1999). In Wyoming, white-tailed deer are found throughout the state, typically concentrated in riparian woodlands, shrubby riparian areas, and associated irrigated agricultural lands, and are generally absent from dry grasslands and coniferous forests (Clark and Stromberg 1987). Density is related to the amount and quality of habitat. In some areas, the deer may make short migrations to areas where more winter food is available. White tailed deer allocate much of their time to foraging. In addition to native browse, grass and forbs, this species also will utilize agricultural crops, fruits, acorns, and other nuts. Mortality of white-tailed deer is typically related to hunting, winter starvation, collisions with automobiles, and predation. Predators may include coyotes, mountain lions, wolves, and occasionally, bears, bobcats, and eagles (Fitzgerald et al. 1994). Although white-tailed deer habitat occurs within the WRPA (Figure 3.8-3), there have only been incidental observations of this species within the WRPA.

Figure 3.8-1. Seasonal Pronghorn Antelope Ranges Within and Near the WRPA.

Figure 3.8-2. Seasonal Mule Deer Ranges Within and Near the WRPA.

Figure 3.8-3. Seasonal White-tailed Deer Ranges Within and Near the WRPA.

Elk

Elk historically ranged over much of central and western North America from the southern Canadian Provinces and Alaska south to the southern United States, and eastward into the deciduous forests. In Wyoming, this species occurs throughout the state in a variety of habitats, including coniferous forests, mountain meadows, short- and mixed-grass prairies, and sagebrush and other shrublands. Elk are gregarious animals, with herds of more than 200 occurring in open habitats (BLM 2003a). In more heavily forested habitats, group sizes are typically smaller. Elk tend to migrate between summer and winter ranges. Like other members of the deer family, this species relies on a combination of browse, grasses, and forbs, depending on their availability. Typically, mortality is a result of predation on calves, hunting, and winter starvation. Predators may include wolves, coyotes, mountain lions, bobcats, bears, and golden eagles.

In the Wind River area, elk ranges include the Owl Creek Mountains and foothills, which extend into the northern portion of the WRPA. Although elk habitat exists throughout the WRPA, most elk utilize the northern portion of the WRPA (Figure 3.8-4).

Moose

In North America, moose occur from Alaska to the northeastern United States and south along the Rocky Mountains into Colorado. In Wyoming, this species occurs in the western half and isolated southern areas of the state. Typical moose habitats in the Rocky Mountains include willow, spruce, fir, aspen or birch forest. These habitats are common to forested riparian, shrubby riparian, and wet meadow vegetation types. Willow is an important dietary component on all seasonal ranges, especially in the winter range when grasses, forbs, and aquatic vegetation are less available. Moose tend to have strong affinity for specific forage and habitat. Major mortality factors include hunting, starvation, and predation. Common predators include mountain lion, wolverine, coyote, bear, lynx, and domestic dog (BLM 2003a).

Limited moose habitat exists within the WRPA, and no moose herd units are contained within the project boundaries (Figure 3.8-5). Moose have been observed in the WRPA (Baldes 2003).

Figure 3.8-4. Seasonal Elk Ranges Within and Near the WRPA.

Figure 3.8-5. Seasonal Moose Ranges Within and Near the WRPA.

3.8.2.2 Raptors

Six raptor nests were identified during an aerial survey of the WRPA (Buys & Associates 2003a) (see Appendix J). Figure 3.8-6 shows the locations of four red-tail hawk nests and one unknown raptor species nest within the WRPA. In addition, a golden eagle nest was observed outside of the project boundaries. The following sections briefly describe the ecology, distribution, and populations of raptor species that occur in the WRPA.

American Kestrel

The American kestrel is found throughout North and South America from Alaska to the southernmost tip of South America. This species is known to breed in every state of the United States, except Hawaii. Kestrels prefer open habitats including desert grasslands, meadows, and brushy fields. The species can often be seen using perches (i.e., dead trees, rock outcrops, utility poles, and wires) for hunting insects and small mammals (Sibley 2003). Nesting sites often include tree cavities, crevices, cliffs, and nest boxes. In Wyoming, the kestrel is a common summer resident of suitable habitats below 8,500 feet in elevation. This species has been identified in the WRPA, but no population estimates are available.

Cooper’s Hawk

The Cooper’s hawk occurs throughout North America from southern Canada to northern South America. This species is closely associated with deciduous and mixed forests and open woodland habitats such as woodlots, riparian woodlands, semiarid woodlands of the southwest, and other areas where the woodlands tend to occur in patches (Johnsgard 1990). The Cooper's hawk is known as a predator of birds, but it also feeds upon mammals. When hunting, the Cooper's hawk usually perches and watches for its prey. Bobwhites, starlings, blackbirds, chipmunks, and squirrels are common prey for this species. Nesting occurs in tall trees, especially pines (Sibley 2003). In Wyoming, the Cooper’s hawk is a common yearlong resident, particularly in the western and central portions of the state. This species has not been observed within the WRPA, and is not likely to nest within the WRPA due to lack of woodland habitat. However, adequate foraging habitat does exist within the WRPA boundaries.

Golden Eagle

In North America, golden eagles occur throughout much of the mountain and grassland regions. Golden eagles typically nest on open cliffs or in trees. Important foraging habitats include grasslands, sagebrush, and farmlands where the species forages on medium-sized mammals (Sibley 2003). In Wyoming, this species is considered a common yearlong resident feeding mostly on jackrabbits, rodents, small mammals, and carrion in the winter (BLM 2003a). Based upon past records and recent surveys, golden eagles utilize much of the WRPA. Buys & Associates biologists observed one and possibly two golden eagles foraging above the WRPA on April 16, 2003. One golden eagle nest was located within the WRPA (Buys & Associates 2003a).

Great Horned Owl

The great horned owl occurs from the northern edge of the boreal forest in Alaska and Canada to the southern tip of South America. The species is found in various moist or arid forested habitats, from lowland forests to open temperate woodlands, including second-growth forests, swamps, orchards, riparian forests, brushy hillsides, and desert. This owl typically utilizes abandoned stick nests in wooded areas adjacent to open spaces such as shrublands, grasslands, and farm fields that provide excellent opportunity for hunting rodents and other small mammals (BLM 2003). In Wyoming, this owl is considered a common resident of habitats below 9,000 feet in elevation, especially in riparian areas dominated by cottonwood (Luce et al. 1999). Great horned owls have been documented in the WRPA.

Long-eared Owl

Long-eared owls range from southern and eastern British Columbia, across parts of Canada, and south to northwestern Baja California, southern New Mexico, northern Mexico, Arizona, and Virginia. In the western states, owls are often associated with deciduous woods near brushy fields or water. Wooded areas are used for roosting and nesting, and open areas are used for hunting. Long-eared owls feed mostly on small mammals, particularly voles (Marks 1986). In Wyoming, long-eared owls are found throughout the state, primarily in lodgepole pine, Douglas fir, Englemann spruce, aspen, and mountain-foothills grasslands (Luce et al. 1999). This species has been observed in the WRPA.

Prairie Falcon

The prairie falcon is found throughout the western half of North America from southern Alberta, Saskatchewan, and British Columbia to central Mexico. Prairie falcons are found primarily in shrubland or grassland habitats, often close to open areas. This species nests almost exclusively on tall cliff faces. Diet includes birds, lizards, and small mammals (BLM 2003). In Wyoming, the prairie falcon is considered a common resident, nesting in cliff habitats in open areas (Luce et al. 1999). This species has been observed within the WRPA.

Red-tailed Hawk

Red-tailed hawks use a variety of habitats and range from Alaska to Panama and eastward to Nova Scotia and the Virgin Islands. This species typically nests in patches of tall trees or on secluded cliff faces, but also use tree windbreaks where available. Red-tails are more tolerant to human activities than are other raptors. Typical prey species include rodents and other small mammals. In Wyoming, this species is a year-round resident common to most habitats below 9,000 feet in elevation, including prairie grasslands, riparian areas, sagebrush communities, and pinyon/juniper woodlands (Luce et al. 1999). Red-tailed hawks have been observed both foraging and nesting within the WRPA. Both active and inactive nests were identified by Buys & Associates biologists on April 16, 2003 (Buys & Associates 2003a).

Sharp-shinned Hawk

The sharp-shinned hawk ranges from Alaska to Saskatchewan, Labrador, and Newfoundland, and south to South America. The species winters in southern Alaska and southern Canada, and also in Panama. Sharp-shinned hawks are primarily found in coniferous forests and open woodlands. During migrations this species will use various habitats, including ridges, lakeshores, and coastlines. Sharp-shinned hawks build stick nests primarily in coniferous or deciduous trees. This species diet consists mainly of small- to medium-sized birds, small mammals, insects, and lizards (Sibley 2003). In Wyoming, sharp-shinned hawks are a year-round resident found primarily in coniferous forests, aspen, woodlands-chaparral, and cottonwood-riparian areas (Luce et al. 1999). This species has been observed within the WRPA.

Short-eared Owl

Short-eared owls range from northern Alaska to northern Labrador, and south to California, Utah, Colorado, parts of the Midwest, and Virginia. The species winters mostly in Baja California, southern Mexico, and the Gulf Coast states including Florida. Short-eared owls are primarily found in open country in prairies, meadows, tundra, moorlands, marshes, savannas, dunes, fields, and open woodlands. This owl nests in depressions on the ground and will roost on low open perches, under low shrubs, or in conifer trees. This species diet consists mainly of rodents (commonly voles), but small birds, insects, and other small mammals are also consumed (Rivest 1994). In Wyoming, short-eared owls are a common year-round resident in basin-prairie shrublands, grasslands, marshes, and irrigated native meadows below 7,000 feet (Luce et al. 1999). This species has not been observed in the WRPA. However, adequate habitat does exist, and the species is considered to be likely to occur.

Swainson's Hawk

The Swainson's hawk breeds in North America and winters in South America. The species is most commonly found in open pine/oak woodlands, and in cultivated land with scattered trees (e.g., alfalfa and other hay crops, and certain grain and row crops). During migration, and in winter, these hawks are also found in grasslands and other open country. Swainson's hawks often use nests built by magpies, crows, ravens, or other hawks, but some may build their own nests in the tops of isolated trees. This species typically preys on rodents, small mammals, and occasionally, rabbits (BLM 2003). In Wyoming, this species is considered a summer resident common to grasslands below 9,000 feet elevation (Luce et al. 1999). Swainson's hawks are relatively sensitive to human disturbance near active nests. They have been observed within the WRPA, and are likely annual summer residents.

Burrowing Owl

The burrowing owl occurs from south-central British Columbia to southern Saskatchewan and throughout most of the western United States. Burrowing owls primarily nest in rodent burrows, particularly prairie dog burrows, in grasslands, shrublands, deserts, and grassy urban settings (Jones 1998). In Wyoming, this species uses grasslands, sagebrush, and other shrublands and agricultural areas (BLM 2003a). Burrowing owls feed on insects, rodents, lizards, and small birds. This species is a confirmed breeder throughout the state (Luce et al 1999). Due to decreases in nesting habitat caused by reductions in prairie dog populations, burrowing owls are listed as a Species of Special Concern for the state of Wyoming. Burrowing owls have not been observed within the WRPA. However, nesting and foraging habitats do exist.

Ferruginous Hawk

The ferruginous hawk is a rare and locally distributed occupant of grasslands, sagebrush, and desert shrub habitats in the Great Plains and Great Basin regions. In Wyoming, this species is a common breeding resident occupying basin-prairie shrublands, short-grass prairie, rock outcrops, and cottonwood-riparian habitats (Luce et al. 1999). Unlike most other hawks, this species often nests on the ground. Nest sites include cliff faces, rock outcrops, and grassy knolls (Sibley 2003). The Ferruginous hawk preys almost exclusively on small- to medium-sized mammals including jackrabbits, cottontails, prairie dogs, and ground squirrels. The ferruginous hawk is a Species of Special Concern in Wyoming. It is known to nest in suitable habitats throughout the state and has been observed within the WRPA.

Great Gray Owl

The great gray owl occurs from central Alaska to northern Ontario; and in California, Idaho, Montana, Wyoming, and northern Minnesota. This species is found in coniferous and hardwood forests, especially pine, spruce, paper birch, and poplar; and also in second growth, especially near water. Great gray owls nest in broken-top snags or use abandoned stick nests of other raptor species. Foraging usually occurs in open areas where scattered trees or forest margin provide suitable sites for visual searching. Prey consists mainly of pocket gophers, voles, and other small mammals (Franklin 1988). In Wyoming, great gray owls are a Species of Special Concern. Observations have been recorded both within the WRPA and further west. However, nesting has only been observed in the Yellowstone area (Luce et al. 1999).

Merlin

The merlin is often found nesting in boreal forests below treeline from coast to coast and along the western mountains south to Oregon, Idaho, and Montana. The species winters in southern latitudes from the southern United States to South America. Merlin are found mainly in deciduous and coniferous forests, frequently near water, where they utilize old corvid nests. Diet consists mainly of birds which they capture on the wing (Sibley 2003). In Wyoming, merlins are listed as a Species of Special Concern. This species is an uncommon resident that occurs in a diversity of habitats below 8,500 feet, including open grasslands and shrublands and coniferous forests (Luce et al. 1999). This species has been observed within the WRPA.

Osprey

The osprey occurs throughout the United States and southern Canada. This species nests in a variety of habitats throughout its range, all of which provide both foraging and nesting habitat. Nesting structures include tall dead trees, standing trees with dead, broken tops, power poles, and goose nest platforms (Barrett 1998). In Wyoming, the osprey is a common breeding resident nesting in suitable habitats throughout the state (Luce et al. 1999). The osprey has not been observed in the WRPA. However, given the available water resources

(Ocean Lake, Boysen Reservoir) in and around the WRPA, they are considered to be likely to occur.

Peregrine Falcon

The peregrine falcon occurs throughout the world, breeding on all continents, except Antarctica. The species is found in various open habitats from tundra, moorland, steppes, and seacoasts (especially where there are suitable nesting cliffs), to mountains, open forested regions, and populated areas. Peregrines feed primarily on birds, but will prey on small mammals, lizards, fish, and insects. Nests are commonly found on cliff ledges or on buildings (Sibley 2003). In Wyoming, the peregrine falcon is a Species of Special Concern. Peregrines are more common to the mountainous regions of western Wyoming, particularly areas with tall cliffs (Luce et al. 1999). This species has been observed in the WRPA.

Rough-legged Hawk

The rough-legged hawk occurs in the northern latitudes of Canada during the summer and in the United States from California to Maine in the winter. Winter prey includes rodents and upland birds. In Wyoming, this species occurs in the short-grass and mixed-grass prairies and sagebrush and other shrublands. This species is considered a common winter resident in Wyoming (Luce et al. 1999). No population estimates of this species have been made because most raptor surveys occur during the breeding season, when rough-legged hawks are not present in Wyoming. Rough-legged hawks have been identified in the WRPA during winter months. However, numbers throughout the state are highly variable, based on weather conditions and the availability of prey (Ehrlich et al. 1988).

Figure 3.8-6. Raptor Nest Locations within the WRPA.

3.8.2.3 Game Birds

About 34 species of upland game birds may occur within the WRPA, as listed in Table 3.8-1. Each of these species is discussed below. Table H-1 in Appendix I provides a listing of the game birds observed within the WRPA and vicinity, their management status, and occurrence within the WRPA. The greater sage-grouse, an upland game bird, is discussed in Section 3.9, since it is a federal and state species of concern.

Table 3.8-1. Game Birds within the WRPA

Common Name	Scientific Name
Wetland Species	
American coot	*Fulica americana*
American wigeon	*Anas americana*
Barrow's goldeneye	*Bucephala islandica*
Blue-winged teal	*Anas discors*
Bufflehead	*Bucephala albeola*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cinnamon teal	*Anas cyanoptera*
Common merganser	*Mergus merganser*
Common goldeneye	*Bucephala clangula*
Common snipe	*Gallinago gallinago*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Harlequin duck	*Histrionicus histrionicus*
Hooded merganser	*Lophodytes cucullatus*
Lesser scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Northern shoveler	*Anas clypeata*
Red-breasted merganser	*Mergus serrator*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Ruddy duck	*Oxyura jamaicensis*
Sandhill crane	*Grus canadensis*
Snow goose	*Chen caerulescens*
Sora	*Porzana carolina*
Trumpeter swan	*Cygnus buccinator*
Tundra swan	*Cygnus columbianus*
Virginia rail	*Rallus limicola*
Wood duck	*Aix sponsa*
Upland Species	
Chukar	*Alectoris chukar*
Gray partridge	*Perdix perdix*
Greater sage grouse	*Centrocerus urophasianus*
Mourning dove	*Zenaida macroura*
Ring-necked pheasant	*Phasianus colchicus*

Source: WGFD 1999.

Wetland Game Birds

Wetland game birds include the many ducks, geese, swans, and other birds that are associated with streams and lakes, and riparian habitats.

American Coot

In the summer, American coots are found on freshwater lakes and ponds in the northern United States and southern Canada. During the winter, migration takes this species to southern portions of the United States from California to Florida, and as far south as South America. In Wyoming, the American coot is a common summer resident to ponds, lakes, and marshes across the state (Luces et al. 1999). The species commonly feeds on grasses and aquatic vegetation, and often forms tight flocks on water and land (Sibley 2003). The American coot has been observed within the WRPA.

American Wigeon

The American wigeon has large winter and breeding ranges that extend from the tips of Alaska and Canada south through Mexico to the northern parts of South America. Winter distribution is concentrated in the lower 48 states and Mexico, excluding high elevation areas of the Rocky and Appalachian Mountains. Breeding takes place mostly in western Canada, but occurs throughout northwestern North America (Mowbray 1999). American wigeons are common in fresh water and sheltered salt water. This species often forages in flocks by picking plants from water surfaces or by grazing in fields. In Wyoming, wigeon are common summer residents found in marshes and lakes below 8,000 feet (Luce et al. 1999). This species has been observed in the WRPA.

Barrow's Goldeneye

The Barrow's goldeneye ranges from Alaska, Canada, Greenland and Iceland south to the mountains of Wyoming and Oregon and the Gulf of St. Lawrence. Winter distribution also includes migrations as far south as California, New Mexico, the Great Lakes region, and Massachusetts. The Barrow's goldeneye builds nests of fine twigs and moss lined with down in decaying tree or stump hollows, or in rock crevices near water. They feed in rivers and bays searching for fish, frogs, shellfish, and tender plant roots and seeds (Sibley 2003). In Wyoming, Barrow's goldeneye is more common to the western portions of the state and occur mostly in aspen, cottonwood-riparian, marshes, lakes, and rivers associated with lodgepole pine (Luce et al. 1999). This species has been identified within the WRPA.

Blue-winged Teal

Blue-winged teal range from southern Canada to southern California, New Mexico, central Texas, Louisiana, and North Carolina. Wintering populations occur in the southern United States to northern South America. This species can be found on marshes, ponds, sloughs, lakes, and sluggish streams. Blue-winged teal nest on dry land near water, and feed primarily on aquatic plants and seeds (Sibley 2003). In Wyoming, this species is a common summer resident found mostly on marshes and lakes below 8,000 feet (Luce et al. 1999). Blue-winged teal have been observed within the WRPA.

Bufflehead

In the summer, the bufflehead occurs from central Alaska and parts of western Canada to northern Washington and northern Montana. Winter populations range from Alaska, the Great Lakes, and the Maritime Provinces south to Mexico and the Gulf Coast states. Bufflehead are found on lakes, ponds, rivers, and seacoasts where they feed on aquatic insects, snails, amphipods, small fishes, and some aquatic plants. This species nests in trees near water, either in natural cavities or in cavities made by flickers or woodpeckers (Sibley 2003). In Wyoming, bufflehead are often observed during migration particularly in aspen, riparian habitats, marshes, lakes, and rivers associated with lodgepole pine (Luce et al. 2003). The bufflehead has been observed within the WRPA.

Canada Goose

Canada geese are found in a variety of habitats near water, from temperate regions in the lower 48 states, to tundra in Canada and Alaska where they feed on marsh grasses, sprouts of winter wheat in the spring, and grains in the fall. This species is highly social, nesting on the ground near water sources (Krohn and Bizeau 1980). In Wyoming, Canada geese are common year-round residents in marshes, lakes, and rivers in association with other habitats, especially wet-moist meadows, sedge meadows, and agricultural areas (Luce et al. 1999). This species has been observed within the WRPA.

Canvasback

In the summer, the canvasback ranges from central Alaska and northwestern Canada to northern California, Nevada, Utah, Colorado, Wyoming, and parts of the midwest United States. Winter populations can be found along the Pacific Coast from Alaska to Baja California, to parts of the Midwest near the Great Lakes. They also winter along the east coast from New England to Florida, and west along the Gulf Coast as far south as Mexico. This species is found on marshes, ponds, lakes, rivers, and bays where it feeds on aquatic plants such as pondweeds, wild celery, water lilies, seeds of grasses, wild rice, sedges, arrowhead, and bulrushes (Sibley 2003). In Wyoming, canvasback are common summer residents found on marshes, lakes, and rivers (Luce et al. 1999). This species has been observed within the WRPA.

Cinnamon Teal

In the summer, cinnamon teal occur from southwestern Canada, eastern Montana, and parts of the Great Plains and Midwestern states to northern Mexico. Winter populations occur in the southwestern United States, Mexico, and rarely in parts of South America. This species is found on shallow lake margins, reed beds, ponds, lagoons, sluggish streams, and marshes, and occasionally in marine areas in winter. Cinnamon teal nest in depressions on the ground, usually in or near marsh habitats (Sibley 2003). Their diet consists mainly of aquatic plants in shallow water areas, especially on rush and pondweed seeds and leaves, but also on grass seeds. In Wyoming, cinnamon teal are common summer residents found primarily on marshes and lakes below 8,000 feet (Luce et al. 1999). This species has been observed within the WRPA.

Common Merganser

In the summer, common mergansers range from Alaska and Canada to central California, Arizona, and Mexico, as well as in the northeastern United States and eastern Canada. Winter populations occur in Alaska and southern Canada, Mexico, and Florida. Mergansers are found mostly on lakes and rivers in summer, and primarily on open lakes, rivers and brackish lagoons in winter. This species usually nests in tree cavities, but will occasionally nest on the ground, around shrubs or under rocks (Sibley 2003). In Wyoming, common mergansers are year-round residents found primarily in cottonwood-riparian habitat, marshes, lakes, and rivers (Luce et al. 1999). This species has been observed in the WRPA.

Common Goldeneye

In the summer, common goldeneye range from Alaska and parts of Canada to northern Washington, central Montana, and the northern United States as far east as Maine. Winter populations occur from southeastern Alaska to southern California, from the Great Lakes to the Gulf Coast, and from Newfoundland to Florida. In summer, common goldeneye are found on ponds, lakes, rivers, and coastal bays. During winter they are less common on rivers and lakes, instead congregating on bays and estuaries. While inland, their diet consists mainly of aquatic insects, crustaceans, and aquatic plants. However, their diet switches to crustaceans, mollusks, small fishes, and some plant material in winter (Sibley 2003). In Wyoming, common goldeneye are frequent winter residents throughout the state, found mostly in aspen, cottonwood-riparian habitat, marshes, lakes, and rivers associated with lodgepole pine (Luce et al. 1999). This species has not been observed within the WRPA. However, winter occurrence is likely.

Common Snipe

The common snipe is found throughout North America, Eurasia, South America, and Africa. They spend winters in the more temperate climates of northern South America and central Africa. The common snipe consumes mostly worms. However, it also feeds on insects, crustaceans, and mollusks, as well as occasional seeds and berries. The common snipe can be found in open areas with low vegetation to provide cover. These areas include marshes, canals, stream banks, bogs, and wet meadows, and even Arctic tundra (Peterson 1961). In Wyoming, the snipe is a common summer resident found mainly in wet-moist meadows, sedges, marshes, irrigated native meadows, willow, and other mixed riparian shrubland (Luce et al. 1999). This species has been observed in the WRPA.

Gadwall

In the summer, gadwall occur in southern Alaska, Canada, north central and western United States and locally in parts of the East Coast states. Winter populations occur from southern Alaska to central California, in portions of the middle United States, as far south as central Florida and the Gulf Coast, and into Mexico. Gadwalls are found on lakes, ponds, rivers, and marshes, but may also be found on any open water during winter migration. Their diet includes leaves, stems, and tubers of aquatic plants, and occasionally algae and seeds of sedges and grasses (Sibley 2003). In Wyoming, gadwalls are common summer residents found primarily in marshes and on lakes below 8,000 feet (Luce et al. 1999). This species has been observed within the WRPA.

Green-winged Teal

In the summer, green-winged teal occur in north-central Alaska, Canada, New Mexico, the northern Great Plains states, western New York, and Maine. Winter populations occur throughout the United States and central Mexico. Green-winged teal are found on freshwater ponds, in marshes, and along shallow edges of lakes where they feed on aquatic plants, seeds of sedges, smartweeds, pondweeds, grasses, aquatic insects, mollusks, crustaceans, tadpoles, berries, grapes, and acorns (Sibley 2003). In Wyoming, this species is a common year-round resident occurring primarily in marshes and lakes below 8,000 feet (Luce et al. 1999). This species has been observed within the WRPA.

Harlequin Duck

In the summer, harlequin ducks occur from Alaska and Canada to eastern Oregon, east-central California, Idaho, and Wyoming. Winter populations occur from the Aleutian and Pribilof islands to central California, and from the Maritime Provinces to Maryland. This species is found in rough, coastal waters, especially along rocky shores. Harlequin ducks nest along clear rocky streams with turbulent currents where they feed on crustaceans, mollusks, insects, and a few small fishes. In Wyoming, isolated populations occur in the Yellowstone/Teton area, where they are found primarily in the mountains (Luce et al. 1999). This species has been observed within the WRPA. However, occurrence and habitat usage is probably rare.

Hooded Merganser

In the summer, the hooded merganser occurs in southeastern Alaska and southwestern Canada, Oregon, Idaho, and Montana. Winter populations occur along the Pacific, Atlantic, and Gulf coasts. Summer populations can be found on streams, lakes, rivers, and in swamps, while winter populations are found along the Gulf of Mexico. The hooded merganser feeds primarily on small fish, crayfish, and other crustaceans, but may also eat aquatic insects (Sibley 2003). In Wyoming, this species has been observed intermittently throughout the state, primarily in marshes, and on lakes and rivers, during migratory periods (Luce et al. 1999). This species has not been observed within the WRPA. However, their occurrence is likely during spring and fall migration.

Lesser Scaup

In the summer, lesser scaup occur from Alaska and parts of Canada to northern Idaho, Wyoming, North Dakota, Minnesota, Washington, California, Colorado, and parts of Midwest. Winter populations occur from southern Alaska to New England, and throughout the southern United States and as far south as northern Colombia, South America. This species is typically found along the coast in sheltered bays, estuaries, and marshes, or inland on lakes, ponds, and rivers. Lesser scaup area also found on saltwater especially during the winter when lakes and ponds are frozen. This species nests in marshy vegetation on or near lakes and ponds. In Wyoming, lesser scaup are common summer residents found primarily in marshes, lakes, and rivers (Luce et al. 1999). This species has been observed within the WRPA.

Mallard

In the summer, mallards occur from Alaska, the Mackenzie Delta, and Maine to southern California, Mexico, Oklahoma, and Virginia. Winter populations occur in southern Alaska, southern Canada, and southern United States and Mexico. Mallards are found primarily in shallow waters such as streams, ponds, lakes, marshes, and flooded fields. During winter, most mallards prefer fresh water and cultivated fields, and are less common in brackish waters. This species feeds primarily on seeds, rootlets, and tubers of aquatic plants, seeds of swamp and river bottom trees, acorns, cultivated grains, insects, mollusks, amphibians, small fishes, and fish eggs. In Wyoming, mallards are common year-round residents where they are primarily observed in marshes and lakes below 9,000 feet (Luce et al. 1999). Mallards have been observed within the WRPA.

Northern Pintail

In the summer, northern pintail occur from the Alaskan tundra and Canada to the western and central United States. Winter populations occur in the eastern and western coastal United States, the Great Lakes region, southeastern Alaska, southwestern British Columbia, and as far south as Colombia and Venezuela, South America. Northern pintail are found primarily on lakes, rivers, marshes, cultivated fields, and ponds in grasslands, barrens, dry tundra, and open boreal forests. During migration and in winter, this species is found in both freshwater and brackish water habitats. Northern pintail feed on a variety of plants and animals, including seeds and nuts of aquatic plants, mollusks, crabs, minnows, worms, fairy shrimp, aquatic insects, and waste grain (Sibley 2003). In Wyoming, this species is a common summer resident throughout the state, and is found primarily in marshes and on lakes below 8,000 feet (Luce et al. 1999). Northern pintail have been observed within the WRPA.

Northern Shoveler

In the summer, the northern shoveler occurs from Alaska to Manitoba, and California, New Mexico, and western Minnesota. Winter populations occur from southwestern British Columbia to Arizona, and in the Gulf Coast states, coastal Georgia and South Carolina, and northern South America. Northern shoveler are found primarily in shallow, often muddy, freshwater areas with surrounding cover, including ponds, marshes, sloughs, and creeks. During migration and in winter, this species occupies both freshwater and brackish water habitats, as well as cultivated fields. Northern shoveler are opportunistic foragers, eating seeds of sedges, sawgrass, pondweeds, smartweeds, algae, and duckweed, as well as mollusks, aquatic insects, and crustaceans (Sibley 2003). In Wyoming, this species is a common summer resident and is found throughout the state, primarily in marshes and on lakes below 8,000 feet elevation (Luce et al. 1999). The northern shoveler has been observed within the WRPA.

Red-breasted Merganser

In the summer, the red-breasted merganser occurs from Alaska and Canada to the Great Lakes region. Winter populations occur along the Pacific and Atlantic coastlines, the Gulf Coast, and locally in Colorado, Oklahoma, Arkansas, Tennessee, Louisiana, and Texas. The red-breasted merganser is primarily found in salt-water lagoons, bays, and sheltered coasts. This species nests on the ground in a variety of settings, where it feeds on small fish. In Wyoming, the red-breasted merganser has been observed throughout the state during migratory periods (Luce et al. 1999). The red-breasted merganser has been observed within the WRPA.

Redhead

Redheads occur locally in Alaska, parts of Canada and Minnesota, parts of the Southwest and Midwest, and in portions of the eastern United States. Winter populations occur from southern British Columbia to Nevada, northern Arizona, and parts of the Midwest, and from New England to Mexico and Guatemala. Redheads are found in large marshes, lakes, lagoons, rivers, and bays. Winter populations are found mostly in brackish and marine lagoons and bays, and less frequently in inland freshwater. This species feeds on leaves and stems of aquatic plants, seeds of sedges and grasses, and some insects, mollusks, and small crustaceans (Sibley 2003). In Wyoming, this species is a common summer resident found in marshes, lakes, and rivers throughout the state (Luce et al. 1999). This species has been observed within the WRPA.

Ring-necked Duck

In the summer, ring-necked ducks occur from southeastern and east-central Alaska and central British Columbia to Saskatchewan and Newfoundland, and from northeastern California, southeastern Arizona, southern Colorado, and parts of the Midwest to New York. Winter populations occur from southeastern Alaska and Massachusetts to the southwestern United States, Mexico, and Panama. Ring-necked ducks are primarily found in marshes, lakes, rivers, and swamps, especially in wooded areas. During winter, populations switch to freshwater and brackish waters on larger lakes, rivers, and estuaries. This species feeds mostly on plant material, such as tubers, leaves, rootstocks, and seeds of aquatic plants (Sibley 2003). Breeding populations of ring-necked ducks have been observed in parts of western Wyoming. However, most observations across the state have typically occurred during migratory periods (Luce et al. 1999). This species has been observed within the WRPA.

Ruddy Duck

The ruddy duck occurs in Alaska and parts of Canada, southern California, central Arizona, southern New Mexico, western and southern Texas, and southwestern Louisiana. Winter populations occur in southern British Columbia, Idaho, Colorado, Kansas, the Great Lakes region, and the Atlantic Coast throughout the southern United States, most of Mexico, and South America. Ruddy ducks are found primarily in marshes, lakes, and coastal areas. Diet varies with age, season, and site. This species feeds primarily on pondweeds, algae, wild celery, seeds of sedges, smartweeds, grasses, insects and their larvae, and shellfish and crustaceans (Sibley 2003). In Wyoming, the ruddy duck is a common summer resident and is found throughout the state in marshes lakes and rivers (Luce et al. 1999). This species has been observed within the WRPA.

Snow Goose

Snow geese breed on the northern coast of Alaska, the Canadian tundra, and Greenland. Winter populations mainly occur along the Gulf Coast, Texas, and Mexico. This species often forms large flocks that nest on low grassy tundra. Snow geese are primarily herbivorous, eating the roots, shoots, and bulbs of grasses, sedges, and aquatic vegetation. This species will also eat insects and some aquatic invertebrates. In the fall, berries, aquatic plants, and grain crops provide a large proportion of this species total food intake. In Wyoming, snow geese have been observed intermittently throughout the state during migratory periods (Luce et al. 1999). Snow geese have been observed within the WRPA.

Sandhill Crane

The sandhill crane spends summers in northern Alaska and the middle arctic Canada, northeastern California, Nevada, Wyoming, Colorado, South Dakota, Minnesota, and the southeastern United States. Winter populations occur from the southern United States to central Mexico. Sandhill crane are found in open grasslands, marshes, marshy edges of lakes and ponds, riverbanks, and, occasionally, pine savannas. Their diet consists mainly of roots, tubers, seeds, grain, berries, earthworms, insects, and small vertebrates (Mullins and Bizeau 1978). In Wyoming, the sandhill crane is found in wet-moist meadow grasslands, sedge meadows, irrigated meadows, and marshes. This species breeds throughout the western portions of the state, but has also been observed in the eastern part of Wyoming (Luce et al. 1999). This species was observed by biologists during a wildlife survey conduced in the WRPA on July 11, 2003 (Buys & Associates 2003b).

Sora

In the summer, the sora occurs in southeastern Alaska, Newfoundland, northwestern Baja California, southern New Mexico, eastern Colorado, southern Missouri, central Ohio, and Maryland. Winter populations of this species occur from central California to southern Texas and the Gulf Coast, and throughout Central America and portions of South America. Sora are found primarily in freshwater marshes near sedges and cattails where mud and water are deep. They also can be found in swamps and slough borders. This species feeds on mollusks, insects, seeds of marsh plants, and duckweed (Sibley 2003). In Wyoming, sora are common summer residents found throughout the state primarily in marshes, willow, riparian shrub, and irrigated native meadows (Luce et al. 1999). The sora has been observed within the WRPA.

Trumpeter Swan

Trumpeter swans occur in Alaska, the western Canadian provinces, southeastern Oregon, eastern Idaho, Montana, and northwestern Wyoming. This species was introduced and has become established in Nevada and southwestern South Dakota. Winter populations of this species occur primarily from southern Alaska to Montana, and in northern California, Utah, New Mexico, and eastern Colorado. Trumpeter swans breed primarily in freshwater in emergent vegetation such as reeds or sedges, but occasionally will utilize brackish waters. Winter populations are found on open ponds, lakes, and sheltered bays and estuaries. Diet consists mainly of aquatic vegetation, but some swans may also graze in fields (Gale et al. 1987). In Wyoming, trumpeter swans are listed as a Species of Special Concern. Breeding populations have been observed in the Yellowstone/Teton area, and in the northeastern part of the state. However, other observations throughout the state are rare (Luce et al. 1999). This species has been observed within the WRPA.

Tundra Swan

In the summer, tundra swans occur in the arctic regions of northern Alaska and Canada. Winter populations are found along the west coast of the United States, Texas, and New Mexico, and along the eastern seaboard. This species is found primarily in fresh water habitats, such as lakes, ponds, and streams, but often frequents saltwater bays and estuaries, as well. The tundra swan feeds on the seeds and roots of aquatic vegetation, and their main animal food is shellfish. In Wyoming, tundra swans are listed as a Species of Special Concern. This species is an annual migratory species that has been observed throughout the state on rivers and lakes (Luce et al. 1999). This species has been observed within the WRPA.

Wood Duck

In the summer, wood ducks occur from southern British Columbia and Alberta to central California and northern Idaho, and throughout most of eastern United States and adjacent southern Canada. Winter populations occur mostly along the Pacific Coast and interior of California, Kansas, southern Iowa, the Ohio Valley, and New England. Wood ducks are found near woodlands on quiet, inland waters, such as wooded swamps, flooded forests, ponds, marshes, and along streams. This species feeds primarily on seeds and other parts of aquatic plants, nuts, fruits, shrubs, and aquatic and land insects (Sibley, 2003). In Wyoming, breeding populations of wood ducks have been observed in the northern and eastern portions of the state, primarily in cottonwood-riparian habitat, marshes, lakes, and rivers (Luce et al. 1999). This species has been observed within the WRPA.

Virginia Rail

In the summer, Virginia rail occur from southern British Columbia to Newfoundland, and in northwestern Baja California, southern Arizona, west-central Texas, Missouri, Ohio, North Carolina, central Mexico, and South America. Winter populations occur from southern British Columbia to northern Baja California, and in the Gulf Coast states and North Carolina. Most commonly, Virginia rail are found in freshwater marshes, mostly in cattails, reeds, and submerged grasses. This species feeds primarily on insects and other invertebrates, seeds of aquatic plants, and duckweed. In Wyoming, the Virginia rail is a summer resident found intermittently across the state, most often in marshes (Luce et al. 1999). This species has not been observed within the WRPA, although suitable habitat does exist and occurrence is likely.

<u>Upland Game Birds</u>

The upland game bird species consist of several familiar game birds such as chukar, partridge, mourning dove, and pheasant.

Chukar

Native to Eurasia, chukar were introduced into North America and are now resident in parts of British Columbia, Idaho, Wyoming, Montana, California, Nevada, Arizona, and Colorado. This species is found on rocky hillsides, mountain slopes with grassy vegetation, open and flat deserts with sparse grasses, and barren plateaus. Chukar build concealed nests on the ground, under rocks, or in bushes. Their diet consists mainly of seeds, leaves, fruits, and insects. In Wyoming, chukar are found intermittently across the state, primarily in mountain-foothills areas and shrublands (Luce et al. 1999). This species has been observed in the WRPA.

Gray Partridge

Native to western Eurasia, the gray partridge was introduced to North America. They have become established locally in southern Canada and the northern United States. Partridges are found primarily in cultivated fields with marginal cover of bushes, undergrowth, or hedgerows. This species feeds primarily on seeds of wheat, corn, barley, oats, smartweeds, and crabgrass, and also eats leaves of clover, alfalfa, bluegrass, and dandelion (Sibley 2003). In Wyoming, gray partridges are year-round residents in the northern half of the state. They are found primarily in basin-prairie shrublands, riparian shrub, grasslands, and agricultural areas (Luce et al. 1999). This species has been observed within the WRPA.

Mourning Dove

Mourning doves range from southern Canada and southeastern Alaska to Panama. The species winters within its breeding range, except for the northernmost populations, which migrate farther south to winter. Mourning doves are found in open woodlands, forest edges, cultivated lands with scattered trees and bushes, parks and suburban areas, and desert country. This species feeds primarily on a variety of wild seeds, as well as waste grain (Reeves et al. 1993). In Wyoming, mourning doves are common summer residents found throughout the state in all habitats below 8,500 feet elevation (Luce et al. 1999). Mourning doves have been observed within the WRPA.

Ring-necked Pheasant

Native to Asia, the ring-necked pheasant was introduced to North America. It occurs in southern Canada, California, Utah, southern New Mexico, southeastern Texas, northwestern Oklahoma, southern Illinois, Pennsylvania, New Jersey, and Maryland. This species is found in open country, especially cultivated areas, scrubby wastes, open woodlands, and the edges of woodlands, but also in shrub steppe, riverside thickets, swamps, and open mountain forests. Ring-necked pheasants nest in depressions in grass or weeds, and feed primarily on waste corn, wheat barley, oats, buckwheat, berries, and seeds of ragweed, burdocks, and pine (Leptich 1992). In Wyoming, this pheasant occurs throughout much of the north-central and eastern portions of the state. Pheasants are associated primarily with agricultural areas, cottonwood-riparian, riparian shrub, and sedge meadows (Luce et al. 1999). This species has been observed within the WRPA.

3.8.2.4 Neotropical Migratory Bird Species

Neotropical migratory bird species migrate long distances from wintering grounds in the New World tropics of Central and South America to breeding grounds in North America. A wide variety of neotropical migrants utilize the various habitats in the WRPA, particularly the more productive and diverse habitats, such as the shrub-dominated riparian areas. Sagebrush shrub-steppe, desert shrub, and mixed grass prairie habitats are present throughout the WRPA and are of critical importance to some neotropical migrants (Rothwell 1992). Several of these species are of high concern because of declining populations and loss of breeding habitats (Saab and Rich 1997).

In response to concerns about neotropical migrants, the Wyoming Bird Conservation Plan (Cerovski et al. 2001) has identified two groups of high-priority species in Wyoming. Table 3.8-2 lists the migratory bird species of management concern in Wyoming (Cerovski et al. 2001), and those that are known or expected to occur in the WRPA (Luce et al. 1999). Other species are discussed elsewhere in this document.

Four levels of conservation classifications are used here to identify the need for managing the conservation of these species:

- Level I species are those that are given priority conservation action.
- Level II species require monitoring, rather than active conservation.
- Level III species are species of local interest.
- Level IV species are not considered a priority species.

Three Level I species and nineteen Level II species have been observed, or are likely to occur, within the WRPA, and are therefore listed in Table 3.8-2.

Table 3.8-2. Migratory Bird Species of Management Concern in Wyoming.

Species	Habitats	Comments	Observed In WRPA
Level I			
Brewers Sparrow (*Spizella breweri*)	Basin-prairie and mountain-foothills, shrublands, especially sagebrush, woodland-chaparral.	Nests in a shrub. Feeds on insects, seeds.	Yes
Sage Sparrow (*Amphispiza belli*)	Basin-prairie and mountain-foothills shrublands.	Nests usually in or under sagebrush. Feeds on insects, seeds.	Yes
Table 3.8-2 (ContinuLong-billed Curlew (*Numenius americanus*)	Sagebrush-grasslands, eastern great plains, great basin-foothills, mountain foothills, and wet-moist meadow grasslands, irrigated native meadows, with aquatic areas nearby.	Nests on the ground near water, sometimes in a moist hollow. Feeds on insects, aquatic invertebrates. Locally common.	Yes
Level II			
Dickcissel (*Spiza americana*)	Shortgrass prairie, eastern great plains grasslands.	Nest is bulky, placed in grass. Feeds on insects, seeds.	Yes
Lark Bunting (*Calamospiza melanocorys*)	Shortgrass prairie, shrub-steppe, basin-prairie and mountain-foothills shrublands, eastern great plains and great basin-foothills, grasslands, agricultural fields.	Nests on the ground, with rim of the nest usually flush with the ground. Feeds on insects, especially grasshoppers, and seeds.	Yes
Lark Sparrow (*Chondestes grammacus*)	Shrub-steppe, pine-juniper, woodland-chaparral, basin-prairie and mountain-foothills shrublands, grasslands, agricultural areas.	Nests in a hollow depression on the ground, feeds on seeds, and insects.	Yes
Loggerhead Shrike (*Lanius ludovisianus*)	Pine-juniper, woodland-chaparral, basin-prairie and mountain-foothills shrublands.	Nest is usually hidden below the crown in the crotch or low branch of a deciduous tree or shrub. Feeds on insects, small vertebrates, carrion.	Yes
Marsh Wren (*Cistothorus palustris*)	Wetlands, marshes, drier habitats during migration.	Nest is attached to reeds. Feeds on insects, snails. Abundant in some areas.	Yes
Sage Thrasher (*Oreoscoptes montanus*)	Basin-prairie and mountain-foothills shrublands.	Nest is concealed in or beneath sagebrush. Feeds on insects, and some fruit.	Yes
Vesper Sparrow (*Pooecetes gramineus*)	Shrub-steppe, basin-prairie and mountain-foothills shrublands, grasslands, agricultural areas.	Nests in an excavated depression on the ground. Food is 50% insects, 50% grass and forb seeds.	Yes

Species	Habitats	Comments	Observed In WRPA
White-throated Swift (*Zonotrichia albicollis*)	Aerially feeds over most habitats with cliffs below 9,000 ft.	Nests deep in a crack or crevice of a rock wall. Feeds on flying insects.	Yes
Broad-tailed Hummingbird (*Selasphorus platycercus*)	Riparian shrub, mountain-foothills grasslands, coniferous forests, wet-moist meadows with Douglas fir, Englemann spruce-subalpine fir.	Nests usually on a horizontal limb of a deciduous or coniferous tree, near or over a mountain stream. Feeds on nectar, and insects.	No
Brown Creeper (*Certhia americana*)	Coniferous forests. Lower habitats during the winter.	Nest is a hammock-like cup, usually beneath loose bark, rarely in a cavity. Feeds primarily on insects, some nuts, seeds.	No
Cordilleran Flycatcher (*Empidonax occidentalis*)	Moist areas of coniferous forests, aspen-riparian, aspen-conifer.	Nests in a variety of areas from streambank to cave, cliff ledge, or cavity in a small tree. Feeds almost entirely on insects; also some berries, seeds.	No
Dusky Flycatcher (*Empidonx oberholseri*)	Ponderosa pine savannah, pine juniper, aspen, cottonwood-riparian, woodland-chaparral, riparian shrub.	Nests in the crotch of a juniper or sage, or near the base of a thorny shrub in dry, open forests.	No
Grasshopper Sparrow (*Ammodramus savannarum*)	Shortgrass prairie, shrub-steppe, basin-prairie shrublands, eastern great plains grasslands, wet-moist meadow grasslands, agricultural areas.	Nest is sunk in a slight depression on the ground. Feeds on insects, and seeds.	No
Gray Flycatcher (*Empidonax wrightii*)	Pine-juniper, woodland-chaparral, basin-prairie and mountain-foothills shrublands.	Nests in the crotch of a juniper or sage, or near the base of a thorny shrub. Feeds exclusively on insects.	No
MacGillivray’s Warbler (*Oporomis tolmiei*)	Aspen, cottonwood riparian, riparian shrub, below 9,000 ft.	Nests close to the ground in dense shrubs. Feeds mostly on insects.	No
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	Aspen and cottonwood-riparian from 7,000 to 9,000 ft. Also coniferous forests. Lower habitats during migration.	Nests in a cavity in a deciduous tree, often near water. Feeds on insects, tree sap.	No
Townsend’s Solitaire (*Myadestes townsendi*)	Coniferous forest, aspen.	Nests often amid tree roots or other shelter on the ground. Feeds on insects, fruit, and worms.	No

Species	Habitats	Comments	Observed In WRPA
Willow Flycatcher (*Empidonax trailii*)	Montane riparian, plains/basin riparian, riparian shrub including willow, hawthorn, water birch, alder, below 9,000 ft.	Nests in an upright or slanting fork in a shrub. Feeds primarily on insects, occasionally berries.	No
Wilson's Warbler (*Wilsonia pusilla*)	Riparian shrub from 7,000 to 10,500 ft.	Nest is usually placed on the ground, often in a vine tangle. Feeds on insects, occasionally berries.	No

Source: Cerovski et al 2001.

3.8.2.5 Reptiles

There are several reptile species that are common residents of Wyoming and Fremont County that may occur within the WRPA, including the bullsnake (*Pituophis melanoeucas sayi*), eastern short-horned lizard (*Phyrnosoma douglassii brevirostre*), great basin gopher snake (*Pituophis melanoleucas deserticola*), northern sagebrush lizard (*Sceloporus graciosus graciosus*), plains hognose snake (*Heterodon nasicus nasicus*), prairie rattlesnake (*Crotalus viridis viridis*), and the wandering garter snake (*Thamnophis elegans vagrans*). The Great basin gopher snakes are habitat generalists, found in all habitats below 9,000 feet, except very rocky areas.

3.8.3 Aquatic Wildlife

3.8.3.1 Amphibians

Only three species of amphibians may occur within the WRPA, including the northern leopard frog (*Rana pipiens*), plains spadefoot (*Scaphiopus bombiforms*), and Woodhouses toad (*Bufo woodhousei*). These species are common throughout Wyoming and Fremont County. However, none have been reported within the WRPA. Habitat for these species occurs within Upper Depression and Middle Depression reservoirs, Muddy and Fivemile Creeks, and several drainage canals in the WRPA.

3.8.3.2 Fish

The Wyoming Game and Fish Department (WGFD) lists forty-nine game and non-game fish species that occur in the State of Wyoming (Table 3.8-3). Ten of these fish species were collected during a Fisheries and Wildlife Survey carried out during August and September 2003 by R. Baldes, Environmental Legacy LLC (Appendix J).

Qualitative fisheries surveys were conducted at the following sites, as shown on Table 3.8-4.

- Five sites on Fivemile Creek (G50, G50a, G50b, and at upstream reference sites 3 and 4);
- Five sites on Muddy Creek (G52, G52a, G52b and upstream reference sites 1 and 2);
- One site on the lower portion of Cottonwood Creek (CCR). Other potential sampling locations along Cottonwood Creek were found to be dry.

Fish communities in various habitat types, such as pools, riffles, and runs were sampled using a seine (4 foot x 20 foot) and/or fish trap (7 inch x 17 inch). All fish captured were identified to species in the development areas and separated into 20 mm total length groups (see Appendix J for details). Fish were also sampled at four reference sites, upstream of the WRPA. Two reference site were in Muddy Creek and two reference sites were in Fivemile Creek.

Table 3.8-4 lists the species and numbers of fish collected at each sampling site within the WRPA. Overall, Muddy Creek had the most diverse fish fauna with eight species, followed by Cottonwood Creek and Fivemile Creek, which contained six species each. Three of the five sites on Muddy Creek contained four fish species. Of the sites sampled, only reference site 2 on Muddy Creek failed to contain any fish. Longnose dace (*Rhinichthys cataractae*) was the most common species collected. It occurred at eight of the 10 stations sampled.

Game fish were not collected during this survey. However, game species have been previously recorded in Fivemile Creek, and their absence in this survey can be attributed to high water volumes in the creek that prevented data collection at two of the lower survey stations.

Table 3.8-3. List of Game and Non-game Fishes Occurring In Wyoming.

COMMON NAME	SCIENTIFIC NAME	GAME/NON-GAME
Arctic grayling	*Thymallus arcticus*	Game
Bigmouth shiner	*Notropis dorsalis*	Non-game
Black bullhead	*Ameiurus melas*	Game
Bluehead sucker	*Catostomus discobolus*	Non-game
Brassy minnow	*Hybognathus hankinsoni*	Non-game
Burbot	*Lota lota*	Game
Central stoneroller	*Campostoma anomalum*	Non-game
Channel catfish	*Ictalurus punctatus*	Game
Common shiner	*Luxilus cornutus*	Non-game
Creek chub	*Semotilus atromaculatus*	Non-game
Cutthroat trout	*Oncorhynchus clarki*	Game
Fathead minnow	*Pimephales promelas*	Non-game
Finescale dace	*Phoxinus neogaeus*	Non-game
Flannelmouth sucker	*Catostomus latipinnis*	Non-game
Flathead chub	*Platygobio gracilis*	Non-game
Goldeye	*Hiodon alosoides*	Non-game
Hornyhead chub	*Nocomis biguttatus*	Non-game
Iowa darter	*Etheostoma exile*	Non-game
Johnny darter	*Etheostoma nigrum*	Non-game
Lake chub	*Couesius plumbeus*	Non-game
Leatherside chub	*Gila copei*	Non-game
Longnose dace	*Rhinichthys cataractae*	Non-game
Longnose sucker	*Catostomus catostomus*	Non-game
Mottled sculpin	*Cottus bairdi*	Non-game
Mountain sucker	*Catostomus platyrhynchus*	Non-game
Mountain whitefish	*Prosopium williamsoni*	Game
Orangethroat darter	*Etheostoma spectabile*	Non-game
Paiute sculpin	*Cottus beldingi*	Non-game
Pearl dace	*Margariscus margarita*	Non-game
Plains killfish	*Fundulus zebrinus*	Non-game
Plains minnow	*Hybognathus placitus*	Non-game
Plains topminnow	*Fundulus sciadicus*	Non-game
Quillback	*Carpiodes cyprinus*	Non-game
Red shiner	*Cyprinella lutrensis*	Non-game

Table 3.8-3 (Continued)

Redside shiner	*Richardsonius balteatus*	Non-game
River carpsucker	*Carpiodes carpio*	Non-game
Roundtail chub	*Gila robusta*	Non-game
Sand shiner	*Notropis stramieus*	Non-game
Sauger	*Stizostedion canadense*	Game
Shorthead redhorse	*Moxostoma macrolepidotum*	Non-game
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	Game
Speckled dace	*Rhinichthys osculus*	Non-game
Stonecat	*Noturus flavus*	Game
Sturgeon chub	*Macrhybopsis gelida*	Non-game
Suckermouth minnow	*Phenacobius mirabilis*	Non-game
Utah chub	*Gila atraria*	Non-game
Utah sucker	*Catostomus ardens*	Non-game
Western silvery minnow	*Hybognathus argyritis*	Non-game
White sucker	*Catostomus commersoni*	Non-game

Table 3.8-4. Number of Individual Fish Species Identified within the WRPA[1].

Sampling Location	Species (Common Name)	Species (Scientific Name)	Number of Individuals
Cottonwood Creek	Creek chub	*Semotilus atromaculatus*	25
	Flathead chub	*Platygobio gracilis*	20
	Johnny darter	*Etheostoma nigrum*	1
	Lake chub	*Couesious plumbeus*	3
	Longnose dace	*Rhinichthys cataractae*	2
	White sucker	*Semotilus atromaculatus*	4
Muddy Creek - Reference Site 2 (upstream)	No fish collected		
Muddy Creek - Reference Site 1 (upstream)	Lake chub	*Couesious plumbeus*	70
	Longnose dace	*Rhinichthys cataractae*	24
	Fathead minnow	*Pimephales promelas*	4
Upper Muddy Creek (G52)	Lake chub	*Couesious plumbeus*	1
	Longnose dace	*Rhinichthys cataractae*	1
	Plains killifish	*Fundulus zebrinus*	28
Middle Muddy Creek (G52b)	Fathead chub	*Platygobio gracilis*	7
	Longnose dace	*Rhinichthys cataractae*	3
	Mountain sucker	*Catostomus platyrhynchus*	1
	White sucker	*Semotilus atromaculatus*	1
Lower Muddy Creek (G52a)	Flathead chub	*Platygobio gracilis*	7
	Longnose dace	*Rhinichthys cataractae*	6
	White sucker	*Semotilus atromaculatus*	2
	Common carp	*Cyprinus carpio*	1
Fivemile Creek - Reference Site 4 (upstream)	Lake chub	*Couesious plumbeus*	32
	Longnose dace	*Rhinichthys cataractae*	1
	White sucker	*Semotilus atromaculatus*	1
Fivemile Creek - Reference Site 3 (upstream)	Lake chub	*Couesious plumbeus*	15
	Fathead minnow	*Pimephales promelas*	1
	Longnose dace	*Rhinichthys cataractae*	6
	White sucker	*Semotilus atromaculatus*	7
Upper Fivemile Creek (G50)	Creek chub	*Semotilus atromaculatus*	4
	Lake chub	*Couesious plumbeus*	26
	Longnose dace	*Rhinichthys cataractae*	18
	Mountain sucker	*Catostomus platyrhynchus*	1
	White sucker	*Semotilus atromaculatus*	2
Middle Fivemile Creek (G50b)	No fish collected		
Lower Fivemile Creek (G50a)	No fish collected		

Source: Baldes 2003.

Brown Trout

Brown trout *(Salmo trutta)* occur from southern Canada to the northeastern United States, and throughout the Appalachians and the Mississippi Valley. This species is also found throughout the western United States at higher elevations. Brown trout occur in a variety of habitats from small streams to large lakes. They require a year-round supply of cold, well-oxygenated water. Spawning in this species typically occurs on gravel bars from late October through November. Brown trout consume a variety of aquatic insects and other invertebrates, as well as fish, crayfish and a wide variety of land insects, such as ants, beetles, gnats, caterpillars, and inch worms. This species has been observed within the WRPA (WGFD 1982, 1967, 1979).

Common Carp

The common carp (*Cyprinus carpio*) were introduced into the United States in the early 1800's, from Europe. Currently they inhabit a wide variety of conditions but generally favor large water bodies with slow flowing or standing water and soft bottom sediments. Common carp thrive in large turbid rivers where they are omnivorous, feeding mainly on aquatic insects, crustaceans, annelids, molluscs, weed and tree seeds, wild rice, aquatic plants and algae; mainly by grubbing in sediments. Carp spawn in spring and summer, laying sticky eggs in shallow vegetation. The common carp has been observed in the WRPA (Muddy Creek) (Appendix J) (WGFD 1967; Baldes 2003).

Creek Chub

Creek chub (*Semotilus atromaculatus*) occur throughout most of the eastern and central United States and adjacent southern Canada. They prefer small to moderate size streams and rivers, as opposed to large rivers and lakes. They are tolerant of turbid (cloudy) water but favor clear to faintly cloudy waters over hard bottoms (gravel, sand, or rubble). Creek Chub are opportunistic feeders, eating a variety of prey including insect larvae, insects, and small fish. Creek chub typically spawn in gravel beds from early May into July when water temperatures are 13-18° C (55-65° F). This species has been observed in the WRPA (Cottonwood Creek, Fivemile Creek) (Appendix J) (Baldes 2003).

Cutthroat Trout

Originally one of the most numerous fish species in North America, cutthroat trout are now confined to the Snake River drainage in Idaho and Wyoming (Behnke 1992). In recent years this species has been successfully stocked in waters across much of the West. Prime habitat for cutthroat trout includes small gravel-bottom mountain streams with cold, clear water, or high-mountain lakes of similar water quality. This species feeds primarily on insects, including grasshoppers, crickets, moths, or aquatic insects such as mayflies and caddis flies. Cutthroats mature in about four years and spawn from March through July. A female produces between 200 and 4,500 eggs, which are laid in the spaces between gravel in flowing water. Cutthroat trout have been observed within the WRPA (WGFD 1975).

Fathead Minnow

The fathead minnow (*Pimephales promelas*) is found in cool to warm aquatic habitats throughout eastern and northern North America. They live in many kinds of lakes and streams, but are especially common in shallow, weedy lakes; bog ponds; low-gradient, turbid (cloudy) streams; and ditches. Fathead minnows are considered opportunist feeders. Their diet consists largely of algae, protozoa (like ameba), plant matter, insects (adults and larvae), rotifers, and copepods. Spawning season for the fathead minnow starts in late May to early June when water temperature exceeds 16° C (about 60° F), and continues into mid-August when the water temperatures begin to cool. The fathead minnow has been observed in the WRPA (Muddy Creek, Fivemile Creek) (Appendix J) (Baldes 2003).

Flathead Chub

The flathead chub is widely distributed in the United States. It ranges from New Mexico to the northern Yukon Territory in Canada. This species inhabits a diverse range of habitats. In the Missouri River, it is found in turbid waters where the current is swift and the bottom is composed of sand or fine gravel. In portions of its range it is also collected in pools with moderately clear water, little current, and bottoms composed of coarse gravel and bedrock. The diet of the flathead chub consists mostly of terrestrial insects supplemented by lesser quantities of other small invertebrates and plant material. This species has been observed within the WRPA (WGFD 1967, 1975, 1979, 1982, 1986; Baldes 2003).

Johnny Darter

In the United States, Johnny darter (*Etheostoma nigrum*) occur throughout the midwest, with smaller populations occurring as far west as Wyoming, south to Alabama and Mississippi, and east to the Carolinas and New York. They occur in sandy and muddy, sometimes rocky, pools of headwaters, creeks, and small to medium rivers, and in the sandy shores of lakes. Young Johnny darters eat mostly small copepods and waterfleas. As they grow, they add larger waterfleas, midge larvae, mayfly larvae, caddisfly larvae and sometimes sideswimmers to their diet. Spawning sites commonly occur in pools, slow runs, or shallow lake waters, where there are large rocks, tin cans, logs, mussel shells, or any other types of debris. This species has been observed in the WRPA (Cottonwood Creek) (Appendix J) (Baldes 2003).

Lake Chub

The lake chub is a northern, periglacial species and is broadly distributed across Canada and the northern United States from Nova Scotia and Labrador to British Columbia and central Alaska. In the continental United States this species can be found in northern New England, New York, Michigan, Wisconsin, Idaho, Wyoming, and Colorado. This species lives in streams, lakes, and ponds, moving into deeper water during the summer. The lake chub is an early spawner. Zooplankton, aquatic insects, algae, and small fishes are this species' chief food items. This species has been observed within the WRPA (WGFD 1982; Baldes 2003).

Longnose Dace

Longnose dace are generally distributed above 40°N latitude from coast to coast, occurring as far north as the Arctic Circle in the Mackenzie River drainage, and to the south in the Appalachian Mountains as far south as northern Georgia, and from the Rocky Mountains to the Rio Grande drainage of Texas and northern Mexico (Page and Burr 1991). In Wyoming, this species has been recorded from several sites in the Green River drainage of the upper Colorado River basin, including Hams Fork Creek (Baxter and Simon 1970). The longnose dace is primarily a schooling species primarily found in sheltered areas. Spawning typically occurs through June and early July, most commonly in gravel bottom runs and riffles. This species has been observed within the WRPA (WGFD 1982, 1979, 1986; Baldes 2003).

Longnose Sucker

Longnose sucker are found throughout most of Canada and Alaska, along the Delaware River drainage in New York, within the Great Lakes basin, along the upper Monongahela River drainage in Maryland and West Virginia, and within the Missouri River drainage in Nebraska and Colorado. This species is typically found in the clear, cold, deep water of lakes and tributary streams (Page and Burr 1991). Longnose suckers move from lakes and deep pools into shallow, gravel-bottomed streams to spawn. This species feeds primarily on benthic invertebrates. Longnose sucker have been observed within the WRPA (WGFD 1975).

McConaughy Rainbow Trout

The rainbow trout was originally found in lakes and streams from Alaska to northern Baja, Mexico, as well as the coastal streams of Asia. The first stocking of rainbows in the eastern states occurred in 1880, when the United States Fish Commission delivered rainbows that originated near McCloud River, California. The species now occurs throughout the United States and in many countries around the world (Behnke 1992). Prime habitat for rainbow trout includes swift-flowing rivers with clean rocky bottom with water temperatures remaining below 70°F. This species feeds primarily on insects, such as grasshoppers, mayflies, and caddisflies. However, they will also eat worms and fish, including other smaller trout. Rainbow trout spawn in March or April, primarily in shallow gravelly riffles. This species has been observed within the WRPA (WGFD 1975).

Mountain Sucker

This mountain sucker is found throughout western North America, ranging from South Dakota to the Pacific coastal states and British Columbia, Alberta, and Saskatchewan. This species can be found in cool rivers and streams with moderate currents and rocky substrates. These fish rarely occur in larger rivers and lakes. Mountain sucker feed primarily on diatoms and other types of algae. Spawning occurs in late spring or early summer, primarily in riffles near pools in fast flowing streams. This species has been observed within the WRPA (WGFD 1975, 1979, 1982, 1986; Baldes 2003).

Plains Killifish

In North America, plains killifish are found in the Mississippi River and Gulf Slope basins in the United States from northern central Montana to central Wyoming and south to the Colorado River, Brazos River, Galveston Bay and the Rio Grande drainages in Texas. This species inhabits shallow sandy runs, pools, backwaters, creeks and small to medium rivers. Killifish tolerate extremely alkaline and saline streams, and often found where few other fishes can survive. This species has been observed within the WRPA (Muddy Creek) (Appendix J) (Baldes 2003).

Sauger

Sauger are native to North America. They are found in a wide band across mid-central North America from Quebec to Alberta, then in a progressively slimmer band further south through the Mississippi River drainage system, from Arkansas to northern Alabama and Tennessee. Sauger are found primarily in large muddy lakes and rivers, although they are tolerant of fast moving rivers. This species spawns in late spring to early summer in the north and earlier in the south, primarily when the water is between 39°F and 43°F. Nests are built in shallow water on gravel shoals. Sauger are mostly bottom feeders, with the majority of their diet consisting of fish such as shad, sunfish, and minnows. This species has been observed within the WRPA (WGFD 1967).

White Sucker

The white sucker is a widely distributed species found in freshwater lakes and streams from Labrador to Georgia, and from Colorado to Alberta and British Columbia and the Mackenzie River delta. This species prefers deeper water in the late fall and winter months and shallow water in lakes and riffle areas in spring. White suckers spawn from April to early May, seeking areas with swift water and a gravel substrate to randomly spread their eggs. White suckers are bottom feeding fish, eating plants, mollusks, insects, diatoms, crustaceans, and protozoans. White suckers have been observed within the WRPA (WGFD 1975, 1967).

3.8.3.3 Macroinvertebrates

The WRIR has been stratified by altitude into four strata (Alpine/Subalpine, Montane, Foothills, and Basin). This classification applies only to high mountain environments, their foothills and the immediate basin drainages below these mountains. Data indicated that this stratification is much more robust than using the Omernik ecoregions approach (Omernik 1987, 1995 and USEPA 1996). It is based on ecological principles and includes previous classifications, such as Rosgen (1996) and Pennak (1996), zonation concepts such as Allan (1975), and the River Continuum Concept of Vannote et. al. (1980). Data also indicated that this classification is appropriate for many high mountain ranges that span and overlay portions of several ecoregions.

Macroinvertebrates in the basin region that include numerous species of arthropods, mollusks, annelids, nematodes, and platyhelmenthes. These species are typically associated with stream channel bottoms or other stable aquatic surfaces and debris. Benthic macroinvertebrates are useful biological monitors, because they are found in nearly all aquatic environments, are less mobile than many other groups of organisms, and are fairly easy to collect. They elicit responses to a wide array of potential chemical pollutants.

Increasing levels of chemical pollution gradually eliminate the more sensitive species, lowering species richness. Pollutant-tolerant species become more dominant in polluted aquatic systems.

In April and May 2002, a benthic macroinvertebrate study was conducted by WREQC at six sampling stations within the WRPA (WREQC 2003) (See Figure 3.5-1). Table 3.8-5 shows the total macroinvertebrates, by class collected at each aquatic sampling station. A detailed listing of species collected at each of the macroinvertebrates sampling stations is provided in Appendex I, Table J-4.

Table 3.8-5. Macroinvertebrate Groups at each Sampling Station within the WRPA[1]

Location	Date	Class	No. Individuals	Percent of Total
Upper Fivemile Creek (G50)	5/16/2002	Crustacea	17	2.1
		Gastropoda	1	0.1
		Insecta	387	46.7
		Oligochaeta	424	51.2
		Total	**829**	**100**
Middle Fivemile Creek (G50b)	4/16/2003	Chelicerata	11	1.1
		Crustacea	6	0.6
		Gastropoda	6	0.6
		Insecta	556	56.1
		Oligochaeta	413	41.6
		Total	**1692**	**100**
Lower Fivemile Creek (G50a)	4/25/2002	Chelicerata	48	2.6
		Crustacea	5	0.3
		Insecta	1422	76.2
		Oligochaeta	391	21.0
		Total	**1866**	**100**
Upper Muddy Creek (G52)	5/16/2002	Crustacea	91	7.1
		Gastropoda	9	0.7
		Insecta	618	47.9
		Oligochaeta	572	44.3
		Total	**1290**	**100**
Middle Muddy Creek (G52b)	4/16/2003	Nematoda	4	1.1
		Chelicerata	81	21.4
		Crustacea	13	3.4
		Oligochaeta	280	74.1
		Total	**378**	**100**
Lower Muddy Creek (G52a)	4/25/2002	Nematoda	2	0.6
		Chelicerata	8	2.2
		Insecta	340	93.7
		Oligochaeta	13	3.6
		Total	**363**	**100**

Source: Shoutis 2003.
[1]See Figure 3.5-1 for location of sampling sites.

3.9 THREATENED, ENDANGERED, AND STATE-SENSITIVE SPECIES

3.9.1 Introduction

In accordance with the requirements of the Endangered Species Act (ESA), the U.S. Fish and Wildlife Service (USFWS) has identified five federally listed endangered or threatened species that may occur within the WRPA and may be affected by the proposed gas development project (USFWS 2002d; USFWS 2003c). These species include the black footed ferret (*Mustela nigripes*), bald eagle (*Haliaeetus leucocephalus*), gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos horribillis*), and Canada lynx (*Lynx canadensis*) (Table 3.9-1). They are discussed in detail in Section 3.9.2.

The State of Wyoming has developed a matrix of four levels of species of special concern in the state. The status of the species is based on whether the populations are restricted or declining and extirpation appears possible, or whether significant loss of habitat has occurred. These species of special concern are discussed in Section 3.9.3.

Table 3.9-1. Threatened and Endangered Species that may be Present in WRPA (from USFWS 2002a).

COMMON NAME	LATIN NAME	STATUS	EXPECTED OCCURRENCE
Black-footed ferret	*Mustela nigripes*	Endangered	Prairie dog towns
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Found throughout the State
Grizzly bear	*Ursus arctos horribilis*	Threatened	Montane areas
Gray wolf	*Canis lupus*	Experimental	Greater Yellowstone ecosystem
Canada lynx	*Lynx canadensis*	Threatened	Montane forests
Mountain plover[1]	*Charadrius montanus*	Removed from “proposed” status	Grasslands

[1]Hnilicka, 2003c states that the mountain plover is still a species of concern, but noted the USFWS withdrew its proposal for Federal listing; USFWS withdrew the proposed rule to list the mountain plover; (USFWS 2003d).

3.9.2 Threatened or Endangered Species

The five listed species identified by the USFWS as potentially occurring within the WRPA, include four threatened species, the bald eagle, grizzly bear, gray wolf, and the Canada lynx, and one endangered species, the black-footed ferret (USFWS 2002) (Table 3.9-1). Each of these species is discussed below. Additional information on these species is provided in a Biological Assessment prepared for this EIS (See Appendix L).

3.9.2.1 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) was listed as endangered on the List of Endangered Species by the Office of Endangered Species on March 11, 1967 (32 FR 4001;

USFWS 1967). It was re-listed as endangered under the Endangered Species Act of 1973 on July 4, 1976. As a result of the recovery of the bald eagle in the lower 48 States, its status was changed from endangered to threatened in July 1995. The USFWS is presently evaluating the removal of the bald eagle from the endangered species list. When the bald eagle is removed from the endangered species list, it will continue to be protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Rutledge 2003).

Historically the bald eagle ranged throughout North America, with the exception of extreme northern Alaska and Canada and central and southern Mexico. The species nested along both the Atlantic and Pacific coasts from Florida to Baja California, in the south, and from Labrador to the western Aleutian Islands, Alaska in the north. In many of these areas bald eagles were abundant. They inhabited large rivers and lakes throughout North America and nested in 45 of the contiguous United States.

The bald eagle is associated with aquatic ecosystems throughout most of its range. Nesting rarely occurs more than 3 km (2 mi) from water. Fish predominate in the typical diet of eagles. Many other types of prey are also taken, including waterfowl and small mammals, depending on location, time of year, and population cycles of the prey species. Dead animals or carrion, especially in wintering areas, are also taken when available (60 FR 3600ff; USFWS 1995).

The nesting season of the bald eagle varies by region. In the Great Plains and western mountain region, breeding generally occurs from January through March. Bald eagles begin breeding at four years of age and remain with the same mate for life. The eagles build large nests, which are often reused year after year (USFWS 2002a). The nests are generally built in large trees in riparian habitat along rivers or streams. A typical nest is around five feet in diameter. Nests are also built on cliffs or on the ground, if no other suitable nesting habitat is available. The nesting territory of the bald eagle ranges from 1-2 mi^2. In the fall, when the northern lakes and rivers begin to freeze, most bald eagles migrate south to areas with sufficient food, and return north in the spring to breed (Rutledge 2003). The eagles in the southern portion of the United States do not migrate, but remain in the same area year-round (Rutledge 2003). During the winter months, bald eagles communally roost in cottonwoods and other large trees along rivers and forage in upland habitats for carrion and small mammals. The bald eagle has made significant recovery since the 1970s, but habitat loss continues to remain a threat to the bald eagle's full recovery.

Although no bald eagle nests were observed during raptor surveys conducted by Buys & Associates on April 16 and 17, 2003 (Appendix J), a bald eagle winter roost site has been reported at the north end of Ocean Lake about 1 mile south of the WRPA. The eagles could potentially roost within the proposed WRPA, although no roost sites have been reported there (Hnilicka, P., USFWS, personal communication, June 2003).

3.9.2.2 Black-footed Ferret

The black-footed ferret is considered to be one of the most endangered mammals in North America (USFWS 1988) and was listed as endangered on the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001) (USFWS 1967).

Black-footed ferrets were once found throughout the prairie ecosystem of the Great Plains from foothills of the Rocky Mountains eastward through the grasslands of Kansas, Nebraska, the Dakotas, Oklahoma, and Texas (USFWS 1988; USFWS 1998; BLM 2002). The ferret's range is closely associated with that of prairie dogs, which were once abundantly distributed throughout the North American prairie. When pioneers moved west to settle and large tracts of prairie were tilled for agriculture, prairie dog and ferret habitat was destroyed. Poisoning campaigns in the early 1900's further reduced prairie dog and ferret populations (BLM 2002; NGPC 1996).

The black-footed ferret is one of five members of the genus *Mustela* in North America. The black-footed ferret is an obligate associate of the prairie dog. The range of the ferret is essentially identical with that of three species of prairie dogs; black-tailed prairie dog, Gunnison prairie dog, and white-tailed prairie dog. Only white-tailed prairie dogs are present in the WRPA. The black-footed ferret depends almost exclusively on the prairie dog ecosystem for food and shelter. Ninety percent of the ferret's diet consists of prairie dogs. Other prey includes cottontail rabbits, ground squirrels, voles, mice, and birds (USFWS 1988; USFWS 1998; BLM 2002). The black-footed ferret utilizes abandoned prairie dog burrows or burrows of prairie dogs they have killed, for shelter, nesting, and rearing of young. The species is primarily nocturnal, with peak activity occurring between sunset and dawn (USFWS 1988; BLM 2002).

Black-footed ferrets are solitary predators except during the breeding season. Female ferrets reach sexual maturity at one year of age. Breeding activity generally occurs in March or April, and after a 41-45 day gestation period, a litter of three or four young (kits) are born. Male black-footed ferrets do not assist in raising the young and generally stay with the female only until breeding occurs. Life expectancy of ferrets in the wild is generally less than five years. The primary threats to ferret survival include accidents, starvation, injury, canine distemper, sylvatic plague, parasites, and predators (e.g., coyotes, great-horned owls, badgers).

The last known wild population of black-footed ferrets was discovered in 1981 on a ranch in Meeteetse, Wyoming. By 1987, the 18 ferrets that had survived canine distemper from infected dogs were taken into captivity to begin recovery efforts for the reintroduction of ferrets back into the wild (USFWS 1998). Currently, all of the captive-bred ferrets that were released into the wild, including those found in the Shirley Basin in Wyoming, are considered parts of experimental, non-essential populations (USFWS 1998). Although the number of captive black-footed ferrets has increased and ferrets have been reintroduced into six sites within their former range, no wild population, apart from the experimental, non-essential populations, is known to exist (Reading et al. 1996).

Although no black-footed ferrets have been observed within the WRPA, prey availability and suitable habitat does exist (Buys & Associates 2003). White-tailed prairie dog surveys conducted by Buys & Associates 2003, evaluated four prairie dog colonies on 1,243 acres within the WRPA and a 2 mile radius as shown in Figure 3.9-1. Seventy-six percent (or 660 acres) of one colony is located within the WRPA, but the three remaining colonies are not. The majority of the active prairie dog colonies are located along the western and northwestern edges of the WRPA. The approximate density of active prairie dog colonies is 10.3 burrows/acre (25.5 burrows/ha) and comprises approximately 4.4 percent of the total 1,243 acres. This density and acreage exceeds the USFWS minimum threshold of 8 burrows/acre and 200 total acres required to support a black-footed ferret population to be (USFWS 1989) (Table 3.9-2).

Figure 3.9-1. White-tailed Prairie Dog Colonies within and adjacent to the WRPA.

Table 3.9-2. White-tailed Prairie Dog Burrow Density Estimates.

Colony	Area (Acre)	Area (Ha)	# Transects	Transect Area (Acre)	Transect Area Ha	# Active Burrows
F	868.81	351.6	46	34.1	13.8	383
G	118.61	48.0	11	8.15	3.3	60
H	176.19	71.3	9	6.67	2.7	67
I	79.32	32.1	8	5.93	2.4	56
Total	**1242.9**	**503.00**	**74**	**54.9**	**22.2**	**566**

Active Burrow/Acre =10.3
Active Burrow/Ha = 25.5

A model prepared by Biggens et al. (1989) was used to estimate the number of ferret families that could be supported by a prairie dog complex. Table 3.9-3 shows that the prairie dog complex within the WRPA has a rating of 1.94 a rating greater than 1.0 indicates that the prairie dog colonies could support ferrets. Survey methods and field data from the white-tailed prairie dog survey are provided in Appendix J

Table 3.9-3. Suitable Ferret Habitat within the White-tailed Prairie Dog Complexes.

Colony	Number Transects	Habitat Size (Ha.)	Suitable Habitat (No. of transects) [1]	Suitable Habitat (%)	Suitable Habitat (Ha.)	Burrows /Ha.	Prairie Dogs /Ha.	Total No. Prairie Dogs	R^2
F	46	351.6	24	52	182.83	45	6.63	1213	1.56
G	11	48.0	4	36	30.03	35	5.16	155	0
H	9	71.3	5	43	13.75	50	7.37	101	0
I	8	32.1	3	56	54.77	36	5.31	290	0.38
								Total	**1.94**

[1]Number of transects that contain suitable ferret habitat.
[2]R = Rating
[3]Ha = Hectare

Prior to construction and drilling operations in or immediately adjacent to the white-tailed prairie dog colonies, a black-footed ferret survey would be conducted. The results of the survey would determine whether proposed development would be permitted could occur within the prairie dog colonies.

3.9.2.3 Canada Lynx

The USFWS published a notice in the Federal Register on March 24, 2000 listing the Canada lynx (*Lynx canadensis*) as threatened in the contiguous United States (65 FR 10652-USFWS 2000). The Canada lynx is one of three major species of wildcats found in the contiguous United States. It is associated with southern boreal forests, and sub-alpine coniferous forests in the West and primarily mixed coniferous/deciduous forests in the East.

The historical and present range of the Canada lynx includes Alaska and the part of Canada that extends from the Yukon and Northwest Territories south across the United States border and east to New Brunswick and Nova Scotia. In the contiguous 48 states, the lynx historically occurred in the Cascade Range of Washington and Oregon, the Rocky Mountain Range in Montana, Wyoming, and Idaho; eastern Washington, eastern Oregon, northern

Utah, and Colorado; the western Great Lakes Region; and the northeastern United States from Maine southwest to New York (USFWS 2000).

Historically, Canada lynx have been observed in every mountain range in the State of Wyoming, including western Wyoming in the Wyoming and Salt River ranges, and in the Teton and Absaroka ranges in and around Yellowstone National Park. Many records of Canada lynx have also come from the western slope of the Wind River Range, with fewer observations in the Bighorn and Uinta Mountains (Reeve et al. 1986; USFWS 2002a). Only 30 verified records of lynx have been reported in Wyoming since 1856 (McKelvey et al 1999, in USFWS 2000). Documented reports of lynx in Yellowstone National Park are rare, and no recent verified records exist from the Greater Yellowstone Ecosystem (McKelvey et al. 1999, in USFWS 2000). The Canada lynx has also been reported from the Big Horn Mountains in north-central Wyoming. Until 1957, there were bounties on lynx in Wyoming. Since 1973, the lynx has been listed as a protected non-game species and its harvest was closed.

Canada lynx are highly specialized predators whose primary prey is the showshoe hare *(Lepus americanus)*, which is found in forests with dense understory that provide forage, cover to escape from predators, and protection during extreme weather. The dependence of lynx on snowshoe hare has been described in numerous studies. In Alberta, lynx productivity was related to prey availability, particularly snowshoe hare (Nellis et al. 1978, Brand and Keith 1979). Other studies of lynx food habits in Canada reveal that lynx will prey on other species, including tree and ground squirrels (Moore 1976, Van Zyll de Jong 1966), small rodents (Van Zyll de Jong 1966), grouse (Van Zyll de Jong 1966; Brand et al. 1976; Nellis et al. 1978), and carrion (Saunders 1963; Brand et al. 1976; Nellis et al. 1978).

The size of the lynx home range varies by the animal's gender, abundance of prey, season, and density of lynx populations. Documented home ranges vary from 8 to 800 km^2 (3-300 mi^2) and are much larger at the southern than portions of the ranges. Individuals are capable of moving extremely long distances in search of food (USFWS 2002a).

The Canada lynx breeds between March and April in the north (Lynx Biology Team 2000). Kittens are born in May to June in south central Yukon. Yearling females give birth during periods when snowshoe hares are abundant. Lynx use areas with downed logs and windfalls to provide denning sites with a high amount of horizontal cover for security and thermal cover for the kittens (65 FR 16052-USFWS 2000).

In 1996 the Wyoming Game and Fish Department began a lynx study in west-central Wyoming. Based on available information, it was not possible to determine the status or trend of lynx throughout the state (65 FR 16052ff-USFWS 2000a). Records of lynx in Wyoming also indicate that most lynx or lynx sign between 1973 and 1986 were in lodgepole pine (18 percent) and spruce-fir (41 percent) communities (Reeve et al. 1986). According to Reeve et al. (1986), more than 50 percent of lynx records in Wyoming have occurred in the northwestern region of the state.

The WRPA does not contain high elevation lodgepole pine/spruce-fir habitat types preferred by this species and does not support a population of snowshoe hares. There are also no recorded sightings in the vicinity of the proposed WRPA (Root, T., USFWS, personal communication, June 2003), and the closest potential habitat is miles away in the Wind

River Range. Therefore, it is unlikely that Canada lynx would occur in or near the WRPA.

3.9.2.4 Gray Wolf

In North America, gray wolves formerly occurred from northern Alaska, Canada and Greenland to the central mountains and high interior plateau of southern Mexico. Poisoning, trapping, and shooting spurred by federal, state, and local government bounties, resulted in the extirpation of this once widespread species from more than 95 percent of its range in the lower 48 states. At the time of the passage of the Endangered Species Act in 1973, it is likely that only several hundred wolves occurred in northeastern Minnesota; on Isle Royale, Michigan; and possibly a few scattered wolves in Montana and the Southwest. The gray wolf was extirpated from Wyoming by the 1930s, and from that time until the early 1990s, there were only occasional wolf sightings in the state, but no reproduction was documented (WGFD 2002).

The gray wolf is the largest wild member of the dog family (*Canidae*), with adults ranging from 18-80 kg (40-175 lbs), depending on sex and subspecies (68 FR. 15804-USFWS 2003a). In the northern Rocky Mountains adult male gray wolves average 45 kg (100 lbs), while females weigh slightly less. Wolves are primarily predators of medium-sized and large mammals. Wolves are social animals, normally living in packs of 2-12 wolves, although two packs within Yellowstone National Park were reported to have 22 and 27 members in 2000. Packs typically occupy, and defend from other packs and individual wolves, a territory of 50-550 km^2 (20-214 mi^2). In the northern Rocky Mountains territories tend to be larger, usually from 520 to 1040 km^2 (200 to 400 mi^2) (68 FR 15804-USFWS 2003a). Dispersal movements of 800 km (500 mi) have been documented (68 FR 15804-USFWS 2003a).

Gray wolves were originally classified as four separate subspecies: eastern timber wolf (*Canis lupus lycaon*), the northern Rocky Mountain wolf (*C. lupus irremotus*), the Mexican wolf (*C. lupus baileyi*) and gray wolf (*C. lupus monstrabilis*). Each species was listed as endangered. On March 9, 1978, the gray wolf was re-listed as endangered at the species level (*Canis lupus*) throughout the contiguous 48 states and Mexico, except for Minnesota, where the gray wolf was reclassified as threatened (USFWS 1978). On November 22, 1994, portions of gray wolf habitat in Idaho, Montana, and Wyoming were designated as “nonessential experimental populations” in order to initiate gray wolf reintroduction projects in central Idaho and the Greater Yellowstone Area. (59 FR 60252ff-USFWS 1994). Today, there are two species of wolves protected by the Endangered Species Act, the gray wolf and the red wolf (*Canis rufus*) (68 FR 15804-USFWS 2003a).

On April 1, 2003, the gray wolf in the western Distinct Population Segment (DPS) and eastern DPS were reclassified from endangered to threatened, except where they were already classified as threatened or as an experimental population (68 FR 15802-USFWS 2003a). The species was also removed from the list of endangered and threatened wildlife in all or parts of 16 southern and eastern States where gray wolves historically did not occur (68 FR 15804).

All wolves within Wyoming are considered part of a nonessential experimental population. Although such wolves remain listed and protected under the Endangered Species Act, additional flexibility is provided for their management under the provisions of the final rule and special regulations promulgated for the nonessential experimental population on

November 22, 1994 (59 FR 60252-USFWS 1994). Requirements for interagency consultation under Section 7 of the Act differ based on land ownership and/or management responsibility where the animals occur (USFWS 2002a). Additional management flexibility is provided for managing wolves inhabiting a National Park or National Wildlife Refuge System (e.g., U.S. Forest Service lands). Wolves that are designated as nonessential experimental populations in these areas, are treated as "proposed" rather than listed species (USFWS 2002a).

With the goal of reestablishing a sustainable gray wolf population in the northern Rocky Mountains (Wyoming, Idaho, and Montana), the USFWS reintroduced 31 wolves to Yellowstone National Park and 35 wolves to central Idaho in 1995 and 1996. The northern Rocky Mountain wolf population consists of three recovery areas: Northwest Montana, Central Idaho, and the Greater Yellowstone Area. The Greater Yellowstone recovery area includes all of Wyoming, including Yellowstone National Park, Grand Teton National Park, the National Elk Refuge, and adjacent parts of Idaho and Montana.

The USFWS has defined a viable and recovered gray wolf population in the northern Rocky Mountains as one containing at least 30 breeding pairs of wolves, with an equitable and uniform distribution throughout Wyoming, Idaho, and Montana for three years (USFWS 2002a). The USFWS determined that 2001 was the second year in which at least 30 breeding pairs of wolves inhabited the northern Rocky Mountain recovery area. If the gray wolf population remains at current levels or increases in number and distribution, and state management plans are in place, de-listing may be proposed.

3.9.2.5 Grizzly Bear

The grizzly bear (*Ursus arctos horribilis*) was listed as threatened on July 28, 1975 (USFWS 1975). Since 1975, much effort has been expended by various federal and state land and wildlife agencies, tribal governments, and segments of the public to conserve this species (USFWS 1993).

Historically, the grizzly bear was distributed in various habitats from the mid-plains and throughout Western North America, and from Central Mexico to the Arctic Ocean. The westward expansion of European settlers in the United States and urban development caused a rapid decrease in distribution and numbers of grizzly bears. Settlement of the western U.S., logging, livestock grazing, unregulated hunting, and protection of human life were responsible for exterminations in several states (USFWS 1993).

Only five areas in the lower 48 States in mountainous regions, national parks, and wilderness areas of Washington, Idaho, Montana, and Wyoming currently contain either self-perpetuating or remnant populations. The population estimate in this area is approximately 236 bears (USFWS 1993).

Grizzly bears are generally larger than black bears and can be distinguished by longer, curved claws, humped shoulders, and a face that appears to be concave. Grizzly bears are relatively long-lived, and individuals have been known to live 40 years (USFWS 1993). The mean density of grizzly bears in productive habitat is estimated to be one bear per eight square miles. The size of the home range of grizzly bears varies in relation to food availability, weather conditions, and interactions with other bears. In addition, individual bears may extend their range seasonally or from one year to the next (USFWS 1993).

Breeding occurs from late May through mid-July, with a peak in mid-June. Upon emergence from the den, the grizzly bears move considerable distances from high, snow-covered elevations to lower elevations to reach palatable, emerging vegetation, or to feed on winter-killed or weakened ungulates on foothill winter ranges. Reproductive intervals of 2 – 4 years precludes any rapid increase in the population (USFWS 1993).

Contiguous, relatively undisturbed mountainous habitat having a high level of topographic and vegetative diversity characterizes the habitat where grizzly bears are found today. However, habitat loss, changes to important components within their habitat, and direct and indirect human-caused mortality continue to cause decline in the grizzly bear population (USFWS 2002). Since grizzly bears are attracted to carrion and waste products of construction camps, recreational camps and sprawling residential areas that have encroached into their habitat, human-bear interactions have continued to increase (USFWS 1993). Currently the two leading challenges in grizzly bear conservation are the reduction of human-caused mortality and the conservation of the remaining habitat (USFWS 2002).

3.9.3 State Sensitive Species

The State of Wyoming has developed a matrix of species of special concern in the state. There are seven native species status (NSS) categories, which include NSS1 through NSS7. Species of greatest concern are those in category NSS1 or NSS2. Populations identified as NSS1 are those that are greatly restricted or declining, with a possibility of extirpation, or suffering from ongoing significant loss of habitat. Populations categorized as NSS2 are those that are declining, with the possibility of extirpation; habitat is restricted or vulnerable, but no recent or ongoing significant loss has occurred; species may be sensitive to human disturbance. Alternatively, this category is defined as populations that are declining or restricted in numbers and/or distribution, extirpation is not imminent; but ongoing significant loss of habitat is occurring (WGFD 2002).

The list of non-game bird species of special concern in the Native Species Status categories is provided in Table 3.9-4, and the list of non-game mammal species of special concern in the state is provided in Table 3.9-5. Some of these species may occur within the WRPA. Tables H-1, H-2, and H-3, in Appendix I, list bird and mammal species that have been observed within the WRPA and have been identified as species of special concern by the State of Wyoming.

3.9.3.1 Mountain Plover

The mountain plover (*Charadrius montanus*) was petitioned for listing as threatened on July 7, 1997. On February 16, 1999, the USFWS filed a notice of a proposal to list the mountain plover as a threatened species pursuant to the ESA (64 FR 7587-USFWS 1999). The comment period for the listing proposal was re-opened on December 5, 2002 (67 FR 234-USFWS 2002b). Proposed species are taxa for which the U.S. Fish and Wildlife Service has published a proposal in the Federal Register to list the species as endangered or threatened. On September 9, 2003, the USFWS withdrew the mountain plover from the proposed list of threatened species (USFWS 2003b, USFWS 2003c, USFWS 2003d). The mountain plover remains a species of concern, to the USFWS (USFWS 2003c).

Historically, the mountain plover was abundant in eastern Colorado, Montana, Wyoming, western Nebraska and South Dakota, western and central Kansas, and Oklahoma (USFWS 1999). The population has declined range-wide by more than 50 percent since 1966 to fewer than 10,000 birds (Grunau and Wunder 2001). Reasons for the species' decline include loss of short-grass and shrub-steppe habitats; changes in range management to emphasize uniform grass cover; declines in native ungulates and burrowing animals (e.g., prairie dogs); habitat loss and fragmentation caused by residential, commercial and industrial development, and possibly population sinks created by certain agricultural practices (USFWS 1999).

Mountain plovers are rarely found near water and show a preference for previously disturbed areas or modified habitat (e.g. prairie dog colonies). They occupy short-grass prairie and shrub-steppe landscapes; dryland, cultivated farms; and prairie dog colonies in many of the Great Plains states from Canada south to Texas from late March through July (USFWS 2002a). The states of Colorado, Montana and Wyoming have the majority of breeding plovers, but some breed in Kansas, Nebraska, New Mexico, and Oklahoma (USFWS 1999). Wintering areas are concentrated in the central valley of California, Texas and Mexico. The breeding season begins in late March or early April, soon after mountain plovers arrive from wintering grounds in south Texas and northern Mexico (USFWS 1999).

Mountain plovers usually breed and build nests in areas with sparse vegetation or bare ground, which are conditions that can be created by prairie dogs, domestic cattle or other herbivores (USFWS 1999). Nests have also been documented on bare ground created by oil and gas development activities (USFWS 2002b). Vegetation in nesting habitats is typically less than four inches in height (Knopf 1994; USFWS 2002b). Nest sites within the shrub-steppe community are found within areas of little or no vegetation. Breeding plovers exhibit close site fidelity, often returning to the same area in subsequent years (Knopf 1996; USFWS 1999).

Excellent mountain plover habitat, including level terrain, prairie dog colonies, bare ground, and *Opuntia* species, are all present within the WRPA (Dana 2001). One mountain plover was observed during a survey that was conducted in May and June 2001, at a site of a proposed well and access road (Tribal Pavillion #13-5) (Dana 2001; Buys & Associates 2003). A mountain plover was also seen during prairie dog surveys in July 2003 (Dworak, A., Buys & Associates, personal communication, July 2003) (See Figure 3.9-2).

Table 3.9-4. Matrix of Nongame Bird Species of Special Concern in Wyoming[1,2]

		A On-going significant loss of habitat	B Habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance
	1 Populations are greatly restricted or declining - extirpation appears possible	NSS1 Common Loon	NSS2
POPULATION	2 Populations are declining or restricted in numbers and/or distribution - extirpation is not imminent	NSS2 Trumpeter Swan Bald Eagle Yellow-billed Cuckoo	NSS3 American White Pelican American Bittern Snowy Egret Back-crowned Night-Heron White-faced Ibis Caspian Tern Forster's Tern Black Tern Harlequin Duck Merlin Peregrine Falcon Long-billed Curlew Lewis' Woodpecker Ash-throated Flycatcher Western Scrub-Jay Juniper Titmouse Bushtit Scott's Oriole
VARIABLES	3 Species is widely distributed; population status and trends are unknown but are suspected to be stable	NSS3 Ferruginous Hawk	NSS4 Clark's Grebe Western Grebe Great Blue Heron Mountain Plover Upland Sandpiper Northern Goshawk Northern Pygmy-Owl Great Gray Owl Boreal Owl Burrowing Owl Black-backed Woodpecker Common Yellowthroat Veery American Redstart Orange-crowned Warbler Indigo Bunting Pygmy Nuthatch

Table 3.9-4 (concluded).

	4 **Populations are stable or increasing and not restricted in numbers and/or distribution**	**NSS4**	**NSS5**

[1] WGFD Nongame Program - NSS Matrix (WGFD 2002)
[2]See Appendix P for definitions of NSS1, NSS2, etc.

Table 3.9-5. Matrix of Nongame Mammal Species of Special Concern in Wyoming.[1,2]

		A On-going significant loss of habitat	B Habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance	C Habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance	D Habitat is stable and not restricted
	1 **Populations are greatly restricted or declining - extirpation appears possible**	**NSS1**	**NSS2** **Black-footed Ferret** **Pygmy Shrew**	**NSS3** **Preble's Shrew**	**NSS4**
POPULATION	2 **Populations are declining or restricted in numbers and/or distribution - extirpation is not imminent**	**NSS2** **Spotted Bat** **Long-eared Myotis** **Northern Myotis** **Long-legged Myotis** **Townsend's Big-eared Bat** **Pallid Bat** **Fringed Myotis** **Lynx**	**NSS3** **Black-tailed Prairie Dog** **White-tailed Prairie Dog** **Dwarf Shrew** **Pygmy Rabbit** **Water Vole** **Cliff Chipmunk** **Pinyon Mouse** **Canyon Mouse** **Swift Fox** **Vagrant Shrew** **Idaho Pocket Gopher** **Great Basin Pocket Mouse** **Plains Harvest Mouse** **Plains Pocket Mouse** **Silky Pocket Mouse** **Olive-backed Pocket Mouse**	**NSS4**	**NSS5**

Table 3.9-5 (concluded).

			Hispid Pocket Mouse **Spotted Ground Squirrel** **Western Heather Vole** **Prairie Vole** **Least Weasel**		
VARIABLES	3 **Species is widely distributed; population status and trends are unknown but are suspected to be stable**	**NSS3** **Little Brown Myotis** **Big Brown Bat** **Western Small-footed Myotis** **Wolverine**	**NSS4**	**NSS5**	**NSS6**
	4 **Populations are stable or increasing and not restricted in numbers and/or distribution**	**NSS4**	**NSS5**	**NSS6**	**NSS7**

[1]WGFD Nongame Program – NSS Matrix (WGFD 2002)
[2]See Appendix P for definitions of terms (NSS1, NSS2, etc.)

Figure 3.9-2. Potential Mountain Plover Habitat and Sightings of Mountain Plovers within the WRPA.

3.9.3.2 Greater Sage-Grouse

Another species of concern that may occur in the WRPA is the greater sage-grouse (*Centrocercus urophasianus*), the largest North American grouse. Although the sage grouse is not federally listed as threatened or endangered at this time, it is a species of high interest among federal and state agencies. Several petitions for listing the sage grouse have been made in an effort to protect it (Erwin, K., USFWS, personal communication, April 2003).

The present range of the sage grouse includes Wyoming, Montana, western Colorado, Utah, southern Idaho, northern Nevada, southeastern Oregon, central Washington, and the northeastern corner of California (Peterson 1990). Sage grouse evolved with the plants, after which they are named, and their occurrence is limited to the higher sagebrush plains (Royal British Columbia Museum 1995). The present number of sage grouse in the United States is estimated to be 200,000 (Smithsonian Magazine 2001). The average life span of sage grouse is 1-1.5 years. However, sage grouse can survive up to 10 years in the wild (Royal British Columbia Museum 1995). The decline of the sage grouse is primarily attributed to agriculture, excessive livestock grazing, sagebrush control using herbicides, and fire. Irrigation projects and commercial, industrial and power developments have also resulted in the loss of sagebrush habitat.

The breeding season of the sage grouse generally begins the same time each year, but ultimately depends on weather and vegetative conditions. Leks (i.e., courtship areas) are the focal point of the breeding season and range in size from 0.04 to 40 ha. Leks are generally in the vicinity of nesting areas and winter and summer habitat and most contain a central area that is barren, and a surrounding area containing sagebrush with a canopy cover of 20-50 percent. Visibility is important on a lek as it is necessary for females to observe displaying males, and for all sage grouse to observe predators. Water is not necessary on a lek (Royal British Columbia Museum 1995). Gravel pits, burned areas, plowed fields, air strips, abandoned homesteads, roads, bare ridges, grassy swales, natural and irrigated meadows void of grass knolls, small buttes, openings in sagebrush stands, dry-lake beds, and areas stripped of vegetation by livestock may be used as a lek.

After mating, sage grouse hens leave the lek to nest approximately 2-6 km from leks. They nest under sagebrush with an average height of 40.4 cm and a canopy cover of 20-40 percent. Females build nests, in shallow depressions on ground sparsely lined with grass and sheltered by sagebrush or clumps of grass and incubate eggs from mid-March to mid-June. After hatching, chicks remain with hens until late summer or early fall, when they congregate with other sage grouse in flocks for migration (Royal British Columbia Museum 1995).

Wintering habitat consists of dense sagebrush with a canopy cover greater than 20 percent, standing an average of 25 cm above the snow. Wintering habitat is typically the most limited seasonal habitat within the range of the sage grouse (Royal British Columbia Museum 1995).

Sagebrush is the most important component of the sage grouse diet, but forbs and grasses are also a significant food source. Insects are eaten, but compose only a small proportion of the diet of adult sage grouse. Predation, especially during nesting, egg laying, and brood rearing, limits the growth of sage grouse populations. Predators cause approximately 50 percent of sage grouse mortality. Adults are more vulnerable to predators in the winter because the snow makes them more visible (Royal British Columbia Museum 1995).

An aerial survey to search for sage-grouse leks was conducted within and adjacent to the WRPA by Buys & Associates on April 16 and 17, 2003. No sage grouse leks were identified within the WRPA during the aerial surveys. Although there was some sage grouse habitat within the WRPA, the majority of the area did not appear to be suitable habitat for sage grouse. The most suitable sage grouse habitat was found immediately south of the WRPA, north of Fivemile Creek and south of the west end of Muddy Ridge. The areas that appeared to be suitable habitat for sage grouse consisted of approximately 50-60 percent sagebrush (*Artemisia* spp.), 10-15 percent short grasses, and the 25 – 40 percent bare ground. Several sage-grouse leks have been documented south and west of the WRPA (Hnilicka, P., USFWS, personal communication, June 2003), and are identified in Figure 3.9-3.

Figure 3.9-3. Sage Grouse Leks near the WRPA

3.10 RECREATION

3.10.1 Introduction

Recreation in and near the Wind River Project Area (WRPA) occurs in a broad setting that includes the Wind River Indian Reservation (WRIR), Fremont County, and the rest of west-central Wyoming. This part of Wyoming includes the Wind River Range, a wide variety of terrestrial habitats and many reservoirs, lakes, and rivers among its recreation resources.

In and near the WRPA, recreation resources are found on tribal, public, and to some extent, private lands. Most recreation resources are on public land or under public management, but tribal lands adjacent to public lands may have similar resource values. Some private lands are made available for recreation by permission of the landowners.

Recreation use in the WRPA includes hunting by tribal members on tribal lands, limited fishing on tribal lands for both tribal and non-Tribal members, extensive hunting and fishing on public lands, and some hunting and fishing on private land, either by individual permission, through Wyoming Game and Fish Department (WGFD) blanket agreements, or with outfitters. Near the WRPA are water bodies with developed recreational facilities and surrounding lands that support hunting, fishing, and water-based recreation.

Recreation in the WRPA occurs in a setting characterized by agriculture, rural development, and agency-managed lands. The WRPA contains a mixture of irrigated croplands, open sagebrush grasslands, and scattered farms and residences. Irrigation water supports riparian and wetland habitats. Depending on elevation and visual screening, parts of the WRPA have distant background views of the Wind River Range to the west and the Owl Creek Mountains to the north. In areas outside but near the WRPA, recreation occurs in a moderately developed or agricultural setting.

Hunting in the WRPA generally occurs in the fall. Hunting in and around the WRPA is principally for waterfowl, pheasant, and deer, with additional interest in antelope, upland birds, and other small game. There is some furbearer trapping. Fishing, boating, camping, and a variety of day-uses occur seasonally at reservoirs in and near the WRPA. In the winter, the larger reservoirs attract ice fishing and related motorized vehicles. There are opportunities year-round for bird watching and other wildlife viewing in managed areas in and near the WRPA.

Off-road vehicle (ORV) use in and near the WRPA generally supports hunting and fishing. ORV use occurs in and near Boysen State Park, but ORV use on the west shore of Boysen Reservoir, closest to the WRPA, is very limited.

Numerical data on recreation use in the WRPA is limited to hunting and use of water-based recreation sites. Counts of big game, waterfowl, and upland bird hunters are available or have been estimated. Numerical data on fishing is available for several bodies of water in and near the WRPA. Total recreation visitor use also is tracked at the main water-based recreation sites near the WRPA. Assessments of resource quality have been assembled from interviews with the resource managers.

3.10.2 Recreation Resources

The recreation resources identified in this section are illustrated on Figure 3.10-1. The principal resources in and near the WRPA occur on tribal lands, in the Sand Mesa and Ocean Lake wildlife habitat management areas, at Boysen Reservoir and Boysen State Park, and on private land by permission of the landowners.

Figure 3.10-1. Recreation Resources in and near the Wind River Project Area.

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3.10.2.1 Tribal Lands

There are 15,000 acres of tribal lands in the WRPA. Antelope, deer, and other game species are generally hunted or trapped by tribal members on tribal lands on Muddy Ridge in the WRPA (Thayer W., WRTFG, personal communication, August 5, 2003), comprising the whole and partial sections identified as Sections 8 to 11, 14 to 17, and 20 to 25 of T4N, R2E, and in areas accessed by the northern extension of North Portal Road, comprising all or part of Sections 11 and 12 of T4N, R3E and Sections 7 to 9 and 18 of T4N, R4E. Limited fishing has been observed on a small water body on tribal land within the WRPA, locally known as Stockpond Reservoir, which is located in Section 18 of T4N, T4E (Roth S., US FWS, personal communication, August 6, 2003).

3.10.2.2 Sand Mesa Wildlife Habitat Management Area

Almost all hunting, fishing, and other water-based recreation activities of the general public within the WRPA occur on resources in the Sand Mesa Wildlife Habitat Management Area (WHMA). WGFD manages Sand Mesa WHMA through a cooperative agreement with the U.S. Bureau of Reclamation (BOR 2003a). The area contains 17,949 acres in five separate units. US Highway/134, US 26, and the Bass Lake Road are the principal roads to the Sand Mesa WHMA.

Sand Mesa WHMA contains croplands managed for wildlife habitat under contract with WGFD and 350 acres of wetland ponds managed for waterfowl production. The remainder of the WHMQ is sagebrush grassland that supports game and non-game species, including pheasant, mule deer and white-tailed deer.

Several important recreation features of the Sand Mesa WHMA are within the WRPA. These are Middle Depression Reservoir and the corridors of Cottonwood Drain, Fivemile Creek, and Muddy Creek. Other features of recreational interest are near, but just outside of the WRPA. These include Lake Cameahwait, Muddy Ridge Reservoir (in T3N, R3E, Section 1) and the Sand Mesa Ponds (also known as the Lower Depression Ponds) west of Boysen Reservoir (WGFD 2002c).

3.10.2.3 Ocean Lake Wildlife Habitat Management Area

Ocean Lake WHMA located 7 miles northwest of Riverton and its surroundings are resources for public hunting, fishing and other water-based recreation. The north access to the area (also the southwest border of the WRPA) is Wyoming State Highway (SH) 134 also known as the Missouri Valley Road. From the south, US 26 accesses the Ocean Lake WHMA.

WGFD manages the Ocean Lake WHMA through a cooperative agreement with the BOR. The area contains 10,316 acres of BOR land and 2,409 acres of deeded WGFD land for a total of 12,725 acres. Ocean Lake WHMA is primarily managed for waterfowl and pheasant hunting (WGFD, no date).

3.10.2.4 Boysen State Park and Boysen Reservoir

Much of Boysen Reservoir and Boysen State Park are located within three miles of the WRPA. About 40 acres of parkland is included within the WRPA. Boysen Reservoir has 19,560 surface acres and 76 miles of shoreline. The park contains another 15,145 acres, of which 825 acres are developed for recreation. US 20 accesses developed areas on the eastern shore. US 26 and Bass Lake Road access developed recreation facilities on the western shore, including those nearest to the WRPA. Facilities at Boysen State Park include six campgrounds with 181 developed sites, 16 RV sites, 181 picnic tables, and four boat ramps (BOR 2003b).

Boysen Reservoir is managed by the Wyoming Area Office of the BOR. Boysen State Park is a unit of the State Parks & Historic Sites division of the Wyoming Department of State Parks & Cultural Resources (BOR 2003b).

3.10.2.5 Private Lands

Private lands in and near the WRPA are a limited hunting and fishing resource. Hunting on private land is primarily by direct permission of the landowner (Thorson 2003). There are also very limited opportunities to hunt on private land through outfitters in and near the WRPA. Of five commercial outfitters registered in WRPA hunting areas, three provide access to deer or antelope on private land (Flagg, J., WSBPGO, personal communication, August 18, 2003). Other hunting occurs at two WGFD Awalk-in” areas in the WRPA. The walk-in areas, containing a total of approximately 1,078 acres, are found in T4N of R2E and T4N, R3E. Walk-in areas are private lands where public access is leased from the owners by the WGFD (WGFD 2003a).

3.10.3 Recreation Use

Recreation use of tribal resources in the WRPA is minimal because of the limited quantity of land involved. On public lands in and near the WRPA, resource usage by the general public varies depending on ease of access, size of site, and quality of resource. Some hunting and fishing resources in and near the WRPA attract recreational users from across Wyoming and from out of state.

3.10.3.1 Hunting

Hunting is an important recreational use in the WRPA. Limited hunting of deer and antelope occurs on tribal lands (Thayer, W., WRTFG, personal communication, August 5, 2003). For the general public, public land is the main resource for hunting of big game, birds, and small game. Some hunting also occurs on private land (Anderson, G., WGFD, personal communication, August 2003; Sims, W., BOR, personal communication, July/August 2003b). The species most often hunted are waterfowl, pheasant, deer, and antelope. Other species are upland birds, such as sage grouse, chukar, and gray partridge, and small game.

Hunting in this part of Wyoming occurs from late September through mid-January, or until the lakes freeze and waterfowl populations decrease. The antelope season is late September through late October, deer season is mid-October through November, pheasant season is generally all of November and December, and the waterfowl seasons are generally from late September through mid-January.

Hunting on Tribal Land

Table 3.10-1 presents estimates of the numbers of hunters and animals taken on tribal lands in the WRPA. Most hunting on tribal lands occurs on Muddy Ridge. The area is included within the much larger Owl Creek Mountains Unit on the WRIR, which extends from north of the Big Wind River to the South Fork of Owl Creek and from the East Fork to the Wind River. The localized estimates of big game hunting on tribal lands presented here were made specifically for this analysis by estimating the share of WRPA land in the Tribal hunting area. The estimates are not precise and may vary from the actual harvest.

Table 3.10-1. Estimates of Tags Sold, Hunters, and Harvest on Tribal Land in the WRPA in 2002.

Species	Tags Sold	Hunters	Harvest
Mule Deer	3	2	2
White-Tailed Deer	2	1	1
Antelope	12	8	4

Source: The estimates are based on data from Hnilicka, P., personal communication, August 6, 2003b.

Tribal lands within the WRPA also contain small game and upland bird habitats. There is also some waterfowl hunting potential on a small water body on tribal land, known locally as Stockpond Reservoir (Hnilicka, P., USFWS, personal communication, August 6, 2003b). However, tribal-member participation in hunting is low for small game and very low for waterfowl (Aragon, D., WREQC, personal communication August 6, 2003). Some trapping of bobcats and other furbearers occurs on tribal lands (Thayer, W., WRTFG, personal communication, August 5, 2003; Nation, R., BIA, personal communication, September 2003).

Hunting on tribal lands is reserved for tribal members only. The hunting areas open to the general public are in close proximity to the hunting areas open only to tribal members. This fact, along with the interconnectedness of roads in and around the WRPA, means that trespass by the general public onto tribal land and illegal hunting of tribal game is a tribal concern (Aragon, D., WREQC, personal communication, August 6, 2003).

Hunting on Wyoming Game and Fish Land

Most hunting in the WRPA occurs on lands managed for public hunting by the WGFD. Ponds, such as the Depression Reservoirs and the Sand Mesa ponds, are managed for waterfowl. Creek, canal, and drain corridors are managed to support pheasants. WGFD creates pheasant hunting opportunities with an annual release of birds in the Sand Mesa and Ocean Lake WHMAs. Riparian areas support white-tailed and mule deer and upland areas support mule deer and antelope. These areas also support waterfowl and pheasant hunting that is of statewide interest. Big game hunting in the area attracts a mix of local residents, other Wyoming residents, and out-of-state residents. Hunting of other birds and rabbits is mainly of local interest (Anderson, G., WGFD, personal communication, August 2003).

Table 3.10-2 summarizes estimates of hunting activity for parts of WGFD-managed hunting areas in the WRPA. Figures 3.10-2 and 3.10-3 depict the hunting areas identified in Table 3.10-2. These hunting areas are Waterfowl Area 4C, Small Game Area 18, Deer Area 157 and Antelope Hunt Area 91. The table presents localized estimates, made specifically for this analysis. The estimate of pheasant hunting in the WRPA is based on information from a WGFD biologist familiar with local habitat and hunting activity (Anderson, G., WGFD, personal communication, August 2003). Estimates of hunting activity in the WRPA were made by GIS analysis of maps to estimate the WRPA share of land in each hunting area. The estimates are not precise and may differ from the actual activity that occurs in the local parts of the hunting areas.

Table 3.10-2. Estimates of Hunting Activity in WGFD-Managed Hunting Areas in the WRPA in 2002.

Game Species	Hunting Area	WRPA Share of Activity in Hunting Area (%)	Estimated number of Hunters in WRPA	Non-Resident Hunters (%)	Hunter Success (%)	Average Days Per Hunter
Goose	4C Wind River Basin	5%	18	NA	NA	5.6
Duck	4C Wind River Basin	5%	25	NA	NA	7.1
Pheasant	18 Copper Mountain	50%	318	NA	NA	4.6
Other Birds & Small Game[1]	18 Copper Mountain	5%	11	NA	NA	3.1
Mule Deer	157 Boysen	29%	74	20%	79%	3.6
White-Tailed Deer	157 Boysen	29%	51	7%	42%	6.2
Antelope	97 Boysen	29%	20	19%	100%	2.2

[1] Sage Grouse, Chukar, Gray Partridge, Dove, and Cottontail Rabbit.
NA: Data not available.
Source: The estimates are based on WGFD 2002d, information from Anderson, G., WGFD, personal communication, August 2003, and a GIS analysis of maps of the hunt areas and the WRPA.

Figure 3.10-2. Pronghorn Antelope, Deer, and Small Game Hunting Areas within and near the WRPA.

Figure 3.10-3 Waterfowl Hunting Areas within and near the WRPA.

3.10.3.2 Fishing

Fishing is a popular year-round recreational activity in and near the "Stock Pond" on Figure 3.10-1 WRPA. On tribal lands, fishing activity is minimal (Thayer, W., WRTFG, personal communication, August 5, 2003) and appears to be confined to Stockpond Reservoir, a site for which there are no data. Stockpond Reservoir, which has been managed for rainbow trout in the past, will be managed for warm water fish in the future (Roth S. US FWS, Anderson, G., WGFD, personal communication, August 6, 2003). Other recreational fisheries and estimates of angler use are presented in Table 3.10-3. All of these fisheries are managed by the WGFD.

Table 3.10-3 Recreational Fisheries and Best Available Estimates of Fishing Activity In and near the WRPA.

Fishery	Maximum Surface Area in Acres	Managed Species	Fishing Visits (Year of Estimate)	Importance for Recreation
Boysen Reservoir	19,560	Rainbow Trout, Walleye	39,449 (1993)	Multi-state
Ocean Lake	6,100	Walleye	16,756 (NA)	In-state region
Lake Cameahwait	465	Largemouth Bass, Yellow Perch, Rainbow Trout	6,410 (1985)	Statewide
Middle Depression Reservoir	126	Rainbow Trout	NA	Fremont County
Muddy Ridge Reservoir	15	Largemouth Bass	NA	Fremont County
Cottonwood Drain below Middle Depression Reservoir	NA	Rainbow Trout[1]	NA	Fremont County

[1] Fish in Cottonwood Drain drift in from Middle Depression Reservoir.
NA: Data not available.
Source: Dufek, D., WGFD, personal communication, 2003.

The fisheries resources in the Sand Mesa WHMA are located in Lake Cameahwait, Middle Depression Reservoir, Muddy Ridge Reservoir, and Cottonwood Drain below Lake Cameahwait. Lake Cameahwait is considered the only good largemouth bass fishery in central Wyoming, and it attracts anglers from many parts of Wyoming. Middle Depression Reservoir is a good rainbow trout fishery with large fish that attracts local anglers and others from the region surrounding Fremont County. Muddy Ridge Reservoir is small, but it has a largemouth bass fishery of local importance (Dufek, D., WGFD, personal communication, 2003) that is popular with tribal people (Aragon, D. WREQC, personal communication August 6, 2003). Lower Cottonwood Drain is a minor fishery that is not stocked but contains fish that drift out of Lake Cameahwait. Fivemile Creek and Muddy Creek also run through the WRPA but do not contain enough sport fish to be of interest to anglers (Dufek, D., WGFD, personal communication, 2003). Of these waters, only Middle Depression Reservoir, part of Lower Cottonwood Drain, and parts of Fivemile Creek and Muddy Creek are within the WRPA proper.

Boysen Reservoir is the most important fishery in the area because of excellent fishing opportunities that generate high use and it attracts anglers from all over Wyoming and from out of state. Ocean Lake is a good walleye fishery of importance to Fremont County and to surrounding counties. Because of size, location, and access, Ocean Lake generates more angler use than Lake Cameahwait (Dufek, D., WGFD, personal communication, 2003). Lake Cameahwait, Boysen Reservoir, and Ocean Lake also attract ice fishing (Sims W., BOR, personal communication, July/August 2003b; Wilson, D., personal communication, August and September 2003).

3.10.3.3 Other Recreation

Public recreation occurs in and around the WRPA at the major water bodies and their facilities, all of which attract varying levels of water-based recreation, including boating, swimming, water skiing, camping, picnicking, and wildlife viewing. Tribal lands in the WRPA are not available to the general public for other types of recreation, and tribal use is generally limited to hunting and fishing.

Table 3.10-4 presents the average annual total visitor use over the past five years at the principal water recreation facilities in and near the WRPA. Total visitor use is estimated from traffic counts on access roads to the facilities. The counts are multiplied by estimates of the number of people in the party occupying the vehicle. Usage in visitor days is estimated by multiplying by the average length of a visit.

Table 3.10-4. Average Annual Visitor Use at Water Recreation Facilities in and near the WRPA.

Facility	Recreation Visits[1]	Average Days per Visitor[1]	Importance for Recreation
Boysen State Park	143,300	2.0	Multi-state
Lake Cameahwait	46,200	0.5	In-state region
Ocean Lake	41,200	0.5	In-state region

[1] Visitor data are averages of counts for 1998 through 2002 (rounded off).
Source: Stevens, D. , WDSP, personal communication, August 7 and August 12, 2003; Sims W., BOR, personal communication, July/August 2003b).

Boysen Reservoir and Boysen State Park attract visitors from out of state because of the large reservoir size, fishing quality, and its location on the way to Yellowstone National Park. Boysen also has extensive developed facilities and undeveloped parklands in the surrounding undeveloped sagebrush hills. Besides fishing, Boysen Reservoir and Boysen State Park attract boating and other water recreation, hunting, wildlife viewing, rockhounding, and horseback riding (Dufek, D., WGFD, personal communication, 2003; Wilson, D., Boysen State Park, personal communication, August and September 2003).

About 10 percent of all Boysen State Park visitors also ride off-road vehicles (ORVs), primarily to get around inside the park and to access the shoreline for fishing. ORVs that are licensed or whose operators have obtained a Wyoming ORV permit may use all existing roads and trails inside the park boundaries. Because ORV use has been continually increasing, a site has been identified for ORV recreation on the east shore of Boysen Reservoir. However, there is no plan to develop the site in the near future (Wilson, D., Boysen State Park, personal communication, August and September 2003).

Visitor use on the west shore of Boysen Reservoir is a small percentage of the total visitor use, and consequently ORV traffic near the WRPA is limited (Wilson, D., personal communication, August and September 2003). The main road leading into Boysen State Park on the west side is Bass Lake Road, a paved county road. All ORVs traveling on Bass Lake Road are required to be street-legal and licensed (McManus, C., WDSP, personal communication, August 18, 2003).

At Boysen State Park, the Sand Mesa Campground, North Muddy Campground, and the north loop of West Shoreline Drive, are closest to the WRPA. Analysis of traffic count data indicate that in the five years ending in 2002, these sites attracted 4 percent of total visitors to Boysen State Park. This equates to an average of 6,040 visits per year.

Lake Cameahwait has boat ramps and other developed facilities for camping and day use. Because of easy access to Boysen Reservoir, Lake Cameahwait attracts spillover camping from Boysen State Park visitors. Lake Cameahwait is said to be especially popular with local families (Sims W., BOR, personal communication, July/August 2003b). All of the facilities at Lake Cameahwait are in close proximity to the WRPA.

Ocean Lake has three boat ramps and other boating facilities, various water recreation uses, camping, and day recreation use (Sims W., BOR, personal communication, July/August 2003b; WGFD, no date). Muddy Ridge Reservoir, which is popular with Tribal residents (Aragon, D., WREQC, personal communication August 6, 2003), attracts some water-based day use in addition to its main use as a small recreation fishery (Roth, S., USFWS, personal communication, August 6, 2003). Ocean lake sites in close proximity to the WRPA are the Stultz and Dickinson sites on the north shore of the Lake. Analysis of traffic counter data indicate that these sites, which are accessed from SH 134, attracted about 34 percent of total visitors to Ocean Lake in the five years ending in 2002, or about 14,070 visits per year on average. These data are calculated from information provided by Sims (BOR, personal communication, July/August 2003b).

A limited amount of wildlife viewing (mainly bird watching) occurs in the Sand Mesa WHMA, typically by individuals whose primary reason for visiting is to hunt or fish (Cowling, B., WGFD, personal communication, September 2003). The Wyoming Wildlife Viewing Tour Guide (WGFD 1995) maps out two driving tours that use roads in and near the WRPA, but not much visitor or local resident travel for wildlife watching has resulted (Sims W., BOR, personal communication, July/August 2003b; Thorson, T., Riverton Chamber of Commerce, personal communication September 2003; University of Wyoming 2003).

3.10.4 Recreation Planning

A comprehensive plan that addresses all land within the exterior boundary of the WRIR, regardless of jurisdiction, is under way at the Land Use Planning department of the New'e Development Corporation of the Eastern Shoshone Tribe with input from the Eastern Shoshone and Northern Arapaho tribal councils. Recreation and other public use goals in the preliminary draft emphasize locating sites for developed facilities at existing residential communities on the WRIR. No recreation goals are anticipated specifically for lands within the WRPA (Cottonoir, M., Newe Development Corp, personal communication, September 2003).

Limited recreation planning is occurring for the non-tribal areas in and near the WRPA. The WGFD has begun preparing Managed Land and Access Summary documents for WHMAs statewide. Planning is scheduled to begin in 2004 for the Sand Mesa and Ocean Lake WHMAs. For these areas, which are at capacity, planning efforts are likely to reinforce the current policy of maintenance, but would not expand existing recreation resources (Cowling, B., WGFD, personal communication, September 2003).

The existing master plan for Boysen State Park is more than 10 years old. Although the Wyoming Department of State Parks & Cultural Resources has begun updating state park master plans, an update of the Boysen State Park master plan has not been prepared to date (Wilson, D., Boysen State Park, personal communication, August and September 2003). The BOR has no recreation plan for the Riverton Withdrawal Area, that includes much of the WRPA (Dallman, J., BOR, personal communication, August 5, 2003).

Fremont County continues to use an existing 1973 land use plan, and the goals and objectives in the Draft Fremont County Land Use Plan (2001) described in Section 3.7.9.3, have not been adopted. The draft 2001 plan names recreation as one of the county=s Ahistorical economic pursuits," and calls for improved recreation for residents and visitors on a countywide basis, including more picnic and camping facilities, improved access to public lands and recreation sites, and partnerships with public land management agencies and private entities to add, upgrade, or abandon roads and facilities (Fremont County 2001). The Fremont County planning documents contain no specific recreation plans for land within the WRPA.

3.11 VISUAL RESOURCES

3.11.1 Regional Characterization

The mountains and public lands of northwestern Wyoming draw many tourists to the region. The Wind River Indian Reservation WRIR and immediate surroundings contain many recreational and scenic attractions, including Boysen State Park, Wind River Canyon, Ocean Lake, and several Wildlife Habitat Management Areas. The region also contains several towns and cities, with populations ranging from 150 to over 9,000. Table 3.11-1 contains additional population data.

Table 3.11-1. Regional Cities and Towns near the WRPA.

Location From WRPA	Population	Distance From WRPA[1]
North:		
Thermopolis	3,172	20 miles
South:		
Arapahoe	1,766	17 miles
Ethete	1,455	13 miles
Fort Washakie	1,477	19 miles
Hudson	407	21 miles
Lander	6,867	26 miles
Riverton	9,310	13 miles
East:		
Shoshoni	635	8 miles
West:		
Pavillion	165	½ mile

[1] Miles represented are direct miles, not travel miles.
Source: 2000 U.S. Census Bureau.

3.11.2 General Visual Characteristics

The WRPA consists of a variety of landscape scenery types. The area is located on the northern fringe of the Intermountain Semidesert Ecosystem Province, and therefore has characteristics of a transitional high desert landscape (Bailey 1995). The WRPA is located in a transitional zone between sagebrush plains and the Owl Creek Mountains, located to the north. Elevations throughout the WRPA range from 4700 feet near Cottonwood Bay on Boysen Reservoir in the northeast, to 5900 feet on Muddy Ridge in the northwest.

Two primary landscape types exist within the WRPA. The southern portion is predominately rolling sagebrush plains, interspersed with small hills and rocky ridges. Some of the ridges create dramatic contrasts in the landscape, especially in the eastern half of the WRPA. This southern portion also contains large areas of irrigated agricultural land. The northern portion of the WRPA is somewhat drier and is predominantly comprised of eroded badlands and mesa formations with sparse natural plant cover. This portion also contains irrigated agricultural lands. Several major mountain ranges are visible from the WRPA including the Owl Creek Mountains to the north, the Absaroka Mountains to the northwest, and the Wind River Range to the west.

Three stream systems traverse the WRPA. Two are perennial and the third is ephemeral. The geography and geology of the area creates a dendritic drainage pattern that generally flows from west to east, toward the north-flowing Wind River. The larger of the two perennial systems is Muddy Creek, which flows in a southeasterly course for 19 miles through agricultural and rangelands in the eastern portion of the WRPA. Fivemile Creek is a smaller perennial system that flows for 10 miles through the southwest portion of the WRPA. This stream flows on a southeasterly course through an area that is primarily agricultural lands. Cottonwood Creek is an ephemeral stream flowing for 5 miles through the northern portion of the WRPA. Outside the WRPA, Cottonwood Creek parallels the northern boundary within a ½ mile for 7 miles to its terminus at Boysen Reservoir. Cottonwood Creek drains the Owl Creek Mountains to the north and traverses a lower-elevation and drier portion of the WRPA. This drainage contains much sparser vegetation than the other two stream systems. Several ponds are also present within the WRPA. Three of the ponds, as well as Fivemile Creek and Muddy Creek, are all managed as part of the Sand Mesa Wildlife Habitat Management Area (WHMA). In addition to these water features, a 16-mile section of the Wyoming Canal flows through the northern portion of the WRPA.

Vegetation throughout the WRPA varies widely. Areas that are utilized for grazing are typically a sagebrush and bunchgrass-dominated landscape. The agricultural lands stand in sharp contrast to the adjacent rangelands. The predominant crops are alfalfa, corn, wheat and vegetables. Riparian zones throughout the WRPA are characterized by a mixture of native and non-native plant species including cottonwood, willow, Russian olive, greasewood, sedges, and grasses. Distinct strips of vegetation consisting of various grasses, sedges, and cattails surround the ponds in the area. The drier lands within the WRPA have much sparser vegetation that includes sagebrush, greasewood, rabbitbrush, cactus, and sedges in low-lying areas.

A majority of the land within the WRPA has been culturally modified, primarily through grazing, farming, and resource extraction. Some areas, such as the agricultural lands, have been heavily modified for production purposes. The agricultural areas contain residences as well as structures including barns, pivot irrigation systems, grain storage structures, fences, irrigation canals and ditches, haystacks, silos, and other associated farm structures. There are no urbanized areas in the WRPA. The community of Pavillion lies just west of the WRPA, and the City of Riverton is located 13 miles to the south (See Table 3.11-1 for other regional cities and towns). Resource extraction facilities exist throughout much of the WRPA in the form of natural gas wells and their associated components including wellheads, storage tanks, production units, meters, pipelines, evaporation ponds, well pads, access roads, and compressor stations. Grazing areas usually contain livestock fencing and some non-native plant species. Several utility lines also traverse the WRPA.

3.11.3 Visual Resource Management System

The Bureau of Indian Affairs (BIA), as the managing agency for the WRPA, lacks a system for identifying and measuring visual quality, contrast, and mitigation. However, the Bureau of Land Management (BLM) has developed a system for Visual Resource Management (VRM) that has been used extensively for BLM-managed lands (BLM 1986). The Department of the Interior governs both the BIA and the BLM. Therefore, in the absence of a BIA visual resource management system, the BLM's system of Visual Resource Management has been used for this EIS.

The BLM's VRM system addresses several key areas of visual resources. The VRM system is based on the premise that all lands have some level of scenic value. However, different levels of scenic value require different levels of management. For example, management of an area that has been determined to have high scenic value might be focused on preserving the existing character of the landscape, while management of an area with little scenic value might accommodate major modifications to the landscape. Prior to formalizing a management strategy for an area, the scenic value of the visual resources within that area must be classified.

The BLM's VRM system provides a set of rules to objectively identify, evaluate, and classify the scenic values of an area. Management of the area from a visual resource perspective is then based on the classification the area has been assigned. The classification system also provides a way to analyze potential visual impacts and apply visual design techniques to ensure that modifications to the landscape conform to the management objectives for that area.

The BLM Visual Resource Classes and management objectives are as follows:

<u>Class I Objective</u>: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

<u>Class II Objective</u>: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.

<u>Class III Objective</u>: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.

<u>Class IV Objective</u>: To provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high (BLM Visual Resource Management, in BLM 1986)

3.11.4 Scenic Quality Evaluation

As part of the VRM system, areas are classified according to their scenic qualities. Scenic quality is a measure of the visual appeal of a tract of land. Land areas are grouped according to similar scenic quality. The following factors are considered when delineating areas:

- Like physiographic characteristics (i.e. landform, vegetation, etc.)
- Similar visual patterns (i.e. texture, variety, color, etc.)
- Areas which have a similar impact from cultural modifications (i.e. roads, structures, mining operations, or other surface disturbances)

The resulting areas are called Scenic Quality Rating Units (SQRU's), and are given a rating of A, B, or C based on the sum of scores for the following factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Table 3.11-2 provides the methodology for evaluating the rating of an area. During the rating process, each of these factors is ranked in comparison with similar features within the physiographic province, in this case the Wyoming Basin.

Table 3.11-2. Scenic Quality Inventory and Evaluation Chart.

Key factors	Rating Criteria and Score		
Landform	High vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variation or highly eroded formations including major badlands or dune systems; or detail features dominant and exceptionally striking and intriguing such as glaciers. **5**	Steep canyons, mesas, buttes, cinder cones, and drumlins; or interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional. **3**	Low rolling hills, foothills, or flat valley bottoms; or few or no interesting landscape features. **1**
Vegetation	A variety of vegetative types as expressed in interesting forms, textures, and patterns. **5**	Some variety of vegetation, but only one or two major types. **3**	Little or no variety or contrast in vegetation. **1**
Water	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **5**	Flowing, or still, but not dominant in the landscape. **3**	Absent, or present, but not noticeable. **0**
Color	Rich color combinations, variety or vivid color; or pleasing contrasts in the soil, rock, vegetation, water or snow fields. **5**	Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element. **3**	Subtle color variations, contrast, or interest; generally mute tones. **1**
Influence of Adjacent Scenery	Adjacent scenery greatly enhances visual quality. **5**	Adjacent scenery moderately enhances overall visual quality. **3**	Adjacent scenery has little or no influence on overall visual quality. **0**

Table 3.11-2 (Continued)

Scarcity	One of a kind; or unusually memorable, or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing, etc. **5+**	Distinctive, though somewhat similar to others within the region. **3**	Interesting within its setting, but fairly common within the region. **1**
Cultural Modifications	Modifications add favorably to visual variety while promoting visual harmony. **2**	Modifications add little or no visual variety to the area, and introduce no discordant elements. **0**	Modifications add variety but are very discordant and promote strong disharmony. **-4**

Source: BLM Visual Resource Management 2003b.

Table 3.11-3. Scenic Quality Rating Summary for the WRPA

Scenic Quality **Rating Unit**	**Landform**	**Vegetation**	**Water**	**Color**	**Adjacent Scenery**	**Scarcity**	**Cultural Modifications**	**Total Sore**	**Scenic Quality Rating[1]**
Agricultural	1	3	0	3	3	1	0	**11**	**C**
Upper Rangeland	1	3	0	1	3	1	0	**9**	**C**
Muddy Ridge	3	3	0	3	0	2	0	**11**	**C**
Lower Rangeland	1	3	0	1	3	1	0	**9**	**C**
Bluffs	3	1	0	2	0	1	0	**7**	**C**
Muddy Creek	1	3	0	2	0	3	0	**9**	**C**
Muddy Ridge Gas Field	1	3	0	1	0	1	-4	**2**	**C**
Indian Ridge	3	1	0	1	0	3	0	**8**	**C**
Middle Reservoir	1	3	5	3	0	3	0	**15**	**B**
Habitat Management Area	1	3	5	3	3	3	0	**18**	**B**

Source: Otak, Inc. 2003.
[1]Rating determined as follows: A = 19 or more
B = 12-18
C = 11 or less

The WRPA was evaluated for its existing scenic qualities. Ten different Scenic Quality Rating Units were identified and rated using the VRM system as shown on Figure 3.11-1. Names assigned to SQRU's are for descriptive purposes only and are relevant to the

WRPA, not the surrounding region. Table 3.11-3 provides the ratings for the various SQRU's within the WRPA, and Table 3.11-4 summarizes the areas and percent of the WRPA for each SQRU. Figure 3.11-2 provides a map of the distribution of scenic quality ratings within the WRPA. The ten SQRU's for the WRPA are described below.

Table 3.11-4. Area of Scenic Quality Rating Units.

SQRU Name[1]	Acres[2]	% of WRPA	Score[3]	Scenic Quality Classification[4]
Agricultural	46,342	50.8%	11	C
Upper Rangeland	19,649	21.5%	9	C
Muddy Ridge	7,685	8.4%	11	C
Lower Rangeland	7,078	7.8%	9	C
Bluffs	3,426	3.8%	7	C
Muddy Creek	3,280	3.6%	9	C
Muddy Ridge Gas Field	2,683	2.9%	2	C
Indian Ridge	441	0.5%	8	C
Middle Reservoir	424	0.5%	15	B
Habitat Management Area	202	0.2%	18	B
Total[2]:	**91,210**	**100%**		

[1]See Figure 3.11-1;
[2]Acreage was generated by a GIS evaluation of the SQRU's, that was created as a shapefile by Otak, Inc. These quantities may or may not coincide with other land area estimates within this EIS. Margin of error is assumed to be less than .01%.
[3]See Tables 3.11-2, 3.11-3;
[4]See Figure 3.11-2.

Figure 3.11-1. Scenic Quality Rating Units and Scenic Quality Rating Unit Names In the Wind River Project Area.

Figure 3.11-2. Scenic Quality Classes in the Wind River Project Area.

3.11.4.1 Agricultural

Four areas were identified as agricultural SQRU's within the WRPA. Agricultural lands were defined as those in agricultural production as well as associated adjacent lands of similar character and visual quality. Many of the agricultural areas are under irrigation, and therefore contrast with adjacent non-irrigated lands. The overall landform is typically flat, with elevation changes being very slight within each SQRU. These SQRU's are heavily culturally modified lands that contain a variety of crops, including alfalfa, wheat, corn, and other vegetables. Crops may exist in varying states of growth or harvest, depending upon the season. Structures may include residences, barns, grain storage structures, silos, outbuildings, pivot irrigation systems, utility poles, fences, haystacks, driveways, and other farm-related items. Straight dirt roads create a grid pattern to most of the areas. Resource extraction facilities exist throughout many of the agricultural SQRU's in the form of natural gas wells and their associated components including wellheads, storage tanks, production units, meters, pipelines, evaporation ponds, well pads, access roads, and compressor stations.

3.11.4.2 Upper Rangeland

Six distinct areas were identified that comprise the upper rangeland SQRU's. This landscape is typified by arid shrublands on flat to rolling topography. The dominant plant species is sage intermixed with bunchgrasses, creating a muted stipple pattern over the landscape. Vegetative cover is usually consistent and plentiful enough to obscure soil coloration. Cultural modifications in these areas usually consist of fences, power lines, and/or two-lane gravel or paved roads.

3.11.4.3 Muddy Ridge

The Muddy Ridge SQRU is comprised of two separate units. Both units encompass portions of the prominent Muddy Ridge formation that extends 10 miles through the western part of WRPA and continues to the northwest outside of the project boundary. The ridge formation is actually a wide mesa in most locations, with steep sides that have been eroded to form gullies, arroyos, small canyons, and some cliffs that add to the overall scenic quality of the SQRU. The mesa top is mostly flat, with some slight rolling undulations and changes in elevation. In other areas, the formation is narrower with some smaller ridges extend 4 feet out from the main ridge. Elevations along the top of the ridge range from 5520 feet to 5860 feet, with ridge heights between 140 feet to 280 feet above the valley floor. Vegetative cover on the sideslopes of the ridge is minimal, exposing brown, tan, gray, and red soil. On the top of the ridge, or mesa, low, rounded shrubs and herbaceous plants create a smooth-textured, stippled appearance to the landscape. Cultural modifications in the area include roads and some resource extraction facilities on the sideslopes of the ridge that detract from the overall scenic quality of the SQRU. The concentrated area of gas wells on Muddy Ridge has been evaluated as a separate SQRU named Muddy Ridge Gas Field.

3.11.4.4 Lower Rangeland

Two areas were identified as lower rangeland SQRU's. These are located in the northeastern portion of the WRPA, in the Cottonwood Creek drainage area. These lands are mostly arid shrublands on flat to rolling topography. Areas containing arroyos and their associated erosion patterns indicate seasonal drainage and flooding. Buttes, small hills, and mesas, comprise a smaller percentage of the land but add to the scenic quality of the area.

Plants primarily consist of greasewood and sagebrush with patches of sedges in several low-lying areas indicating moist soil conditions. A lack of uniform vegetative cover reveals soil colors of brown and tan, with some reddish colors evident in taller, eroded land formations.

3.11.4.5 Bluffs

Bluffs comprise one SQRU in the northeastern portion of the WRPA. The area is a transitional landscape from the higher elevations in the south to the lower elevations in the north in the Cottonwood Creek drainage. This SQRU is defined by a long, linear erosional formation created on the edge of a plateau. The bluffs roughly parallel Cottonwood Creek, and are comprised of rills, gullies, arroyos, and sediment deposition areas below the base of the bluffs. They range in height from 50 feet to 150 feet. Minimal vegetative cover exposes the gray, brown, and red colors of the soil that sometimes occur in horizontal banding. Cultural modifications in the area include some roads and utility poles with overhead lines.

3.11.4.6 Muddy Creek

Muddy Creek comprises one SQRU, mostly in the eastern portion of the WRPA. The creek follows a slow, meandering course through 19 miles of the WRPA, from an elevation of 5340 feet at the north boundary to 4760 feet at the eastern boundary. Muddy Creek and its associated riparian area create a band of vegetation from 25-500 feet in width that contrasts with the adjacent lands. This riparian area is distinct in color, texture, line, and form in comparison to the surrounding lands. Vegetation includes areas of cottonwood stands mixed with Russian olive trees, greasewood, and grasses. The stream channel is deeply incised in many places and its width is typically narrow in comparison to the overall riparian area, ranging from 5-15 feet. Due to the narrow channel and extensive surrounding vegetation, the water surface is not readily visible in most locations, and therefore does not enhance the overall scenic quality of the SQRU.

3.11.4.7 Muddy Ridge Gas Field

The Muddy Ridge Gas Field is located on Muddy Ridge, but has been evaluated as a separate SQRU due to substantially different scenic qualities. This SQRU is located in the western portion of the WRPA, between the two units of the Muddy Ridge SQRU. The ridge formation is a wide mesa in most locations, with steep sides that have been eroded to form gullies, arroyos, small canyons, and some cliffs. The mesa top is mostly flat, with some slight rolling undulations and changes in elevation. In other areas, the formation is narrower, with some smaller ridges extending out from the main ridge. Elevations along the top of the ridge range from 5560 feet to 5700 feet, with ridge heights between 140 feet to 280 feet above the valley floor. Vegetation is minimal on the side slopes of the ridge, exposing soil colors including browns, tans, grays, and some reds. On the top of the ridge, or mesa, more vegetative cover exists than on the side slopes, although it is limited due to extensive roadways and resource extraction facilities. Here, low rounded shrubs and herbaceous plants create a smooth-textured, stippled appearance to the landscape. The scenic quality of the area has been highly modified by existing resource extraction facilities, in the form of gas wells and their associated components, which are located on both the sides and top of Muddy Ridge. The area is visible from a variety of locations and distances within the WRPA. The presence of the resource extraction facilities detracts from the overall scenic quality of the SQRU.

3.11.4.8 Indian Ridge

The Indian Ridge SQRU is comprised of one unit located in the southwest portion of the WRPA, surrounded by agricultural lands. Indian Ridge is a prominent rock formation in a northwest to southeast orientation that is 2.5 miles long and varies in width from 500-1700 feet. The height from the surrounding landscape averages around 100 feet. The ridge is comprised of mostly blocky vertical cliffs with broken rock at its base. The solid nature of the rock material combined with its brown and tan coloring contrast sharply with the surrounding agricultural landscape. Vegetation on the ridge is minimal, and includes small sagebrush, grasses, and cactus. Cultural modifications on the ridge include roads and some resource extraction facilities on the sides and top of the ridge that detract from the overall scenic quality of the SQRU.

3.11.4.9 Middle Reservoir

The Middle Reservoir SQRU is comprised of one unit and is located in the eastern portion of the WRPA. Middle Reservoir is also included in the Sand Mesa WHMA. The unit is highly visible from the adjacent Sand Mesa Road, which is a county road. The dominant element within the SQRU is a large pond. The pond has an undulating edge, with clear open water. The landform within the unit is generally sloping to flat. Vegetation is comprised of a distinct band of grasses around the wetland edge of the pond, and sagebrush and grasses on the upland terrain adjacent to the wetlands. Cultural modifications on adjacent lands include agricultural lands and facilities, and some resource extraction facilities. The existence of these cultural modifications detracts from the overall scenic quality of Middle Reservoir.

3.11.4.10 Habitat Management Area

This SQRU is comprised of one unit in the western portion of the WRPA. The unit is within the Sand Mesa WHMA, to the north of Fivemile Creek. The main feature of this SQRU is a large pond with clear, open water. Surrounding the pond is a wide ribbon of wetland grasses that creates a strong contrast to the water and to the surrounding rangeland and agricultural land. A few stands of cottonwoods in the area and the nearby escarpments of Muddy Ridge add to the overall scenic quality of the unit.

3.11.5 Sensitivity Level Analysis

Sensitivity levels are a measure of public concern for scenic quality. Lands within the WRPA were assigned high, medium, or low sensitivity levels by analyzing various indicators of public concern. These factors and explanations as defined by the VRM system (BLM 1986) are as follows:

- Type of Users. Visual sensitivity will vary with the type of users. Recreational sightseers may be highly sensitive to any changes in visual quality, whereas workers who pass through the area on a regular basis may not be as sensitive to change.

- Amount of Use. Areas seen and used by large numbers of people are potentially more sensitive. Protection of visual values usually becomes more important as the number of viewers increase.

- Public Interest. The visual quality of an area may be of concern to local, state, or national groups. Indicators of this concern are usually expressed in public meetings, letters, newspaper or magazine articles, newsletters, land-use plans, etc. Public controversy created in response to proposed activities that would change the landscape character should also be considered.

- Adjacent Land Uses. The interrelationship with land uses in adjacent lands can affect the visual sensitivity of an area. For example, an area within the view shed of a residential area may be very sensitive, whereas an area surrounded by commercially developed lands may not be visually sensitive.

- Special Areas. Management objectives for special areas such as Natural Areas, Wilderness Areas or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and Areas of Critical Environmental Concern (ACEC) frequently require special consideration for the protection of the visual values. This does not necessarily mean that these areas are scenic, but rather that one of the management objectives may be to preserve the natural landscape setting. The management objectives for these areas may be used as a basis for assigning sensitivity levels.

- Other Factors. Consider any other information such as research or studies that includes indicators of visual sensitivity.

Each of these factors is discussed below:

3.11.5.1 Types of Users

There are several types of users within and adjacent to the WRPA. These include, but are not limited to, residents, recreationists (including hunters, anglers, boaters, and water sports enthusiasts), auto travelers, air travelers, tourists, farmers, ranchers, and resource extraction industry workers.

3.11.5.2 Amount of Use

Some areas within and adjacent to the WRPA receive high levels of use, while other areas receive low amounts of use. Ocean Lake and Boysen State Park recreation areas are adjacent to the WRPA and receive high levels of use, with combined visitor days at 184,448, based on a 5-year average (Sims, W., BOR, personal communication, July and August 2003a). The southern boundary of the WRPA is defined by State Route 134, which carries approximately 170,333 vehicles per year, based on a 3-year average, and is considered to be highly used by VRM standards. US Highway 26, near the eastern boundary of the WRPA carries approximately 1,400,383 vehicles per year, based on a 3-year average, and is also considered to be highly used (WYDOT 2001; Steele, E., WYDOT, personal communication, December 18, 2003). Alternately, the north-central portion of the WRPA is a remote area and receives a low amount of use. The majority of the other areas within the WRPA are estimated to receive mostly moderate levels of use from residents, workers, and others. (Traffic count data is not available for roads within the WRPA.)

3.11.5.3 Public Interest

Several areas of public interest have been identified regarding natural resources in the WRPA. The goals of the draft Wind River land use plan include providing a plan to conserve and preserve future resources. The document entitled Land Use Planning in Fremont County (Fremont County 2003), specifically addresses scenic areas in the section Scenic Areas and Historic Sites. The stated "Goal" of this section is to "Preserve, protect, and enhance scenic areas, historic sites, and cultural sites…”. The “Objectives” to the “Goal” include the following: “To identify and delineate areas which a majority of Fremont County residents believe to have outstanding qualities,” and “To develop by management, programs to protect areas of outstanding scenic beauty and historical significance.”

Scoping comments presented to the BIA in the form of letters and oral comments regarding the WRPA highlight concerns related to the scenic quality of the area. Areas of specific concern include:

- Impacts to air quality, clarity, and visibility in nearby Wilderness Areas and roadless areas.
- Construction impacts and the associated production of fugitive dust impacting air clarity.
- Impacts to local and regional visibility and haze.
- Impacts to visual impairment as associated with well densities.
- Impacts from night lighting of facilities.
- Reclamation and restoration of disturbed lands.

3.11.5.4 Adjacent Land Uses

Lands adjacent to the WRPA are owned and/or managed, by several entities, including the BLM, BOR, WRIR Wyoming State Parks, Wyoming State Wildlife Habitat Management (Wyoming Game and Fish), and private landowners. Several different land uses exist adjacent to the WRPA, including agriculture, ranching/rangeland, a State Park, Wildlife Habitat Management Areas, towns, and residential areas.

Adjacent to the eastern boundary of the WRPA, Boysen State Park and Cameahwait Lake have over 200 developed public sites that provide access and/or facilities for camping, boating, swimming, water skiing, fishing, ice fishing, picnicking, wildlife watching, hiking and ORV riding (Wyoming Division of State Parks & Historic Sites 2003). The Sand Mesa WHMA, also located on the eastern boundary, provides recreational opportunities in the form of hunting, fishing, and wildlife watching (WGFD 2003).

Adjacent to the southern boundary of the WRPA, there are three primary land uses. Rangeland managed by the BLM comprises the majority of the land use here. Privately-owned agricultural lands comprise another large area adjacent to the WRPA. The third land use type in this area is recreational use of the Ocean Lake (WHMA), which abuts the WRPA, and a small area of the Sand Mesa WHMA along Fivemile Creek. The Ocean Lake WHMA has 6 developed public sites that provide access and/or facilities for camping, boating, fishing, hunting, and hiking (WGFD 2002a).

Adjacent to the western boundary of the WRPA are four primary land use categories: private residential and agricultural lands, BIA-managed rangelands, BLM-managed rangelands, and a small portion of the Sand Mesa WHMA along Fivemile Creek. Private lands include the residential town of Pavillion, with a population of 165 (U.S. Census Bureau 2000).

Adjacent to the northern boundary of the WRPA there are four primary land use categories: BIA-managed rangelands, private residential and agricultural lands, BLM-managed rangelands, and a small portion of Boysen State Park. The majority of the land along the northern boundary of the WRPA is in a more remote area of the Wind River Indian Reservation that is not served by any federal or state roads or highways.

3.11.5.5 Special Areas

Three areas of special interest have been identified adjacent to and/or within the WRPA. These include the 40,000-acre Boysen State Park, the Ocean Lake WHMA, and the Sand Mesa WHMA. Boysen State Park, on a 5-year average, receives approximately 143,300 visitors per year (Sims, W., BOR, personal communication, July and August 2003), and is managed for recreational uses and wildlife. The State Park is adjacent to, and partly within, the WRPA. The Ocean Lake WHMA, on a 5-year average, receives over 41,000 visits per year (Sims, W., BOR, personal communication, July and August 2003) and is managed for wildlife while providing public access and facilities for various recreational activities. The Ocean Lake WHMA is adjacent to, and has a portion within, the WRPA. The Sand Mesa WHMA is managed for wildlife, while providing public access for hunting, fishing, and other uses. The Sand Mesa WHMA has a large portion of its area within and adjacent to the WRPA, including the two major perennial streams that traverse the WRPA.

3.11.5.6 Other Factors

The WRPA is located within 26 miles of several cities and towns that account for a total population of 25,254 (See Table 3.11-1). Fremont County comprises an area of 9,182 square miles, with a population of 35,967 (U.S. Census Bureau 2000).

The Riverton Regional Airport supports an average of 27 flights per day (9855 flights annually), including both commercial and private flights. The WRPA is within 10 miles of the airport. The airport promotes itself as a “year-round gateway” to the National Parks and other areas of northwestern Wyoming. Some airport travelers may be sensitive to visual impacts within the WRPA as viewed from aircraft (Riverton Regional Airport 2002).

3.11.5.7 Distance Zones

Per the VRM system, landscapes are subdivided into 3 distance zones based on relative visibility from travel routes or observation points (BLM 1986). The 3 zones are foreground-middleground, background, and seldom seen. The foreground-middleground (FM) zone includes areas seen from highways, rivers, or other viewing locations that are less than 5 miles away. Areas seen beyond the foreground-middleground zone but usually less than 15 miles away are in the background (BG) zone. Areas not seen as foreground-middleground or background (i.e., hidden from view) are in the seldom-seen (SS) zone.

Distance zones were evaluated from state and U.S. roads and highways within and adjacent to the WRPA. Limited portions of the WRPA are visible from US 26/WYO 789 west of Shoshoni, and US 20/ WYO 789 north of Shoshoni. These visible areas are in the Sand Mesa portion of the WRPA in the BG distance zone, beyond five miles from the road. Several areas of the WRPA are visible from WYO 134, along a 12-mile segment of the southern boundary. Travelers on the highway in this area have a continuous view into the southern portion of the WRPA. The majority of the area visible from this area of WYO 134 is in the FM distance zone, with three specific areas having visibility beyond the FM zone into the BG zone. These areas on WYO 134 are identified as follows:

- 0.25 mile east of Ocean View Road, BG zone into WRPA is visible for 0.25 mile or approximately 16 seconds at 55 mph,

- 0.75 mile east of Ocean View Road, BG zone into WRPA is visible for .10 mile or approximately 7 seconds at 55 mph,
- From Pattison Farms Road to the east 0.25 mile, BG zone into WRPA visible for approximately 16 seconds at 55 mph,
- From the 12-mile segment of WYO 134 from North Portal Road in the east to WYO 133 in the west, the WRPA is visible within the FM zone.

Terrain features in the landscape prevent visibility into the WRPA from other portions of the state and U.S. roads in the area.

Distance zones were also evaluated from county roads within the WRPA. Most areas within the WRPA are within the FM zone of county roads. Some areas within the WRPA are not visible from a county road due to terrain features, such as ridges or valleys, and are therefore considered to be in the SS distance zone. These areas include the northern portions of Sand Mesa and Coastal Extension in the Cottonwood Creek valley, and parts of Muddy Ridge.

Other key areas were evaluated for their visibility into the WRPA. The southwestern portion of the WRPA is visible from areas in the Ocean Lake WHMA. The areas visible are in the FM and BG distance zones, and can be seen from the Dickinson Park and Mills Point access sites, as well as from the water surface. Some areas of the eastern portion of the WRPA are visible from Boysen State Park in the FM and BG zones. Parts of the northern portion of Sand Mesa are visible from the Cottonwood Bay area, and other portions of Sand Mesa are also visible from the eastern shore area of Boysen State Park. Visibility into the WRPA from and near the water surface is limited due to terrain features and the low surface elevation of the reservoir relative to surrounding land.

Sensitivity Level Rating Units (SLRU's) were defined in the WRPA based on the factors listed above. Table 3.11-5 provides the sensitivity ratings and Figure 3.11-3 shows the data in graphical format. There are no standard procedures for delineating SLRU's. The boundaries depend on the factor that is driving the sensitivity consideration. Distance zone plays an important role in identifying SLRU boundaries.

Table 3.11-5. Sensitivity Level Ratings.

Sensitivity Level Rating Unit[1]	Type of User	Amount of Use	Public Interest	Adjacent Land Uses	Special Areas	Overall Rating[2]
1	M	H	M	M	M	M
2	L	L	L	L	L	L
3	M	M	M	M	M	M

Source: Otak, Inc. 2003.
[1]Refer to Figure 3.11-3
[2]H = High, M = Medium, L = Low

Figure 3.11-3. Sensitivity Level Rating Units Within the Wind River Project Area.

Two areas of medium sensitivity were identified within the WRPA. One area is located in the eastern portion, adjacent to Bass Lake Road. Bass Lake Road is the primary travel route to the west side of Boysen State Park. The factors driving the sensitivity level in this area are the types of users, amount of use, adjacent land uses, and special areas. The types of users in this area include recreationists traveling along Bass Lake Road to various sites at Boysen State Park, Cameahwait Lake, and Sand Mesa WHMA. Recreationists may be more sensitive to scenic quality than other types of users. This area receives a higher level of use than some other areas within the WRPA, primarily due to the adjacent recreational opportunities. These adjacent lands are managed for recreational uses and wildlife habitat, and may therefore be sensitive to other types of adjacent land uses. Boysen State Park has been evaluated as a Special Area because it is the only State Park of this size and type in the region. This medium sensitivity area comprises an area from the eastern boundary of the WRPA to three miles west of Bass Lake Road, encompassing much of the FM distance zone from Bass Lake Road.

The other medium sensitivity area is located adjacent to the southern boundary and WYO 134, and includes the majority of the southwestern portion of the WRPA. The factors driving the sensitivity level in this area are the types of users, amount of use, adjacent land uses, and special areas. Types of users in this area include recreationists at Ocean Lake WHMA, travelers/tourists along WYO 134, and residents within the WRPA and the nearby town of Pavillion. Adjacent lands include the residential town of Pavillion, and the Ocean Lake WHMA, which may be sensitive to other types of adjacent land uses. Ocean Lake WHMA has been evaluated as a Special Area, since it is a unique recreational and wildlife amenity in the region. This medium sensitivity area comprises an area from WYO 134 north, including the majority of residential and agricultural lands within the western portion of the WRPA.

One area of low sensitivity was identified. This area comprises a large portion of the central, northern, and western portions of the WRPA. The types of users in this area are generally residents and workers. The amount of use is lower than other areas of the WRPA, due in part to a lack of major roads and recreational areas, and a lower residential density than other areas of the WRPA. Many parts of this area are located in the SS distance zone from county roads within the WRPA. Adjacent lands to this area are primarily managed as rangelands or agricultural lands.

3.11.6 Visual Resource Inventory Classes

Per the VRM system (BLM 1986), visual resource classes are categories assigned to lands, which serve two purposes:

(1) an inventory tool that portrays the relative value of the visual resources
(2) a management tool that portrays the visual management objectives

Visual resource inventory classes are assigned through the inventory process. There are four classes: I, II, III, and IV (as described in Section 3.11.3). Class I is assigned to those areas where a management decision has been made previously to maintain a natural landscape. This includes areas such as national wilderness areas, rivers classified as "wild" under the National Wild and Scenic Rivers Act, and other congressionally and administratively designated areas that are preserved as natural landscapes. Classes II, III, and IV are determined based on a combination of scenic quality, sensitivity level, and distance zones. Classes are assigned to areas by combining maps for scenic quality, sensitivity levels, and distance zones and using the BLM VRM guidelines. The visual resource inventory (VRI) classification provides the basis for considering visual values and future visual management of an area (BLM 1986).

The WRPA has been evaluated to determine VRI classes. Through the process of evaluating the factors of scenic quality, sensitivity levels, and distance zones, two VRI classes have been identified. Table 3.11-6 provides the acreage and percent of the WRPA within each VRI class. This information is shown graphically in Figure 3.11-4. The majority of the WRPA has been identified as a Class IV area. A smaller portion of the WRPA has been identified as a Class III area. Two separate Class III units have been identified, both located in the Sand Mesa WHMA and both consisting of ponds and wetland vegetation that are relatively unique to the region.

Table 3.11-6. Visual Resource Inventory Classes.

VRI Class	Acres[1]	% of WRPA
III	626	0.7%
IV	90,584	99.3%
Total:	**91,210**	**100%**

[1]Acreage was generated by a GIS evaluation of the SQRU's, that was created as a shapefile by Otak, Inc. These quantities may or may not coincide with other land area estimates within this EIS. Margin of error is assumed to be less than 1%.

Figure 3.11-4. Visual Resources Inventory Areas (VRI) In the Wind River Project Area.

Per the VRM system, the established objectives for these Visual Resource Classes are:

- Class III Objective: The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

- Class IV Objective: The objective of this class is to provide for management activities that allow for major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

3.12 CULTURAL RESOURCES

The following section is organized to address a definition of cultural resources, the general cultural context of the WRPA, the nature and extent of existing information concerning cultural resources, and the affected environment for each of the alternatives.

3.12.1 Definitions

Cultural resources are the products of human history in the form of material items produced by human workmanship or use, and elements of the natural environment that were altered by peoples' activities. Examples in the planning area include historic artifacts, buildings, mines, trails, railroads, ditches and trash dumps, and historic landscapes from the last two centuries, and archeological sites with stone tools and flaked debris from their production, remnants of animals and plants produced by food processing, the remains of fires, rock art, and other evidence of ancient human activity. Cultural resources are considered important because the resources may yield information that will expand understanding of history or prehistory and/or because the resources represent specific historic events, patterns of historic activities including building and engineering practices, or the lives of persons who were important in history. Physical manifestations of human activity must normally be more than 50 years old to be considered cultural resources, but sites, structures or objects related to exceptional historical events within the past 50 years may also be considered to be cultural resources.

Cultural resources may also include Traditional Cultural Properties (TCPs), which are properties that are critical to a living community's beliefs, customs, and practices. TCPs may include religious or ceremonial sites, other locations important in the belief systems of the community, and areas used by the community for gathering or otherwise producing materials used for traditional ceremonial, spiritual, medicinal, or subsistence purposes. TCPs may be topographical features; stone alignments, rock art, or other physical artifacts; sources of plants or other materials; or areas without obvious physical manifestation of the site's cultural significance. Consideration of TCPs is especially pertinent in the current WRPA, because this area has been occupied by Shoshone people for at least several centuries and perhaps as long as 3,300 years. The Wind River Indian Reservation has been the permanent home of the Eastern Shoshone since 1868, and it has been home of the Northern Arapaho since 1878. The continuity of cultural association of these communities with the WRPA could indicate a relatively high sensitivity for existence of TCPs in the WRPA.

Four authorities may have primary responsibility for consideration of cultural resources within the WRPA: the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), the Bureau of Reclamation (BOR), and the Joint Business Council of the Eastern Shoshone and Northern Arapaho Nations. The BIA, BLM, and BOR are executive agencies of the United States government, and as such are bound by provisions of NEPA, the National Historic Preservation Act (NHPA), and other laws and regulations of the United States pertaining to cultural resources. Impact assessment for cultural resources under NEPA generally follows provisions of NHPA and implementing regulations of the Advisory Council on Historic Preservation in 36 CFR 800. The affected environment for cultural resources is limited to those sites, structures, objects, or historic districts that are eligible for nomination to the National Register of Historic Places (NRHP). To be eligible for the NRHP, properties must have historical, archaeological, architectural, or engineering significance and must have sufficient integrity of location, design, setting, materials, workmanship, feeling, and association to convey the significance of the property (36 CFR 60.4).

The Eastern Shoshone and Northern Arapaho Nations, through their Joint Business Council, administer activities on tribal lands (surface ownership) on the Wind River Indian Reservation. Some cultural resources, particularly archaeological sites, may have spiritual significance to the Shoshone and Arapaho Tribes that would not be easily identified under the Criteria for Evaluation for nomination to the NRHP. For example, a sparse prehistoric lithic scatter might be evaluated by an archaeologist as ineligible for the NRHP because the site is unlikely to yield important scientific information, but Shoshone or Arapaho cultural representatives might find spiritual significance in the site. On tribal surface lands, the affected environment for cultural resources may therefore extend to sites that are not otherwise believed to be eligible for the NRHP.

3.12.2 General Cultural Context of the WRPA

Cultural resources may be significant within one or more historical contexts. The general prehistoric and historic contexts below provide a framework for identification and evaluation of cultural resources within the WRPA.

3.12.2.1 Prehistory

Prehistory can be defined as Native American activities prior to written Euro-American history in the region. Information about prehistoric lifeways and chronologies is gathered by means of archaeological, ethnographic, and linguistic investigations.

The current WRPA is entirely within the desert-scrub vegetation community that dominates the Wind River Basin floor and the High Plains areas to the east and south. However, the mountain slopes of the Wind River Basin successively support communities of juniper and pine, grasslands, heavily timbered mountain slopes, and ultimately alpine communities (Porter 1962). The six vegetative zones of the region provided a variety of plant and animal resources to prehistoric and historic peoples, and the varying altitude and topography provided opportunities for seasonal human occupation and migration within the basin. The uplift that created the basin exposed Paleozoic and Mesozoic era strata that contain cherts and quartzites, which Native Americans used to make chipped stone tools. Subsequent glaciation shaped the mountain valleys, created the modern rivers, and resulted in deposit of lithic materials in lag deposits in many locations in the basin, including within the WRPA.

Previous archaeological investigations have indicated that the Wind River Basin has had human occupation for at least 11,000 years, from PaleoIndian periods to the present. The WRPA has been considered by archaeologists to be part of the Northwestern Plains culture area (Frison 1978, 1991), but research beginning in the late 1970s also indicates that prehistoric cultures in the study region had much in common with cultures from the Great Basin cultural area to the west and southwest. The cultural chronology for the Wyoming Basin developed by Metcalf (1987) and revised by Thompson and Pastor (1995) addressed the influences of the Great Basin cultures in western Wyoming, and that chronology is applicable to the WRPA. Cultural periods are identified chronologically by years before present (B.P.).

3.12.2.2 Paleoindian Period (11,500-7,500 B.P.)

The earliest human occupation in Wyoming appears to date from the beginning of the Holocene Epoch, when the decline of the Wisconsin Glacial Advance left a warmer, wetter climate than existed previously and than exists today. The open grasslands that dominated the region supported mammoths, bison, elk and a variety of other large game, small game, birds, and fish. The climate continued to be warm and dry during this period, resulting in the probable extinction of some of the mega-fauna by the end of the period.

Human occupation of the region during the PaleoIndian Period is generally divided into a series of cultural complexes represented by distinctive projectile point types. Clovis Complex peoples appear to have occupied the region beginning about about 11,500 years B.P. Multiple Clovis projectile points have been found in direct association with mammoth remains, which seems to indicate that the Clovis people relied substantially on mammoth hunting. By 10,900 years B.P., the Clovis Complex had been replaced by the Folsom Complex, which is represented by superbly crafted fluted lanceolate projectile points. Folsom points are frequently found in association with remains of now-extinct bison but not in association with mammoths, which may mean that mammoths were extinct by the time the Folsom Complex arose. Folsom Complex occupation of the general region appears to have ended about 10,200 years B.P. (Frison 1991). In the Northwestern Plains chronology, the Folsom Complex was followed by the Agate Basin Complex (10,500-10,000 B.P.), the Hell Gap Complex (10,000-9,500 B.P), the Alberta/Cody Complex (9,500-8,400 B.P), and several subsequent lesser complexes or phases ending between 8,000 and 7,500 years B.P.

Extensive evidence of PaleoIndian occupation has been found in the Wind River Basin and surrounding areas, in all ecozones from the basin floors to near timberline. Artifact assemblages from rockshelters and other sites in mountains around the Wind River and Bighorn River Basins seem to indicate that the PaleoIndian occupants of the mountains and foothills areas differed in subsistence strategies from PaleoIndian plains peoples. The mountain/foothills people seem to have relied on a wide variety of plant and animal resources, particularly deer and mountain sheep, while the plains peoples relied heavily on bison (Francis and Loendorf 2002:11).

3.12.2.3 Archaic Period (8,000-1,500 B.P.)

About 8,000 years ago, the climate of the region became much warmer and drier, resulting in extinction of the very large game animals and the rise of modern bison, elk, antelope, small mammals, and other modern wildlife. People occupying the Wind River Basin and surrounding areas apparently adopted a somewhat broader variety of subsistence patterns than had occurred in the PaleoIndian Period, although most plains peoples continued heavy dependence on big game hunting. Archaic Period sites in the region include rockshelters, open lithic scatters, fire hearths, roasting pits, and stone circles. Implements for grinding plant materials and insects are common in the artifact assemblages, and the Archaic Period as a whole is represented by multiple types of relatively large projectile points. Initial designation and characterization of the Archaic Period in this region occurred as a result of excavations near Boysen Reservoir, a few miles east of the current WRPA (Mulloy 1954, 1958; Frison 1978).

The Archaic Period is generally subdivided into three periods. The Early Archaic Period (8,000-4,500 B.P) corresponds to the Altithermal interval, in which the climate became much warmer and drier. In response to the harsh climate, at least some peoples moved to higher elevations in the mountains. The Middle Archaic Period (4,500-3,000 B.P.) is represented by the McKean Complex, which is characterized by a projectile point type, ground stone, roasting pits, and the first stone circles. Common occurrence of ground stone indicates the people were relying more heavily on plant resources for subsistence (Frison 1991). Use of semi-subterranean house structures began in the late Early Archaic Period, around 5,200 B.P., and continued through the Middle and Late Archaic Periods to the Late Prehistoric Period. Use of the house pit structures may indicate that cyclical or semi-sedentary occupation, rather than purely nomadic lifestyles, became more pronounced in the region during this time.

The Late Archaic Period (3,000-1,500 B.P) is characterized in the Northwestern Plains in general by large-scale, sometimes communal, bison hunting. Projectile points change from lanceolate and stemmed McKean types to corner-notched dart points. In the mountain/foothills area, however, a more diverse subsistence strategy appears to have persisted, including use of deer, bighorn sheep, and a variety of small game and plants. People in this area also appear to have maintained cultural connections with the Great Basin, as is evident in basketry found in several rock shelters (Francis and Loendorf 2002:13).

3.12.2.4 Late Prehistoric Period (1,500-500 B.P.)

The Late Prehistoric Period began with the introduction of the bow and arrow, and sites of this period contain relatively small side-notched and corner-notched projectile points. Pottery was also introduced during this period, generally consisting of cord-wrapped storage containers that reflect influences of Fremont Culture from the southwest. Pit house structures appear to have declined in use during the Late Prehistoric Period; these structures appear to have been largely replaced by more mobile structures that are archaeologically evident as stone circles. In the Northwestern Plains area in general, these changes in the archaeological record are understood to reflect a movement toward a more nomadic lifestyle based on hunting of increased herds of bison. Late Prehistoric Period sites are very common in the Wind River Basin.

3.12.2.5 Protohistoric Period (500-150 B.P.)

The Protohistoric Period is considered to be the period after technology introduced by Europeans began to affect the lifeways of the Native Americans, but before actual European contact with Native Americans in this region. Spanish expeditions in the 16th and 18th centuries extended into Colorado and Kansas, but these expeditions did not approach the current WRPA, and the expeditions had little lasting effect on the Native Americans of the Central Plains/Rocky Mountain Region. Of far greater effect was the introduction of horses by the Spanish in their permanent settlements in Mexico and northward into New Mexico. Escaped or stolen horses, and the progeny of those horses, were eventually obtained by the Shoshone and other tribes of the Northwestern Plains. Horses allowed much more efficient pursuit of the bison herds, and this in turn accelerated the shift to nomadic or cyclical lifestyles began in the Late Archaic and Late Prehistoric periods. By the end of the Protohistoric Period, Native Americans in the Wind River Basin had also begun to receive European trade goods, including metal items and beads, by means of trade with other tribes. Sites identified as being specifically from the Protohistoric Period are less common than Late Prehistoric sites in the region, probably because of the shorter duration of the

Protohistoric Period and because Euro-American items are found in upper components of many sites that originated in the Late Prehistoric Period or earlier.

3.12.2.6 Historic Period (150 B.P.-Present)

Exploration and the Fur Trade

The Historic Period in the general region may have begun in A.D. 1742-1743, when French traders Francois and Louis-Joseph Verendrye traveled from Mandan villages on the Missouri River in North Dakota southwestward, possibly as far as the Bighorn Mountains near current Sheridan, Wyoming. By 1805, at least one trader from British territories to the north had penetrated the Powder River drainage to the east of the current WRPA, but the Louisiana Purchase in 1803 and the subsequent Lewis and Clark Expedition of 1804-1806 opened the Northwestern Plains and Rocky Mountains to fur trappers and traders from the United States. In 1807-1808, John Coulter explored and trapped from the Yellowstone River to the Cody area and Jackson Hole. In 1811, Wilson Price Hunt led a party of 60 trappers up the Bighorn and Wind River Valleys and across the Wind River Range to the headwaters of the Green River. The Hunt party was accompanied for at least part of this journey by a party of Shoshone from the Wind River Valley. In 1812, Robert Stuart led a party of Astor (later American Fur Company) partners eastward from the Pacific Coast, probably across South Pass to the south of the current WRPA (Chittenden 1986:I:189; Larson 1978:8).

The fur trade dominated Indian-White relations in the region from 1810 to about 1840. Rendezvous were held at various locations along the Green River and along the southern side of the Wind River Range from 1824 to 1840, in which trade goods and supplies hauled from Missouri were traded for furs and contracts for furs to be produced in the following year. The Wind River Valley played prominently in the fur trade, and at least two rendezvous were held on the Wind River or its tributary, the Popo Agie River to the south and southwest of the current WRPA (Trenholm 1964: 73, 75). By 1840 the fur trade boom in the region had largely ended as a result of over-exploitation of the resources and decreasing profits for furs. As a result of the fur trade, Native American populations in the region received guns and large quantities of manufactured goods, but they also were exposed to smallpox and other diseases.

Overland Emigration

One unintended result of the fur trade and rendezvous system was the establishment of what became known as the Great Platte River Road, which ascended the Platte River, North Platte River, and Sweetwater River to South Pass. In several variations, the route then coursed westward or southwestward to the Green River and then eventually to California, Utah, or Oregon. Fur trader William Ashley began using this route in 1826 to bring pack trains of supplies and trade goods to trappers and traders at the rendezvous in Cache Valley, north of the Great Salt Lake in Utah. In the summer of 1830, fur trader William Sublette used wagons to transport goods westward to near South Pass and then northward to the annual rendezvous on the Popo Agie River. In 1835, Reverend Samuel Parker and Marcus Whitman accompanied an American Fur Company provision train to South Pass, and the two men then went on to Oregon. Whitman retraced the route from Missouri to Oregon in 1836, this time with wagons and the first White women to cross South Pass. Parker and Whitman's journeys along the trail were made for proselytizing purposes; beginning about 1841 the route became heavily used by wagon trains of prospective settlers headed for Oregon. Emigrant use of the trail swelled after gold was discovered in California in 1848, and in the 1850s portions of the route were used by Church of Latter Day Saints emigrants bound for the Great Salt Lake. Wagon trains continued to travel the Oregon-California-Utah Trail until well after the transcontinental railroad was completed in 1868 across southern Wyoming (Haines 1987). Extensive permanent White settlement began in central Wyoming with the re-discovery of gold near South Pass in 1865 (Larson 1978:112).

Historic Native American Occupation

The fur trade and White emigration profoundly affected the Native Americans of the region. The Wind River Basin was a part of a vast territory occupied by a people who became known as the Northern or Eastern Shoshone Tribe. Shoshones were linguistically related to the Comanche, Utes, Paiutes, and various groups in California. These peoples are generally understood to have expanded gradually from the southern Great Basin in California, but the time of their arrival in western Wyoming is not certain. According to one authority, Shoshone tradition has the tribe reaching the region by way of the upper Snake River in Idaho sometime before A.D. 1500 (Trenholm 1964:vii). This geographic migration pattern is supported by recent archaeological scholarship, but the same scholar postulates that ancestral Shoshones reached western Wyoming from 3,300 to 3,500 years before present (Holmer 1994:186-187). Other authorities argue that the Shoshones were the indigenous culture of the region for the past 8,000 years, or that the Shoshones did not occupy western Wyoming until the historic period (Swanson 1972; Butler 1981, 1983).

In prehistoric times, the Shoshones typically consisted of scattered families or small groups that subsisted by hunting a variety of large and small game and by gathering available plant resources. As the Shoshones moved onto the Plains, they became more dependent on hunting buffalo, and they adopted some of the lifeways of other Plains natives, including use of the skin lodge or tipi in replacement of structures with woven grass coverings. In the early 1700s, the Shoshone obtained horses, possibly through trade with Comanches or from the Utes. Horses allowed increased mobility for buffalo hunting and warfare, but horses and later guns obtained by other tribes also allowed those tribes to invade Shoshone territory.

Shoshones may have forayed as far north as the South Saskatchewan River in Canada, as far south as Mexico, and certainly as far east as the Missouri River during hunting or war expeditions. At some time in the late prehistoric period, the Shoshones may have been pushed from the Plains back into the Rocky Mountains by one or more enemies, possibly the Piegan division of the Blackfeet. At the end of the prehistoric period, the Shoshones occupied the Plains to the east of the Rockies in Wyoming. At that time the Kiowas occupied the area west of the Black Hills, and the Comanches occupied territory to the south of the Kiowas; these tribes appear to have had a friendly relationship with the Shoshones. By A.D. 1700 the Comanches had begun to migrate southward, with some ending up in Texas. The Kiowas, too, migrated southward to the area along the Platte River (Trenholm 1964:19).

The Kiowas and Comanches were replaced in the Black Hills and the eastern High Plains by the Staitans, the Cheyennes, and after about 1800 by the Teton Dakotas or Sioux. The Shoshones also came into contact, sporadically hostile and friendly, with the Crows, who moved westward from the Missouri River to occupy the southern tributaries of the Yellowstone River, principally the lower Bighorn, Tongue, and Powder Rivers. Shoshones also came into contact and conflict with the Arapahos, who were linguistically related to the Blackfeet and the Cheyennes. The Arapahos also moved southward through the region in historic times, finally ending up in Colorado prior to the reservation period. In the early 1800s, the Arapahos formed an alliance with the Cheyennes and later with the Dakotas against their common enemies, including the Shoshones. In historic times, the Arapahos were a thoroughly nomadic people who depended heavily on buffalo hunting (Trenholm 1964:19-22).

By the 1840s, the WRPA in the Wind River Basin was hotly contested among the Shoshones, the Crows, the western elements of the Cheyenne and Dakotas, and occasional parties of Blackfeet from the north. In 1841 the Cheyenne and Dakotas began open, wide-scale hostilities against Whites traveling through the High Plains. At that time, the Eastern Shoshones apparently drifted southward to the Green River, and they became known to Whites as the Green River Snake Indians. Movement of the Shoshones to the Green River may have been a result of pressure from other Native groups, the advantages for trade and supply offered by Fort Bridger after 1843, or a combination of those factors. Some Eastern Shoshones apparently joined their western kinsmen in depredations on White wagon trains along the Oregon-California-Utah Trail, but the Shoshones generally were friendly to Whites and served as scouts and fighting forces for several U.S. Army expeditions against other tribes in the 1860s and 1870s.

In July 1868, the Eastern Shoshones agreed to relinquish 44,672,000 acres of their traditional occupation areas in Wyoming, Colorado, Utah, and Idaho in exchange for a 3,000,000-acre reservation centered on the Wind River Basin in Wyoming. In 1872 the Eastern Shoshones relinquished an additional 601,000 acres in the southern portion of the reservation, and in 1896 they relinquished 64,000 acres from the northeast corner of the reservation. When the Shoshone reservation (Wind River Reservation) was established in 1868, the Northern Arapahos asked the U.S. government to place them on that reservation. Shoshone Chief Washakie acceded to a temporary location of the Arapahos on the reservation, but the next year the Arapahos left the Wind River Reservation and requested their own reservation along the North Platte River in the vicinity of Casper. However, in 1878 the U.S. government again placed the Northern Arapahos on the Wind River Reservation. In general, the Arapaho settlement was in the eastern area of the reservation, and the Shoshones settled in the western portion of the reservation near the foothills of the Wind River Range.

Irrigation and Euro-American Settlement

In 1905 the U.S. government determined that the Wind River Reservation included “excess lands” that could be sold to non-Indian settlers. Funds from sale of the lands would be applied to per-capita payments, development of an irrigation system, and creation of a school district and a welfare and improvement fund. The government offered 1,480,000 acres for sale in an area bounded by the north fork of the Big Wind River on the west, the Big Horn River on the east, the Wind River on the south, and Owl Creek on the north. In August 1906, an estimated 10,000 people rushed in to claim homesteads (Autobee 1995:7-8)

The Wind River Reservation receives an average of only about nine inches of precipitation per year, and at least some of the homesteaders may have been misled by a State of Wyoming estimate that up to 265,000 acres of the reservation could be irrigated profitably. Irrigation had actually started in the general region as early as the 1860s, mostly to water hay fields immediately adjacent the Popo Agie and Wind Rivers. Irrigation of Indian lands began in 1871 with construction of the Crooked Creek Ditch, and in 1905 the U.S. Indian Service supervised five irrigation units on the reservation. Homesteaders’ desire for irrigation encouraged a speculative canal-building venture initially led by salt magnate Jay Morton and Wyoming’s Secretary of State Fenimore Chatterton. The Wyoming Central Irrigation Company was granted a state permit to construct two canals, 35 and 40 miles long, from the Wind River, with the water to be sold as perpetual water rights to homesteaders in the Riverton area. The first of the canals was completed in 1907, but by 1910 the venture had proven unprofitable in part because much of the land in the region was not irrigable. In 1918 all rights to the canal were assigned to the U.S. Reclamation Service, later renamed the Bureau of Reclamation (Autobee 1995:9).

Federal irrigation studies began in 1916, and in 1918 a Reclamation Service report indicated that, contrary to the earlier studies, large portions of the area could not be irrigated without construction of drainage systems to control seepage. Even so, the federal government authorized the Riverton Project on 1918 under provisions of the Indian Appropriation Act, and the Secretary of the Interior withdrew about 322,000 acres of the “excess” reservation land that had not been claimed by homesteaders or had been subsequently abandoned. About 100,000 acres of the withdrawn lands were offered for settlement, and the Indians were compensated at $1.50 per acre for lands that were actually sold by the Reclamation Service.

The Riverton Project was constructed in many stages between 1920 and 1951. Key features of the Project are the Wind River Diversion Dam, about 34 miles northwest of Riverton and built in 1921-1923; the 62.4-mile Wyoming Canal, built in stages from 1920 to 1951; the Pilot Butte Dam and Reservoir, built in 1922-1926; the Pilot Butte Power Plant, built in 1923-1925; the 38-mile Pilot Canal, built in 1926-1947, and Bull Lake Dam and Reservoir, built in 1936-1938. In addition to the main features, the Project includes 300 miles of lateral ditches (including 104 miles of lined ditches and 6 miles of pipelines) and 335 miles of drainage structures (including 141 miles of closed pipelines. The portion of the Wyoming Canal in the current WRPA was built from 1947 to 1951 (Autobee 1995:11-20).

The Riverton Project did not attain the level of development that had been hoped for by the Reclamation Service, either in the number of irrigated acres or the number of homesteaders on the land. Water was first made available in 1925 for 1,600 acres west of Pilot Butte Reservoir. By 1929, the area that could be irrigated had expanded to 20,000 acres, but in fact only 1,075 acres were irrigated that year. As the Great Depression deepened, farmers left dryland farms for the available irrigable lands in the Riverton Project, which then extended in two irrigation divisions from the Wind River Diversion Dam eastward to about seven miles east of the Pilot Butte Reservoir. By 1939 all of the available farm units in these two divisions had been purchased, and in 1947 an additional 7,000 acres of irrigable lands were opened for purchase in the Lost Wells and Pilot Extension areas of the Second Division. A Third Irrigation Division was created to the east, and about 13,000 acres of supposedly irrigable lands were opened for sale from 1948 to 1950. However, a 1951 soil survey indicated that large areas of the Third Irrigation District were actually not irrigable, and by the early 1960s most farms in the Third District had failed or were in dire financial condition. The Bureau of Reclamation bought back about 22,000 acres and eventually sold the most productive lands to farmers of the Midvale Irrigation District (Autobee 1995: 26-28).

3.12.3 Cultural Resources Investigations in the WRPA

Within the current WRPA, investigation and reporting of cultural resources is complicated by split-estate ownership of surface and mineral rights and the separate and dual authorities of federal agencies and the Tribes. Cultural resources investigations in the WRPA have been accomplished and reported under three scenarios. Standard investigation and reporting under Section 106 of NHPA has been accomplished for lands in which (1) surface rights are owned by the United States and administered by the Bureau of Land Management or the Bureau of Reclamation, (2) surface rights are owned by non-Native individuals, but mineral rights are held by the United States, or (3) surface rights are owned by non-Native individuals, but mineral rights are held by the Tribes and administered in trust by the BIA. Survey or other investigation of these lands is conducted by persons qualified under the Secretary of the Interior’s Standards (36 CFR 60). Standard reporting includes submittal of survey and site information to the State Historic Preservation Officer (SHPO) and the maintenance of such information at the Wyoming Cultural Records Office (WCRO) at the University of Wyoming.

The Eastern Shoshone and Northern Arapaho Tribes, as sovereign nations, have maintained authority for cultural resource investigations of lands where the surface is owned by the Tribes. Cultural resource investigations on these lands have been conducted by professional archaeologists, but the results of most of these investigations are not reported to the SHPO and are not represented in records of the WCRO. In addition to professional archaeological investigations, many project areas were examined by tribal elders for the purpose of determining cultural sensitivity that may or may not be represented by archaeological materials. Site and survey records for investigations on Tribal surface lands are maintained by the Tribes’ Joint Business Council at their offices at Fort Washakie.

Prior to about 1985, some proposed project areas on Tribal lands were examined only by tribal elders, without accompanying examination by professional archaeologists. These tribal examinations were not formally reported, and therefore no record of these examinations exists.

Records of the WCRO/SHPO and the Joint Business Council contain reports of 191 cultural resource investigations within the current WRPA. Appendix M contains a summary of investigations for the WRPA. Reported cultural resources investigations have addressed approximately 20 percent of lands within this WRPA. A majority of cultural resources investigations within the WRPA have been conducted in advance of oil and gas development, within limited well pad areas or narrow pipeline or access road corridors. However, large, contiguous blocks of land on the eastern end of the WRPA were surveyed by the Bureau of Reclamation in the 1970s. Because very little of the WRPA has been surveyed for cultural resources, the results of surveys to date may not be representative of the WRPA as a whole or any part of the WRPA that has not had extensive surveys completed.

3.12.4 Known Cultural Resources within the WRPA

Available records indicate that 150 cultural resource sites have been recorded within the WRPA. The dominant site type is prehistoric lithic scatters, which contain flaking debris from production of stone tools at various stages. Lithic scatters may include projectile points or other artifacts that are diagnostic of the general prehistoric, protohistoric, or historic period when the site was used. The WRPA also includes extensive lithic procurement areas, especially on wind-blown ridges where Pleistocene lag gravels containing quartzites are exposed. Lithic procurement areas typically exhibit tested cobbles or flakes produced in the initial stages of reduction of raw materials to functional tools. Lithic scatters and lithic procurement areas in the WRPA appear to date from the archaic to the late prehistoric period, with possible paleoindian representation as well. Most recorded lithic scatters and lithic procurement areas are on the crest of Muddy Ridge, but others have been recorded throughout the WRPA.

Other recorded sites within the WRPA include hearths or fire cracked rock, which are generally considered to be evidence of campsites. Most of these sites have been recorded on ridge tops where wind erosion has exposed sand and sandstone bedrock. Ground stone tools are present in some of these sites, probably indicating that processing of plants for food occurred there. Presence of ground stone tools for plant processing is common in Archaic Period sites in the region, but such tools were used well into the historic period. Available information indicates the campsites evidenced by hearths or fire cracked rock extend from the Archaic Period to the Late Prehistoric Period within the WRPA. Recorded campsites are generally located throughout the WRPA, but are generally more likely to be near permanent water sources or on high hills that offered views of surrounding territory.

Less common site types in the WRPA include rock art sites, a possible rock alignment, and a single recorded stone circle. Seven rock art sites have been identified in the WRPA. Recorded rock art sites are typically petroglyphs with human figures etched into vertical or near-vertical sandstone exposures, although some petroglyph sites also include etchings of animals, animal tracks, and figures representing spiritual beings. The petroglyph sites are typically relatively small, with only one or two panels (although other panels may have been eroded over time at some of the recorded sites. Most of the petroglyphs have been recorded on the southern side of Muddy Ridge, but other petroglyphs have been recorded in scattered rock face locations throughout the WRPA. Anecdotal information provided by Shoshone and Arapaho elders indicates that petroglyphs may be found on many of the sandstone ridges of the area.

A possible stone alignment has been recorded on Indian Ridge, and one prehistoric stone circle site has been recorded in the northwest portion of the WRPA near Muddy Creek. The stone circle site is considered to be evidence of an open camp, rather than a ceremonial function at the site. The stone alignment and stone circle are of unknown cultural affiliation or period.

Historic sites in the WRPA are almost exclusively associated with non-Native American settlement, irrigation, and transportation through the area. Elements of the Riverton Project, including portions of the Wyoming Canal, are within and adjacent to the WRPA. Three homesteads dating from the 1930s have also been recorded in the WRPA, and all of these homesteads appear to be of non-Native American affiliation. Three modern houses and two dumps or debris scatters have also been recorded in the WRPA that are associated with non-Native American settlement. The Copper Mountain to Pilot Butte electrical transmission line extended in an east-to-west direction through the WRPA, but the historic transmission line has been removed.

Other recorded historic period sites include an historic dugout, car bodies dating from 1928 to 1937, and a bridge over an irrigation canal. The Mexican Pass Stage Road may have run through the eastern portion of WRPA, but physical or definitive archival evidence of the route has not been documented. General Land Office plats from 1894 and 1906 show a number of roads or trails in the WRPA. Two of these roads are identified as the Ft. Washakie to Thermopolis Road and the Ft. Washakie to Lander Road; both of these routes were in the central and southwestern parts of the WRPA, but neither road has been recorded as an historic resource. A summary of recorded cultural resources within the WRPA is presented in the Summary below.

3.12.5 Traditional Cultural Properties and Sites of Native American Cultural Concern

Petroglyphs, stone alignments, and stone circles have distinct spiritual importance for the Eastern Shoshone and Northern Arapaho people. Other archaeological sites, including campsites and lithic scatters, often also have spiritual significance. Locations or topographic features with no apparent cultural manifestations may have spiritual significance to Native Americans. Locations and cultural resource sites that have importance to Native Americans can be defined in two classes: traditional cultural properties and sites of Native American cultural concern.

A Traditional Cultural Property (TCP) "can be defined generally as one that is eligible for inclusion in the [National Register of Historic Places] (NRHP) because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (U.S. Department of the Interior 1994:1). Examples of TCPs are:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world.
- A rural community whose organization, buildings and structures, or patterns of land use reflect the cultural traditions valued by its long-term residents.
- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice; and

- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historical identity (U.S. Department of the Interior 1994:1).

All TCPs are important for maintaining and continuing the cultural identity of a living community. Archaeological sites, such as stone alignments or petroglyphs, may have spiritual or other cultural meaning to Native Americans, but many of those sites are not directly important in maintaining and continuing the cultural identity of the living community. The latter category of sites may be considered to be “sites of cultural concern.” The distinction between TCPs and sites of cultural concern is important, because TCPs are by definition eligible for nomination to the NRHP and may be further protected under provisions of the American Indian Religious Freedom Act. Unless importance for maintaining and continuing cultural identity can be demonstrated, archaeological sites and other properties are not considered to be TCPs.

The WRPA includes lands with surface rights held by the Eastern Shoshone and Northern Arapaho Tribes, and the Tribes exercise sovereign rights over the Tribal lands. As a result, provisions of the National Historic Preservation Act and NEPA, which address responsibilities of BIA and other federal agencies concerning cultural resources, may be augmented by tribal laws, regulations, and practices. Tribal representatives conduct oversight of development on tribal lands, including review of placement of proposed gas wells, pipelines, and other facilities. Consequently, sites of cultural concern (that are not TCPs or otherwise eligible for NRHP) within Tribal lands may have higher standing for preservation than similar sites on non-Tribal lands.

Consultation among the BIA, representatives of the Eastern Shoshone and Northern Arapaho Tribes, and a representative of the Wind River EIS project team was conducted in September and October 2003. Consultation consisted of a meeting with elders of both tribes at the Wind River Agency offices and development area consultation during a tour of the WRPA. Consultations addressed the potential for existence within the WRPA of TCPs or other sites or resources of cultural concern to the Tribes. Conclusions from the tribal consultations are:

- The WRPA is not located near the permanent settlement areas of either the Eastern Shoshone or the Northern Arapaho Tribes, and therefore the WRPA is not currently an important source for plants, animals, or minerals used for traditional ceremonies, subsistence, or medicines. Elders stated that portions of the WRPA had elk, deer, antelope, and sage grouse, but that none of the WRPA was particularly good hunting territory for them.

- The WRPA is not known to the elders to contain sites used for ceremonial or spiritual purposes. However, some ceremonies are personal or familial, rather than communal, and it is possible that individuals or families would occasionally visit locations in the WRPA for spiritual purposes. According to the elders, the most likely locations for spiritual use are the crests of hills and the edges of high escarpments, and individual spiritual use is unlikely to occur in the vicinity of non-Native farms. Principal traditional spiritual sites known to the elders are located many miles outside the WRPA, primarily on buttes and in mountains to the west and north of the WRPA.

- Petroglyphs in and around the WRPA are important to both tribes as connections both to ancestors and the spirit world, and elders of both tribes said that many such rock art sites exist in the general area. Elders of both tribes said that the meaning of the etchings and paintings was lost or obscure to them, and that the meaning or purpose of the rock art may have only been known to the person or family who created the art.

- Shoshone elders said that the general areas containing rock art might also contain burials, although human remains had also occasionally been uncovered in relative lowlands away from the sandstone ridges. The elders expressed a general concern for placement of well pads near the bases of escarpments, and suggested avoidance of the escarpment walls.

- Elders of both tribes expressed satisfaction that operators had relocated well sites and other facilities in response to tribal requests to avoid archaeological sites. The elders said that massive well development areas in the future could conceivably result in noise and visual intrusion on spiritual or ceremonial sites, but that they were not aware of any such sites within the WRPA.

3.12.6 Summary

The Affected Environment for cultural resources consists of those properties that are eligible for nomination to the NRHP. To be eligible for the NRHP, a property must possess "the quality of significance in American history, architecture, archaeology, and culture present in districts, states, buildings, structures and objects of state and local importance that possess integrity of location, design, setting materials, workmanship, feeling and association." A site or other property must possess significance in at least one of the following Criteria for Evaluation:

- Association with events that have made a significant contribution to the broad patterns of our history (Criterion A).

- Association with the lives of persons significant in our past (Criterion B).

- Embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possesses high artistic values, or that represents a significant and distinguishable entity whose components may lack individual distinction (Criterion C).

- Have yielded, or may be likely to yield information important in prehistory or history (Criterion D) (36 CFR 60.4).

Of the 150 cultural resource properties recorded within the WRPA, 58 recorded properties have been formally evaluated for eligibility for the NRHP by the State Historic Preservation Officer (SHPO). Of these 58 properties, 5 properties have been determined to be eligible for the NRHP, and 53 properties have been determined to be not eligible. Of the 92 recorded properties that have not been formally evaluated by the SHPO, consultants and land management agencies have recommended that four properties are eligible for the NRHP, 66 properties are not eligible for the NRHP, and no recommendation of eligibility has been offered for 22 properties. Recorded cultural resources in the WRPA are listed in Appendix M.

Because only about 20 percent of the WRPA has been surveyed for cultural resources, additional properties may exist in the WRPA that are eligible for the NRHP. Consultations with elders of the Eastern Shoshone and Northern Arapaho Tribes did not yield indications that the WRPA might contain Traditional Cultural Properties.

3.13 SOCIOECONOMICS

3.13.1 Study Area

The study area for assessing potential socioeconomic impacts of the Proposed Action and alternatives is defined by the issues identified during scoping and by the standard topics of socioeconomic impact assessment. The socioeconomic study area includes the Wind River Indian Reservation, Fremont County, and private land in the Midvale Irrigation District that is also inside the Wind River Project Area (WRPA).

3.13.1.1 Wind River Reservation

The Proposed Action would occur entirely on land within the exterior boundaries of the Wind River Indian Reservation (WRIR) although only a portion of the surface subject to development is trust land held by the federal government for the benefit of the Eastern Shoshone and Northern Arapaho tribes. In contrast, most of the minerals, including oil and natural gas, that are subject to development are owned in trust for the tribes, so the tribes would benefit from royalty and tribal severance tax revenues derived from the sale of produced gas. These revenues would help fund the operation of the reservation and tribal governments and provide direct income for members of the Tribe. Certain Tribal services (emergency response, law enforcement, environmental enforcement, water regulation) would also be affected by the Proposed Action and alternatives.

3.13.1.2 Fremont County

The portion of the WRIR that contains the WRPA is located in Fremont County. Fremont County would benefit from the economic activity associated with the gas development. The county would receive ad valorem property tax revenue from natural gas production and from some gas field facilities associated with the Proposed Action and alternatives. The county and its incorporated municipalities would also receive sales and use tax revenues from the purchase of gas field equipment and supplies and local consumer purchases by the natural gas development and operations workforce. A small portion of the Wyoming severance tax revenue from gas sales would also accrue to the county.

Certain Fremont County services (emergency response, law enforcement, and road maintenance) would also be affected by the activities associated with the Proposed Action and alternatives. Note that the Fremont County Transportation Department is addressed in the Transportation Section (3.14).

3.13.1.3 Private Lands in the Wind River Project Area Part of the Midvale Irrigation District

Some land in the WRPA that would be directly affected by the Proposed Action and alternatives is privately owned and used for agricultural or rural residential purposes. Socioeconomic aspects of the WRPA portion of the Midvale Irrigation District (MID) include district facilities, land use, agricultural production and the rural setting.

3.13.2 Geographic Setting

The WRIR is the only American Indian reservation located in Wyoming. Today, the reservation boundaries encompass approximately 2.27 million acres, of which 1.83 million acres are tribally owned or held in trust for the Eastern Shoshone and Northern Arapaho tribes by the federal government (trust lands). Of the total area within the WRIR boundaries, 88 percent lies within Fremont County; the remainder is in neighboring Hot Springs County. Encompassing nearly 9,266 square miles (5,930,112 acres), Fremont County is Wyoming's second largest county in terms of land area. The WRPA is comprised of approximately 92,000 acres of tribal, private, state, and federal lands located within the boundaries of the WRIR. The WRPA encompasses approximately 4 percent of the reservation's total land area and 1.6 percent of the county's total area.

Land surface within the WRPA (the "surface estate") includes a combination of trust lands owned jointly by the Shoshone and Arapaho tribes, patented land held in fee simple by private owners, and federal land managed by the US Bureau of Reclamation (BOR). Sub-surface minerals (the "mineral estate") are generally owned by the tribes, although some minerals are privately owned. The situation where the surface and mineral estates are owned by different parties is called "split estate."

3.13.3 History of Ownership within the WRPA

Current split mineral and surface estate, and a commingling of different types of surface ownership result from the creation and subsequent history of the WRIR.

The Treaty of July 3, 1868 fixed the boundaries of the Shoshone Indian Reservation at 3,054,182 acres in the Wind River Valley. The Reservation boundaries at that time were from the mouth of the Owl Creek north of Thermopolis, to the divide between the Sweetwater and Popo Agie rivers, that along the Wind River Mountains to the North Fork of the Wind River. (Treaty with Eastern Band Shoshone, 15 Stat. 673). In 1878, the Northern Arapaho Tribe was placed on the Reservation by the United States violation of the Treaty. In 1939, the Shoshone Tribe was paid compensation for the placement of the Northern Arapaho Tribe on the Reservation. Pursuant to Supreme Court decision, each tribe has an undivided ½ interest in the Reservation. Governance of the Reservation is by the Business Councils of each Tribe meeting as the Join Business Council to govern the Reservation as a whole.

Two subsequent agreements altered the boundaries and size of the Reservation. These agreements were the Lander Purchase and the Thermopolis Purchase. In the Lander Purchase (Bruno Cession), the Tribes sold 710,642 acres in the southern portion of the Reservation to the federal government for the sum of $25,000. The purpose of this land transfer was to resolve difficulties from the trespassing on the Reservation of persons in the Sweetwater Mining district near South Pass. The Lander Purchase specifically changed the southern boundary of the Reservation and the lands covered by the Lander Purchase are no longer a part of the Reservation. Likewise, in 1897, the United States purchased 10 square miles in the northeast corner of the Reservation from the Tribes. The agreement to sell the lands made it clear that all interest of the Indians was acquired and these lands also ceased to be a part of the Reservation.

The act of March 3, 1905 ("1905 Act") ratified an agreement with Tribes which opened the portions of the Reservation north and east of the Big Wind and Popo Agie Rivers, Including the WRPA, to settlement by non-Indians under the homestead, town site, and mineral land laws. The 1905 Act preserved the right of Tribal members to acquire and retain allotments in the opened area. Congress never contemplated that all of the opened area would leave Indian ownership. Congress only hoped that 150,000 acres might be settled within 2 years, another 150,000 acres within 4 years, and the remainder would not be settled, if ever, until after six years. By 1914, only the 128,986.56 acres were settled, leaving over 90% of the opened lands unsettled. In 1915, the Secretary of Interior postponed further sale of lands to protect the Indians. Article II provided that there was to be no immediate acquisition by the United States of the area opened. Article IX of the 1905 Act provided the United States shall act as trustee for said Indians to dispose of said lands and to expend for said Indians and pay over to them the proceeds received from the sale thereof only as received, as herein provided. The language of Article IX has been held to mean that the Indians only (i) released their possessory right so that the government, as trustee could, convey fee title to a purchaser, (ii) the unsold lands remained in Indian ownership, and (iii) the lands never became "public lands" in the sense of being subject to sale, or other disposition under the General Land Laws.

In 1916, Congress authorized oil and gas leasing on the lands covered by the 1905 Act. Act of August 21, 1916 (39 Stat. 519). In connection with the 1916 Act, Congress engaged in an extended debate concerning whether unpurchased lands opened by the 1905 Act were held in Indian or federal title. Congress resolved the issue by enacting legislation, which established the 1905 Act lands, retained their Indian character.

In 1918, portions of the Reservation, including the WRPA, were withdrawn for reclamation purposes. The BOR remains the federal agency responsible for management of the surface estate of the project. In 1921, irrigators from the First and Second Division of the Riverton Reclamation Project formed a new entity, the Midvale Irrigation District (MID).

The next Time Congress dealt with the lands within the Reservation was in 1939. The Act of July 27, 1939, (53 Stat.1128), paid the Shoshone Tribe for locating the Arapaho Tribe on the Reservation, In addition, the Act permanently withdrew the authority under the 1905 Act to sell Reservation lands.

Lands for the Boysen Reservoir were acquired from the Tribes in 1952. The United States acquired the surface estate of various lands within the WRPA as part of the Boysen Purchase.

In 1953, the United States acquired from the Tribes the surface estate of lands within the Riverton Reclamation Project, which had not been previously patented. The Act also purported to acquire the mineral interest of the Tribes. Congress declared in the Act of August 27, 1958 (72 Stat. 953), that all the minerals covered by the 1953 Act were held in trust for the Tribes. Some of these mineral rights are within the WRPA (Schumacher 2004).

3.13.4 Population, Economy, and Finance of the Wind River Indian Reservation

Much of the information about the WRIR contained in this section was obtained from the Executive Summary of the 1998 Wind River Indian Needs Determination Survey (WINDS-2), titled *Looking to the Future of the Wind River Indian Reservation* (JBC 1999) and a related paper, *Residential and Household Poverty of American Indians on the Wind River Indian Reservation* (Antell et al. 1999). The WINDS-2 survey and a previous 1987 WINDS survey were commissioned by the Joint Business Council to provide detailed information about the living conditions, education, employment, health, public safety, housing and other features of the every day life on the WRIR.

3.13.4.1 Population

The WINDS-2 survey established the 1998 population of the WRIR (excluding the City of Riverton and the Riverton Reclamation Project area) at 7,680 persons. This estimate is important because it represents both Indian and non-Indian people who live in areas served by the WRIR and tribal agencies and organizations. Seventy-nine percent of the surveyed population was Native American. Table 3.13-1 describes the breakdown of the surveyed population by affiliation.

Table 3.13-1. Estimated Wind River Indian Reservation Population by Affiliation in 1998.

Affiliation	Population	Percent of Total
Northern Arapaho	3,810	49.6
Eastern Shoshone	1,630	21.2
Other American Indians	660	8.6
Non-American Indians	1,580	20.6
TOTAL	**7,680**	**100**

Source: JBC 1999.

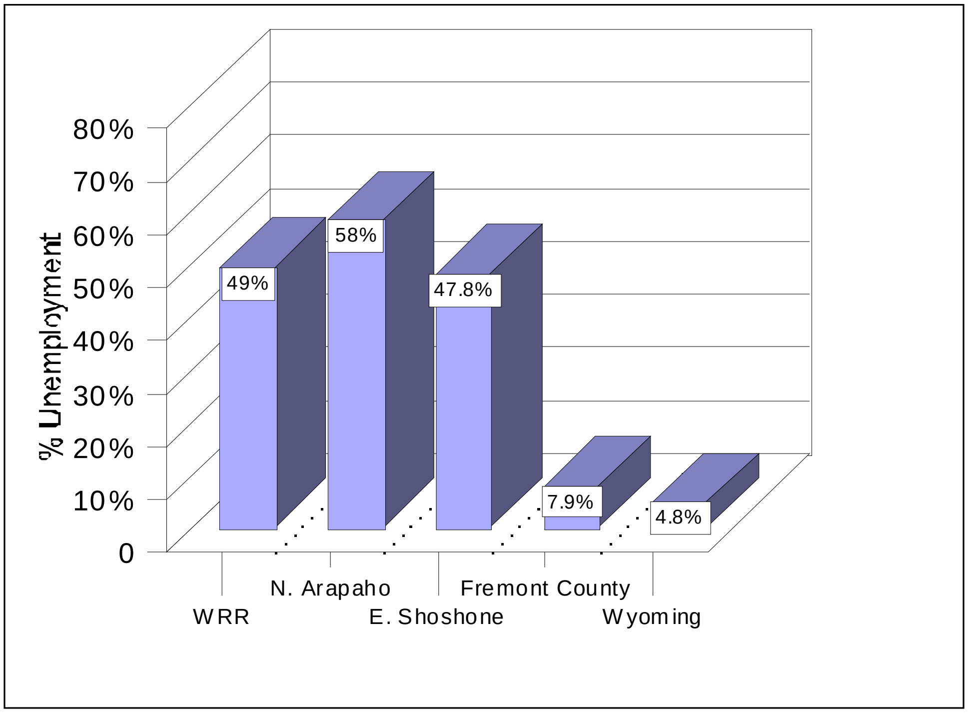
3.13.4.2 Employment and Income

The key characteristics of the WRIR economy are very high levels of unemployment, a large number of families living below the national poverty level, the high importance of tribal oil and gas royalty revenues to the income of enrolled members of the two tribes and royalty and severance tax revenues for funding tribal facilities and services.

The 1998 WINDS-2 survey found that 49 percent of all residents of the WRIR aged 15 to 54 were unemployed, compared to about 8 percent and 5 percent unemployment for Fremont County and the State of Wyoming, respectively (see Figure 3.13-1). The report defined unemployed persons as employable persons who did not have paid work.

WINDS-2 found that more than half of the employed persons on the WRIR held federal, state, reservation, or tribal government jobs. The most common occupations were secretary or clerk (12.1 percent), semi-skilled and skilled construction (7.4 percent), health service (6.4 percent), maintenance (6.3 percent) and teacher (6.1 percent). The report observed that a scarcity of other job opportunities for WRIR residents contributed to high unemployment.

Figure 3.13-1. 1998 Unemployment Rates: Wind River Indian Reservation, Fremont County, Wyoming.



Source: WINDS-2 1999; Wyoming Department of Employment 2003a. Note: Fremont County and the State of Wyoming are average annual estimates; WRIR and tribal estimates represent point-in-time estimates and may not reflect seasonal variations.

The tribes own a number of business enterprises on the WRIR. Both tribes lease land for grazing and crop production, and both tribes and individual tribe members operate livestock raising businesses. Tribal enterprises include a construction company, a bingo parlor, a utility company, a senior citizens' home, gas stations, an auto repair shop, grocery stores, a recreational vehicle park, a coin laundry, a printing business, and a truck stop. Private businesses also operate on the Reservation, and non-tribal employers (including oil and gas companies and contractors) on the reservation must hire at least 50 percent of their workforce from reservation residents to comply with the provisions of Tribal Employment Rights Ordinances (St. Clair 2003). Nevertheless, the public sector provides the largest percentage of employment for WRIR residents at federal and tribal agencies, organizations, and at school districts (USDC EDA 2003).

The poverty rate on the WRIR is also high (Table 3.13-2). The 1987 WINDS survey found that 71.5 percent of Northern Arapaho and 65.7 percent of Eastern Shoshone were living below the federal poverty threshold. By 1998, these numbers had fallen to 62.4 and 49.5 percent, a decrease of 9 and 16 percentage points, respectively. As will be discussed later, the decreases may reflect a general improvement in the Fremont County economy.

Table 3.13-2. Percent of Households in Poverty on the WRIR by Tribe in 1987 and 1998.

Tribe	% Below Poverty Level 1987	% Below Poverty Level 1998	% Change
Northern Arapaho	71.5	62.4	-9.1

Eastern Shoshone	65.7	49.5	-16.2

Source: Antell et al. 1999.

The oil and gas royalties, bonuses, and rentals from tribal minerals are distributed equally to each Tribe. Fifteen percent of that amount is available for tribal governmental purposes. The remaining 85 percent is distributed to tribal members on a per capita basis. The Tribes' also assess a severance tax on oil and gas development. Severance tax receipts are used to provide governmental services which benefit both members and nonmembers within the WRIR. The main sources of revenue subject to this arrangement are royalty payments and the lease and bonus payments associated with the leasing of tribal and trust minerals for oil and gas development.

Although they increased in nominal dollars, as shown by Table 3.13-3, per capita payments to both tribes decreased between 1987 and 1998 when adjusted for inflation. Still, the WINDS survey indicated that per capita payments are a large part of total income for many members of the Shoshone and Arapaho tribes (Table 3.13-4), though they appear to have declined somewhat in importance from 1987 to 1998. This change is due in part, to changes from year to year in oil and gas revenues received by the tribes as prices and production levels change. In addition, as inflation impacts the purchasing power of per capita payments, tribe members may look to other sources of income to supply basic needs. Finally, an improving Fremont County economy has provided more employment opportunities for all residents, including residents of the WRIR.

Table 3.13-3. Per Capita Payments in 1987 and 1998.

	1987	1998 (Nominal $)	1998 (Constant 1987 $)
Eastern Shoshone	$1,950	$2,275	$1,586
Northern Arapaho	$1,300	$1,075	$749

Source: Antell et al. 1999.

Table 3.13-4. Relationship of Per Capita Payments to Total Income: 1987 and 1998.[1]

Respondents who relied on per capita payments for 100% of income	1987	1998
Eastern Shoshone	54%	19.5%
Northern Arapaho	45.4%	17.5%
Respondents who relied on per capita payments for 50% of income	**1987**	**1998**
Eastern Shoshone	98%	56.8%
Northern Arapaho	67.2%	28%

[1]Percentages from the 1998 WINDS-2 survey responses.
Source: Antell et al. 1999.

3.13.4.3 Tribal Minerals

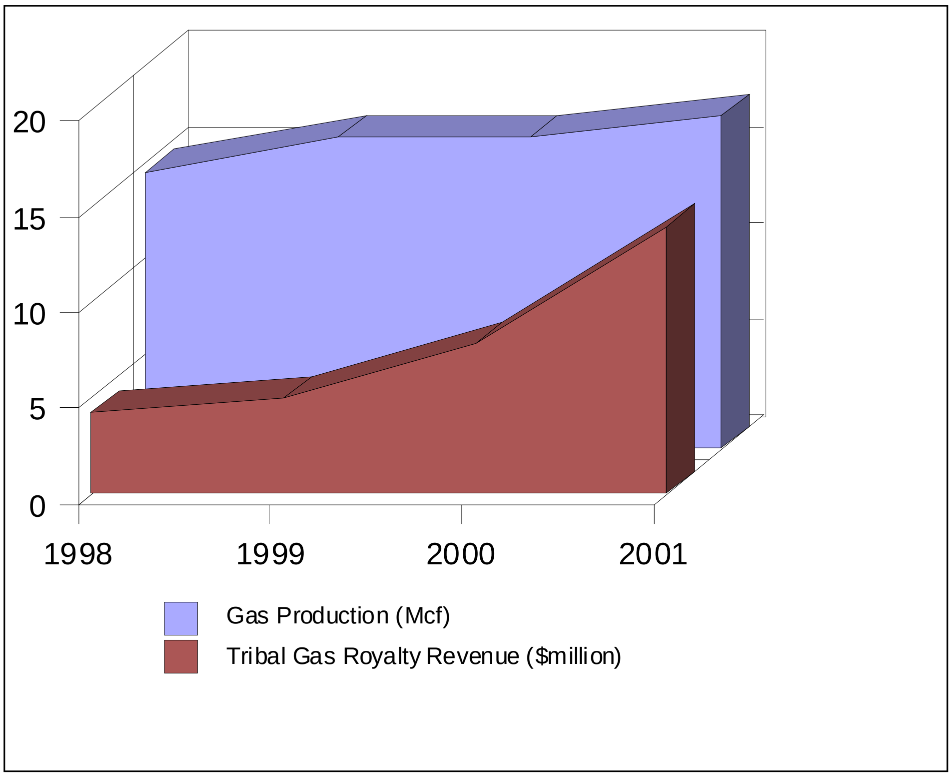
Table 3.13-5 displays tribal royalty, bonuses, and rentals for the 1998 period through the 2001 period. Although tribal revenues from mineral production increased dramatically during this period, the increase was due more to commodity prices than to increased production. Figure 3.13-2 shows that although tribal gas production increased gradually by about 20 percent from 1998 to 2001, tribal royalty revenue from natural gas increased by 230 percent.

Table 3.13-5. Mineral-Related Revenues, Shoshone and Arapaho Tribes in 1998 – 2001.

	1998	1999	2000	2001
Natural Gas Royalties	$4,168,389	$4,870,806	$7,750,614	$13,906,079
Gas Plant Products	$15,010	$16,951	$69,398	$72,036
Oil Royalties	$6,235,596	$3,874,696	$11,376,581	$12,201,046
Rents	$71,043	$72,446	$93,112	$103,517
Other Revenues	$87,953	$690,392	$4,808,708	$1,297,929
TOTAL	**$10,579,989**	**$9,527,290**	**$24,100,413**	**$27,582,605**

Source: MMS 1998-2001.

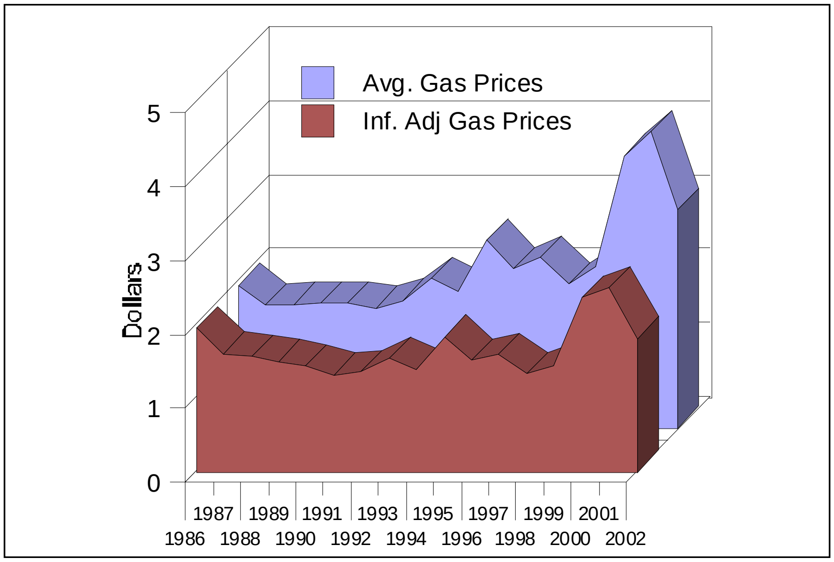
Figure 3.13-2. Tribal Gas Production and Royalty Revenue in 1998-2001.



Source: MMS1998-2001.

Tribal gas royalty revenues may be volatile as gas prices fluctuate. MMS production and revenue statistics used for Figure 3.13-2 were only available through 2001; however, 2002 gas prices were substantially lower than the previous two years. Figure 3.13-3 depicts national average annual wellhead gas prices between 1986 and 2002, in both current and inflation-adjusted 1986 dollars. In current dollars, 2002 average gas prices were 27 percent ($1.07) lower than 2001 prices. Also in 2002, the difference between current-dollar prices and inflation-adjusted prices (in 1986 dollars) was 39 percent or $1.15.

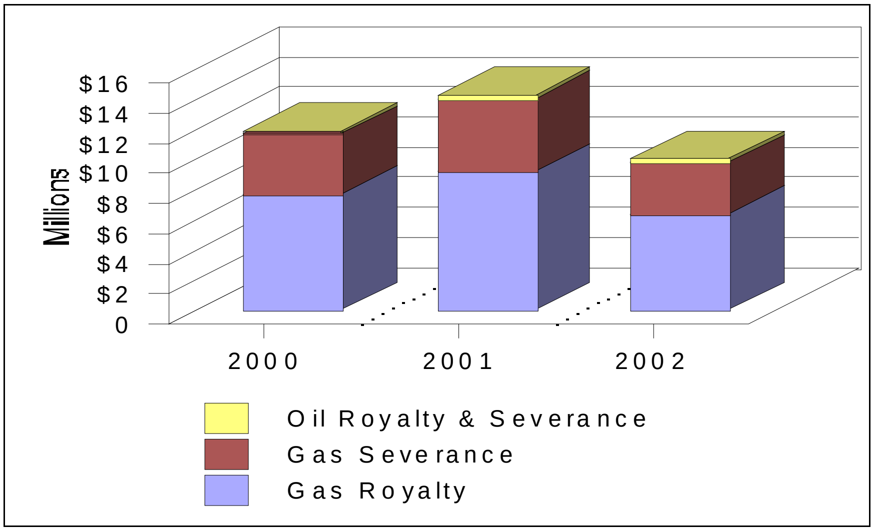
Figure 3.13-3. Average Natural Gas Wellhead Prices in 1986-2002.



Note: These prices reflect national averages; Wyoming averages are often substantially lower.
Source: US DOE Energy Information Administration, 2003.

Revenue from natural gas royalties and severance taxes from fields within the WRPA represents a substantial portion of income to the tribes, which is used to support tribal government and per capita payments to individual tribe members. Figure 3.13-4 displays recent gas and oil royalty and severance tax payments to the tribes for the fields within the WRPA. As discussed above, the differences in annual payments are associated with changes in commodity prices more than production levels.

Figure 3.13-4. Tom Brown Incorporated Royalty and Severance Tax Payments on Tribal Oil and Gas Production in 2000-2002.



Source: TBI 2003.

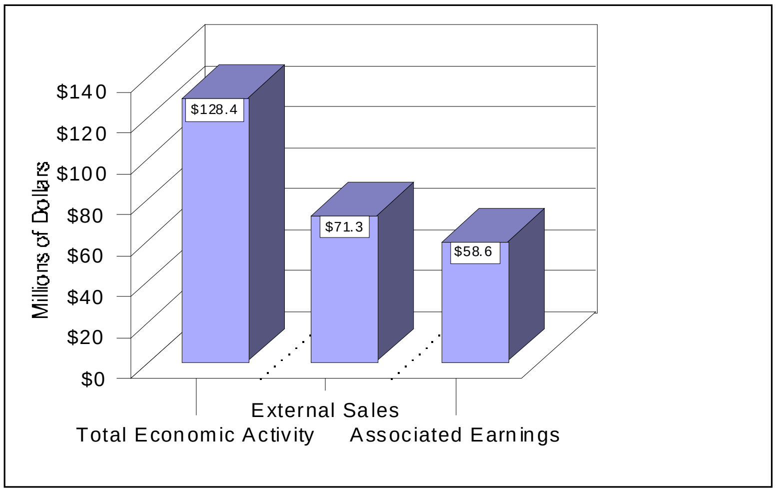
3.13.4.4 Reservation and Tribal Services

As noted, 15 percent of income from joint tribal assets, including oil and gas royalty revenues, and 100 percent of severance tax income, supports various joint and individual tribal services, including medical services, basic transportation, housing, police protection, fire protection, solid waste disposal, and a variety of human services (Ortiz 1993).

3.13.4.5 Impact of the Wind River Reservation on the Fremont County Economy

Although many residents of the WRIR live in poverty, collectively tribal members and the tribes contribute a substantial amount to the Fremont County economy. In a November 1997 report, the University of Wyoming Department of Agricultural Economics published a study entitled *The Economic Impact of the Wind River Reservation on the Fremont County Economy* (UW 1997). This study estimated that the WRIR generated $128.4 million in economic activity for the Fremont County economy during 1996, including $71.3 million in external sales, or sales by business outside the WRIR, and $58.5 million in earnings from 1,647 direct and secondary jobs associated with tribal government, BIA, Public Schools, Indian Health, and Indian households.

Figure 3.13-5. Wind River Reservation Impacts on the Fremont County Economy in 1996.



Source: UW 1997.

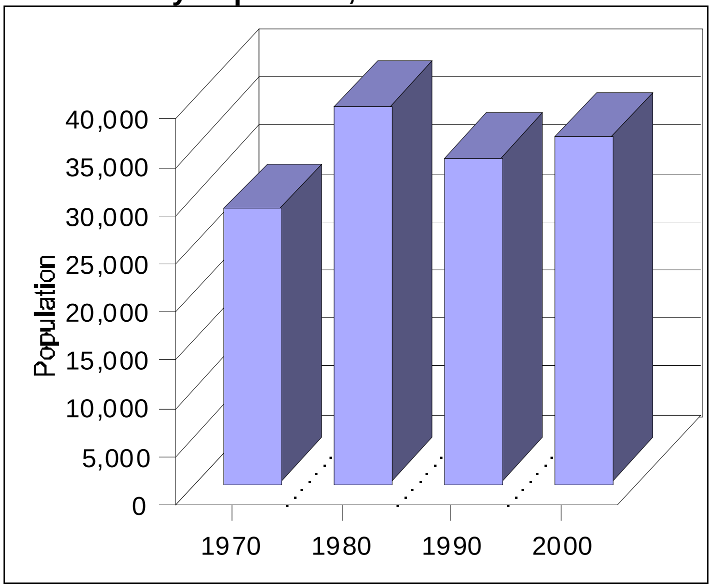
The study estimated that the WRIR accounted for 7.5 percent of total Fremont County economic activity, 8 percent of total external sales, 9.9 percent of total earnings, and 8.9 percent of total employment.

3.13.5 Existing Conditions in Fremont County

3.13.5.1 Population, Demographics, and Mobility

Changes in population and demographic characteristics over time provide insights into the dynamic forces at work in the region. For much of the past 30-plus years, population trends in Fremont County have been influenced by changes in domestic energy and mineral resource prices and development policies. The oil embargo of 1973 and on-going national investment in nuclear-powered electrical generation prompted increases in the local oil and gas and mining industries. As a result, the population of Fremont County rose by more than 10,000 residents, or 38 percent, between 1970 and 1980. The 1980 census enumerated a population of 38,992 in Fremont County. Subsequent contractions in those same industries and the metals mining industry in the mid-1980s brought about a decline of more than 5,300 residents by the 1990 census. Economic development and diversification efforts, intended to stem the decline and promote a more stable and sustainable long-term economic future, contributed to a modest population gain of 2,142 residents, or 6.3 percent, during the 1990s. Growth has continued at a modest rate, with the county's population estimated at 36,113 in 2002, as illustrated by Figure 3.13-6 below (U.S. Census Bureau 2003).

Figure 3.13-6. Fremont County Population, 1970 to 2000.



Source: U.S. Census Bureau, 2000 Census of Population and Housing 2002.

The overall trends in population had important manifestations for the distribution of population within the county. In 1980, about 44 percent of the county's population of 38,992 residents lived in either Lander or Riverton, the two largest towns in the county. The remaining residents, 21,878 in number, lived in small towns, unincorporated communities, and other outlying areas of the county. Nearly 13,800 of those rural residents, including both Indians and non-Indians, lived within the boundaries of the WRIR. Population declines through the 1980s, precipitated by weakness in the region's oil and gas industry, the collapse of the uranium mining industry and closure of the US Steel iron mine located south of Lander on South Pass, were concentrated in Lander and unincorporated areas off the WRIR in southern Fremont County as displayed in Table 3.13-6 and Figure 3.13-7.

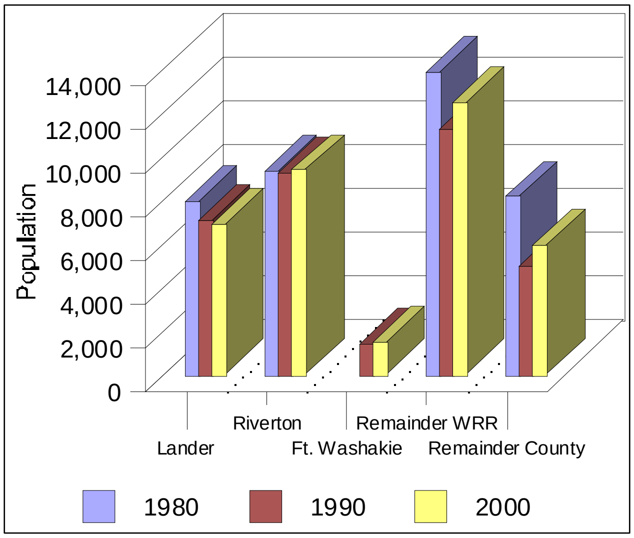
Table 3.13-6. Fremont County Population Trends from 1980 to 2000.

	City of Lander	Wind River Reservation[1]			Rest of County	Total County
		City of Riverton	Fort Washakie CDP[2]	Other		
1980 Census	7,867	9,247	NA[3]	13,791	8,087	38,992
1990 Census	7,023	9,202	1,344	11,171	4,922	33,662
2000 Census	6,867	9,310	1,477	12,368	5,782	35,804
Chg. 1980 – 2000	(1,000)	63	NA[3]	(1,423)	(2,305)	(3,188)
Percent Change	(12.7)	0.7	NA[3]	(10.3)	(28.5)	(8.2)

[1] Fremont County portion only. The remainder of the Wind River Indian Reservation is in Hot Springs County.
[2] CDP is a "Census designated place."
[3] The Fort Washakie CDP was not reported as a distinct area prior to the 1990 Census.
Sources: U.S. Census Bureau, 1993 and 2001.

As did many other areas of the west, Fremont County experienced population increases in its rural areas between 1990 and 2000. Such gains were registered both within the WRIR and in other unincorporated areas, and were generally concentrated in the northern half of the county.

Figure 3.13-7. Population Trends for Selected Areas of Fremont County in 1980, 1990 and 2000.



Note: The census bureau did not recognize Fort Washakie as a separate place in 1970; therefore the "Remainder WRIR" designation includes Ft Washakie population in 1970.

Source: U.S. Census Bureau, 2000 Census of Population and Housing 2002.

Communities within the general vicinity of the WRPA include Pavillion, Ethete, and Fort Washakie. All are located inside the exterior boundary of the WRIR. Pavillion was founded on patented land in the early 1900s as a labor camp associated with the development of the water storage and irrigation project that today comprises the Riverton Unit of the BOR and the MID. Ethete and Fort Washakie, located 10 to 15 miles south of the WRPA, are the largest of six communities on tribal lands. Fort Washakie is the headquarters of the Eastern Shoshone tribal government and of the Bureau of Indian Affairs agency. Populations for these places and others in Fremont County in 2000 are shown on Table 3.13–7.

Table 3.13-7. Fremont County Population in 2000

County Subdivision or Place	Population
Dubois (town)	962
Ethete CDP	1,455
Fort Washakie CDP[1,2]	1,477
Hudson (town)	407
Lander (city)	6,867
Pavillion (town) [2]	165
Riverton (city) [2]	9,310
Shoshoni (town)	635
Wind River CCD (remainder) [2]	10,676
Other unincorporated County	3,850
Fremont County Total	**35,804**

[1] CDP is a "census designated place".
[2] Is located wholly within the boundaries of the WRIR.

Source: U.S. Census Bureau, 2001.

In 2000, 76 percent of residents identified themselves as white, thereby comprising the largest racial group in Fremont County. A total of 7,047 residents, representing 20 percent of the population, identified themselves as American Indians or Alaska Natives. Blacks, Asians, other races, and individuals identifying themselves as being of two or more races, including white and American Indian, accounted for the remaining four percent of the population (see Table 3.13-8).

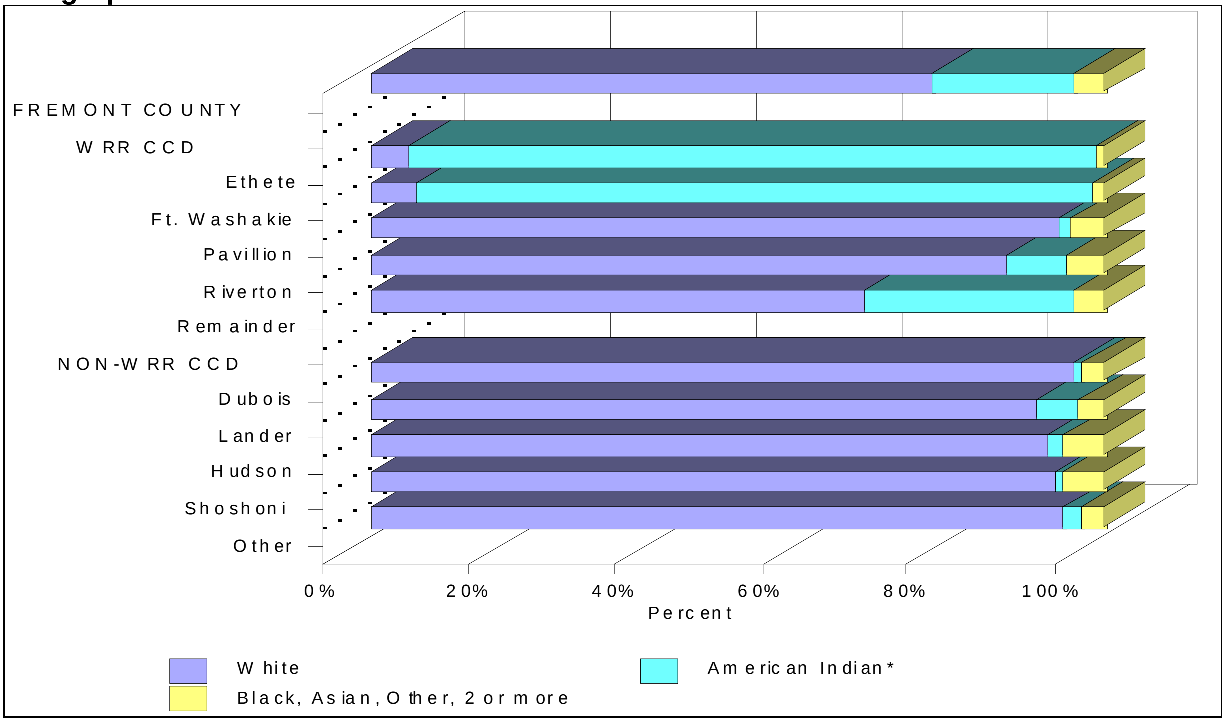
Table 3.13-8. Fremont County Population by Race: 2000.

Race	Number of Persons	Percent of Total
White	27,388	76%
American Indian and Alaska Native	7,047	20%
Black, Asian, other and two or more races	1,369	4%

Source: US Census Bureau, 2000 Census of Population and Housing.

Racial composition of the population varies across Fremont County. The relative share of white residents is higher in Lander, Dubois and other areas outside the WRIR. Due to Riverton's location and numerous privately owned farms and ranches within the WRIR, whites also comprise a substantial portion of the population on the WRIR. Members of the Shoshone and Arapaho tribes and other American Indians are more concentrated in and around Fort Washakie and Ethete (Figure 3.13-8).

Figure 3.13-8. Fremont County Racial Composition - 2000, Selected Census Geographies.



Note: American Indian includes Alaskan Natives, if any.
Source: US Bureau of Census, 2000 Census of Population and Housing.
W RR CCD = Wind River Reservation County Census Division.

The 2000 census found an average household size of 2.58 persons in Fremont County, compared to the Wyoming average of 2.48. In part, this is due to the larger households headed by American Indians. According to the 2000 census, the average household size in the predominantly white communities of Lander and Riverton was about 2.33 persons, compared to 4.25 and 3.29 in the predominantly American Indian communities of Ethete and Fort Washakie. In the WINDS-2 survey, WRIR residents reported both larger families and that about one in four families shared housing with another family.

The median age of 37.7 years in Fremont County also is higher than the median age of 36.2 for Wyoming (U.S. Census Bureau 2000). This is due to the older and much larger, non-Indian population in communities like Lander. The smaller American Indian population in Fremont County is much younger than the Wyoming average, exemplified by a median age of 22.6 years in Ethete and 27.2 years in Fort Washakie.

Fremont County residents are also relatively mobile. Nearly 19 percent of county residents older than 5 in 2000 lived somewhere other than in Fremont County in 1995. Table 3.13-9 presents the migration data from the 2000 census. The reported level of immigration of about 6,300, compared to a net gain of 2,142 residents during the 1990s, indicates that Fremont County experienced considerable out-migration from 1990 to 2000.

Table 3.13-9. 1995 Place of Residence, Fremont County Residents, 5 Years and Older in 2000.

Residence In 1995	Percent of Total
Same House	59%
Elsewhere in Fremont County	22%
Elsewhere in Wyoming	6%
Different State	12%
Foreign Country	1%

Source: US Census Bureau 2002.

3.13.5.2 Employment, Unemployment, and Income

Employment

Total Fremont County employment was 21,116 in 2000, up by 4,261 jobs from 1990 (Table 3.13-10). The decade from 1990 to 2000 was a period of recovery for employment in Fremont County. In 1998, employment exceeded the previous high of 19,930 jobs set in 1980 during a period of active mining and oil and gas development. In percentage terms, the county's economic expansion during the 1990s represented cumulative growth of 25.3 percent and a compounded average annual growth rate of 2.3 percent.

Table 3.13-10. Total Full and Part-Time Employment, Fremont County, 1990 – 2000.

Year	Employment
1990	16,855
1995	19,152
2000	21,116
Absolute Change	4,261
Percent Change	25.3%

Source: US Bureau of Economic Analysis 2002.

Historically, Fremont County's economy has been relatively dependent on natural resource development and agriculture, but the economy has shifted away from this dependence over time. In 1980, there were about 4,000 mining jobs (including oil and gas jobs), over 1,100 farm jobs, and many other jobs in construction and transportation. Over time, the region's agriculture sector has remained stable while mining employment has declined. Thus, employment gains in the financial, trade, and services sectors have accounted for employment growth and have diversified Fremont County's economic base. Many of the jobs in the retail, wholesale, service, and construction sectors are indirectly linked to activities in basic sectors such as mining and agriculture.

Table 3.13-11 breaks out the contributing sectors to a net employment gain of about 2,000 jobs in Fremont County from 1995 to 2000. Almost half of the job growth was in the services sector. In 2000, the trade and services sectors combined provided nearly half of all jobs in Fremont County. The construction industry also experienced substantial job growth.

The mining sector, including the oil and gas industry, grew modestly, but still provided only 3.0 percent of all the county's jobs in 2000. Total private sector employment grew, and total government employment declined over the same period. As a result, government now provides about 19 percent of all local jobs, down from 21.7 percent in 1995. Farm employment stayed at about 1,140 jobs from 1995 to 2000.

Table 3.13-11. Employment in Fremont County by Major Industry in 1995 and 2000.

Industry	Employment		Change 1995 - 2000	Share of Total 2000 Employment
	1995	2000		
Private Sector				
Farm	1,142	1,146	+4	5.4%
Ag. Services, Forestry & Other	278	370	+92	1.8%
Mining, Oil & Gas	562	643	+81	3.0%
Construction	1,350	1,893	+543	9.0%
Manufacturing	915	813	(102)	3.9%
Transportation & Utilities	768	888	+80	4.2%
Wholesale & Retail Trade	3,991	4,136	+145	19.6%
Finance, Insurance & Real Estate	823	1,130	+307	5.4%
Services	5,158	6,123	+965	29.0%
Subtotal - Private Sector	14,987	17,142	+2,155	81.2%
Government Sector	4,165	3,974	(191)	18.8%
TOTAL EMPLOYMENT	**19,152**	**21,116**	**+1,964**	**100.0%**

Source: US Bureau of Economic Analysis 2002.

Agricultural Trends in Fremont County

Agriculture has always been a vital component of the region's economy, from a land use perspective and from the perspective of the county's role in the state's agriculture industry. Both the number of farms and the total amount of land in agricultural use has been increasing over time as shown in Table 3.13-12. Of 5.9 million acres of land in the county, including tribal and federally managed lands used for to graze livestock, about 44 percent is in agricultural use.

Table 3.13-12. Selected Characteristics of Fremont County Farms in 1987, 1992, and 1997.

	1987	1992	1997	Change 1987-1997
Number of Farms	908	877	983	75
Total Acres in Farms	2,464,688	2,415,873	2,618,866	154,178
Average Size/Farm (acres)	2,714	2,755	2,664	(50)
Irrigated Land (acres)	135,774	132,197	153,707	17,993

Source: US Department of Agriculture, 1997 Census of Agriculture.

The economic importance of the agriculture in Fremont County is illustrated by its statewide rank. Table 3.13-13 ranks the county on selected measures of agricultural assets and outputs. Although the county is 14th in agricultural acreage, the county ranks at or near the top in numbers of livestock and the value of livestock inventory and crop production.

Table 3.13-13. Fremont County Agricultural Ranking among Wyoming Counties.

Economic Variable	Value	Rank [1]
Number of farms, 1997	983	1
Land assessed as Agricultural Use (acres)	789,100	14
Value of livestock inventory and crop production – 2001	$ 119.8 million	2
Head of cattle and calves, Jan. 1, 2002	110,000	3
Head of breeding sheep, Jan. 1, 2002	14,000	7
Acres of hay harvested, 2001	88,000	4
Tons of hay produced, 2001	243,000	1

[1] Rank among Wyoming's 23 counties with 1 being the highest.
Source: Wyoming Agricultural Statistics Service 2002.

- Other noteworthy characteristics about the county's agricultural sector include the following:

- About one-quarter of all farms, 254 total, are smaller than 50 acres in size. This compares to almost 50 percent, 486 operations, that are 180 acres or larger in size.

- Approximately 27 percent of all farms, 261, reported annual sales of $50,000 or more in 1997.

- Most Fremont County farm operators report farming as their principal occupation (59 percent and are full owners of their property (65 percent). (Based on Fremont County from the 1997 agricultural census.)

The gross income of local farmers and ranchers depends on the amount of land in production, crop types, productivity, and prices. Total annual receipts from livestock and crop sales reported in past agriculture censuses were $37.4 million in 1987, $61.7 million in 1992 and $59.8 million in 1997. In 2000, farm receipts for sales of livestock and crops were $65.4 million (Table 3.13-14).

Table 3.13-14. Sources of Farm Income.

	1987	1992	1997	2000
Source of Income (Millions)				
Receipts from livestock and products	$29.04	$40.61	$41.30	$50.59
Receipts from crops	$8.40	$21.05	$18.51	$14.84
Government payments	$1.00	$0.94	$0.94	$1.15
Miscellaneous & imputed	$5.44	$6.30	$6.30	$9.56
Total gross income	**$43.88**	**$68.90**	**$68.90**	**$76.13**

Sources: US Census Bureau and Bureau of Economic Analysis.

Fremont County agriculture is diverse, but livestock sales are the largest source of farm income. Livestock sales typically account for about 70 to 80 percent of total farm receipts, while receipts in Fremont County from the sale of crops have generally declined recently.

Irrigated land used to raise hay and other crops totaled 153,707 acres in 1997, representing less than six percent of the total land area in agricultural use. Approximately half of the total irrigated land in the county is served by the MID, a portion of which lies within the western portion of the WRPA. Farms and ranches served by the district account for a substantial share of total annual agricultural income in the county. The district estimated the aggregate value of crop production in 2002 at $15.6 million. Although not a directly comparable measure to receipts or income reported in Table 3.13-13 above, the estimate nevertheless indicates the contribution of farms served by the district to the region's agricultural sector. Gross revenue per acre of irrigated land in the district for 2002 ranged from $11 (pasture) to $615 (sugar beets).

<u>Oil and Gas Production Trends in Fremont County</u>

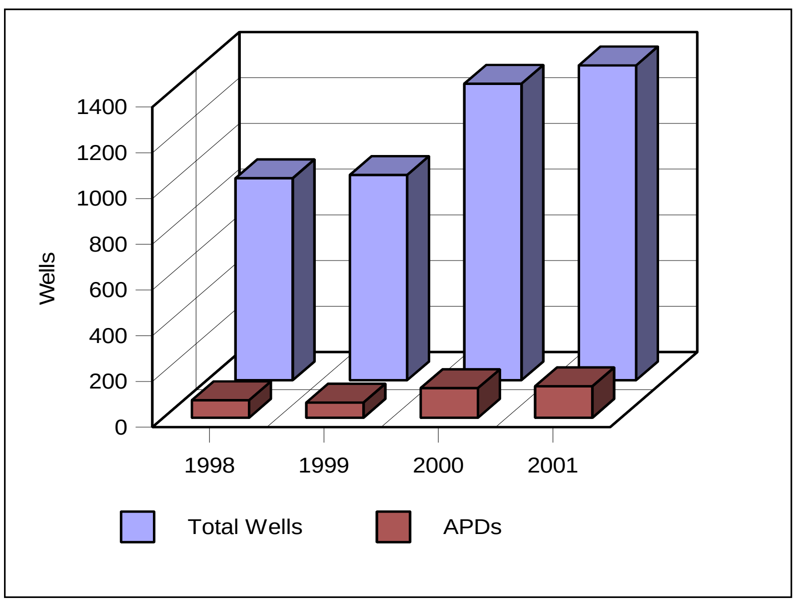
As does the agricultural industry, the oil and gas industry has strong ties to the local economy. Those ties date to 1884 when the first oil well in Wyoming was completed near Lander. A lack of pipeline infrastructure limited the level of development and production for many years. Production expanded across the state, including in Fremont County, as pipelines were completed to provide oil delivery capacity to refineries and gas delivery capacity to consumer markets. Production and exploration activity experienced a "boom" in the late 1970s and early 1980s. In Fremont County the boom fueled large increases in employment evidenced by an increase in the industry's annual payroll from $8.7 million in 1976 to $41.3 million in 1981. Subsequent contractions reduced the industry's annual payroll to $14.9 million by 1989. Since that time the industry has experienced several cycles of modest expansion and decline.

Oil and gas production increased in Fremont County in the aftermath of the boom. Perhaps as importantly, exploration conducted during the boom and the subsequent infrastructure development were the precursors to the current cycle of oil and gas development. Though the industry is well established and has a mature presence in the regional economy, it nevertheless is relatively small in terms of direct employment. Data for the first quarter of 2002 reports a total of 32 oil and gas, oil and gas service, and other mining firms, with a combined employment of 303. In part, the sharp decline from earlier years reflects reductions in exploration and in part the consolidation of the oil and gas field services in Casper, Rock Springs, the Powder River Basin, and elsewhere.

It is important to note, however, that the oil and gas industry, like other basic industries, generates jobs in other sectors of the local economy. Oil and gas operating companies and their relatively high-paid employees spend substantial amounts locally for goods and services. A high percentage of oil and gas royalties, particularly tribal royalties, are also spent locally. Most ad valorem property taxes on oil and gas production and facilities are spent locally by local governments and school districts for salaries and for goods and services purchases. This local economic activity combines to generate substantial indirect or secondary employment in the local economy.

The total number of producing oil and gas wells in Fremont County increased by 56 percent between 1998 and 2000, from 884 to 1,377 (Figure 3.13-9). Permits to drill wells (APD) approved each year increased during the period to 138 from 77, up 79 percent. In 2001, Fremont County produced about 6 percent of the state's total oil production and about 9 percent of the state's total gas production.

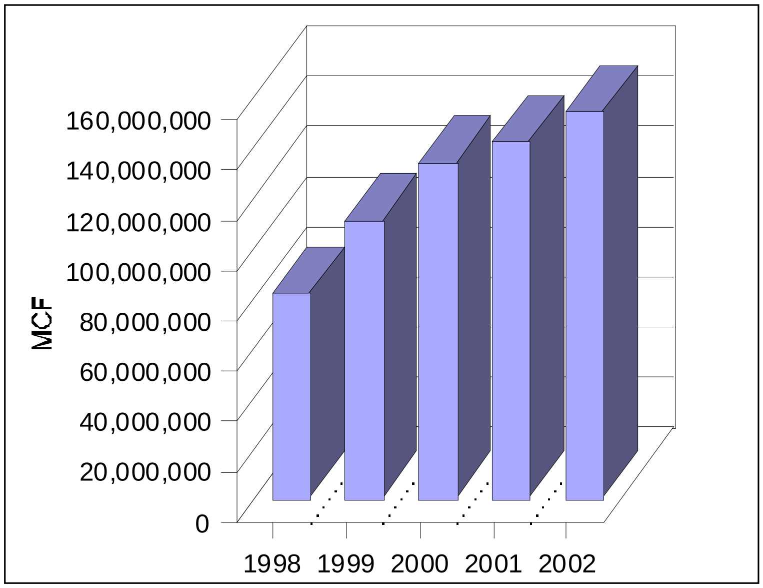
Figure 3.13-9. Total Wells and Approved APDs in Fremont County in 1998 to 2001.



Sour
ce: WOGCC 1998 – 2001.

As shown in Figure 3.13-10, natural gas production in Fremont County has been increasing in recent years, from 81.6 million MCF in 1998 to 154 million MCF in 2002, an 88 percent increase over the five-year period.

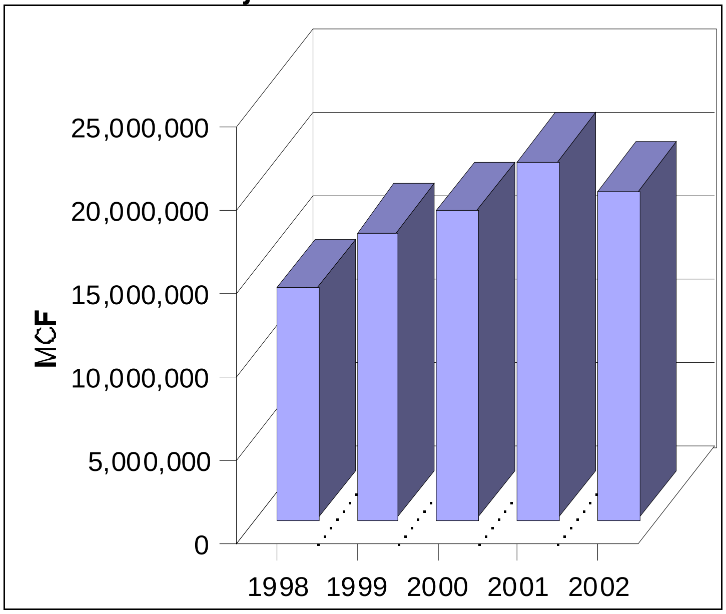
Figure 3.13-10. Fremont County Natural Gas Production in 1998 – 2002.



source:
OGCC: 1998-2002.

Gas production in the three existing fields within the WRPA also increased from 1998 to 2001, by 55 percent (see Figure 3.13-11). However, between 2001 and 2002, production in the WRPA fell by 10 percent as production from more recently completed wells failed to offset the declines from older wells.

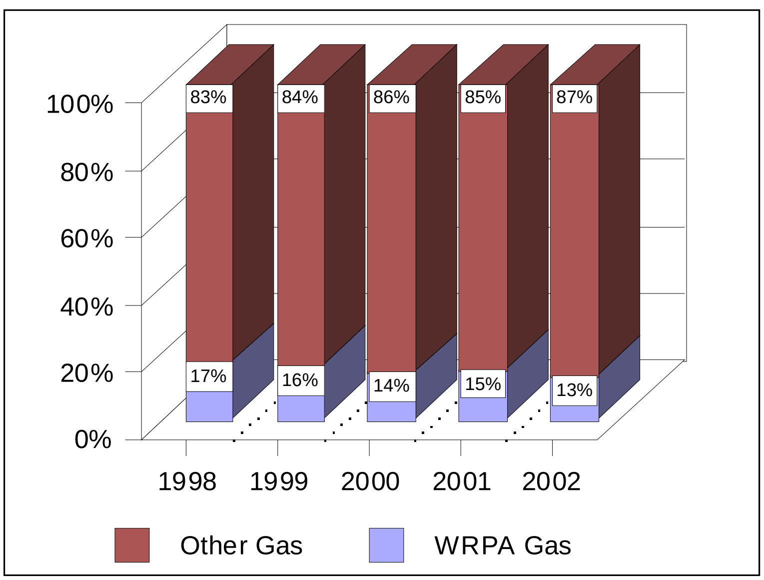
Figure 3.13-11. Wind River Project Area Natural Gas Production: 1998-2002.



Source: WOGCC: 1998-2002.

Between 1998 and 2002, the WRPA's share of total county gas production declined from 17 percent to 13 percent (Figure 3.13-12).

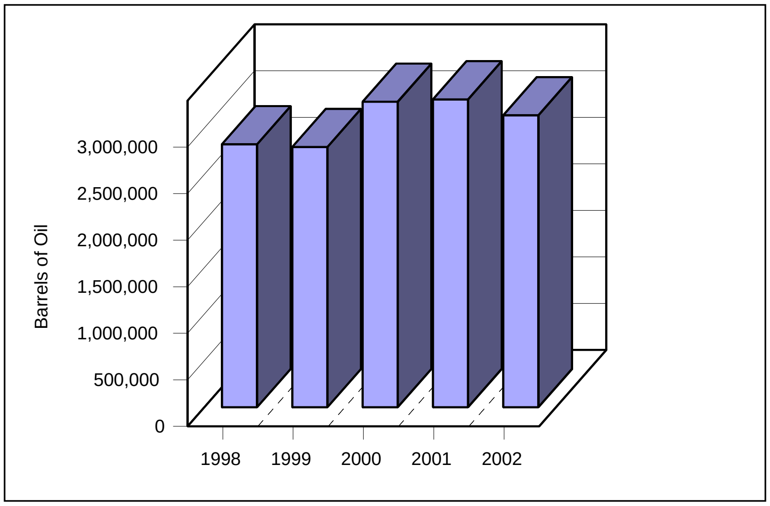
Figure 3.13-12. WRPA Gas Production as a percent of Total Fremont County Production: 1998-2002.



Source: WOGCC 1998- 2002.

As shown on Figure 3.13-13, Fremont County oil production increased by about 17 percent between 1998 and 2001, but declined by 5 percent between 2001 and 2002.

Figure 3.13-13. Fremont County Oil Production in 1998 – 2002.



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Source: WOGCC: 1998 – 2002.

Unemployment and Labor Force

The labor market in Fremont County has improved in recent years, though unemployment has stayed above the Wyoming average (Table 3.13-15). The number of jobs grew faster than the population in the 1990s – 4,261 new jobs compared to a net gain of 2,142 residents. This is reflected in the unemployment rate in Fremont County, which fell from 7.6 percent to 6.2 percent from 1999 to 2002. At the same time the unemployment rate for all of Wyoming fell from 4.9 percent to 4.2 percent.

Table 3.13-15. Annual Average Unemployment Rates in 1999 - 2002

	1999	2000	2001	2002
Fremont County	7.6%	6.4%	6.4%	6.2%
Wyoming Statewide	4.9%	3.9%	3.9%	4.2%

Source: Wyoming Department of Employment 2003a.

The incidence of unemployment varies widely, both geographically and on a racial basis. Data from the 2000 Census indicate that 8.9 percent of the civilian labor force in Fremont County was unemployed. These data differ from those reported by the state in Table 3.13-10 above because they rely on a different set of measurements. However, while unemployment rates were generally below the countywide average in the towns and unincorporated areas off the WRIR, unemployment rates were consistently above 20 percent in the Indian communities and rural areas of the reservation (Table 3.13-16). As noted in Section 3.13.4.2, the WINDS-2 survey also reported very high unemployment among American Indians on the WRIR reservation.

Table 3.13-16. Fremont County Unemployment by Area in 2000.

County Subdivision or Place	Labor Force	Unemployed	Unemployment Rate
Dubois (town)	522	32	6.1%
Hudson (town)	211	21	10.0%
Lander (city)	3,337	151	4.5%
Shoshoni (town)	289	17	5.9%
Ethete CDP	517	151	29.2%
Ft. Washakie (CDP)	567	127	22.4%
Pavillion	111	2	1.8%
Riverton	4,694	436	9.3%
Wind River CDP (remainder)	5,307	567	10.7%
Other unincorporated	2,082	58	2.8%
Fremont County Total	**17,637**	**1,562**	**8.9%**

Source: US Census Bureau 2001.

Fremont County's population out-migration may be due in part to long-term high unemployment. In addition, workers out of a job for a long time may stop looking for work. Fremont County also may be experiencing this effect. The county has had a gross labor force participation rate of 49 percent, based on a civilian labor force of 17,637. This compares to a statewide rate of 54 percent (Table 3.13-17). Although the difference may be due to other demographic characteristics, the gap may also result from a decline in labor force participation because of extended unemployment, especially among American Indians in Fremont County.

Table 3.13-17. Population, Employment, and Labor Force in 2000.

	Population	Labor Force	Gross Labor Force Participation Rate
Fremont County	35,804	17,637	49%
Wyoming	480,045	258,808	54%

Source: US Census Bureau 2002.

Earnings and Income

Despite relatively high unemployment, total annual earnings of employees and proprietors in the region mirror employment trends, rising steadily with recent local economic growth. Total earnings climbed by $93.2 million in Fremont County between 1995 and 2000, from $362.1 million to $456.3 million. Industries accounting for the largest shares of total earnings and the largest absolute gains over the six-year period include government, services trade and construction, underscoring their economic importance (Table 3.13-18). However, real earnings in the manufacturing and government sectors actually declined, as the total earnings did not keep pace with the overall rate of inflation of 12.5 percent over the period. Farm income during this period declined by 28 percent.

Table 3.13-18. Fremont County Earnings by Major Industry in 1995 and 2000.

Industry	Earnings (Millions)		Change 1995 to 2000	Share of Total 2000 Earnings
	1995	2000		
Private Sector				
Farm	$7.9	$5.4	$(2.5)	-28%
Ag. Services, Forestry & Other	$2.3	$2.8	$0.5	22%
Mining, Oil & Gas	$22.1	$26.8	$4.7	21%
Construction	$30.9	$52.7	$21.8	71%
Manufacturing	$16.5	$17.9	$1.4	8%
Transportation & Utilities	$25.2	$31.9	$6.7	27%
Wholesale & Retail Trade	$53.0	$62.9	$9.6	18%
Finance, Insurance & Real Estate	$9.8	$17.3	$7.5	77%
Services	$85.1	$117.4	$32.3	38%
Subtotal - Private Sector	$252.8	$334.8	$82.0	32%
Government Sector	$110.3	$121.5	$11.2	10%
TOTAL EMPLOYMENT	**$362.1**	**$456.3**	**$93.2**	**26%**

Source: US Bureau of Economic Analysis 2003b.

Wages in Fremont County have consistently been below statewide averages and less responsive to growth over time. Average weekly wages across all industries in Fremont County were $437 in the first quarter of 1999, rising by a modest 6.2 percent to $464 for the same period in 2002. By comparison, statewide averages climbed from $469 in 1999 to $547 in 2002, a 16.6 percent increase as displayed in Table 3.13-19.

Table 3.13-19. Average Weekly First Quarter Wages in 1999 – 2002.

	1999	2000	2001	2002
Fremont County	$437	$428	$444	$464
Wyoming Statewide	$469	$504	$522	$547

Source: Wyoming Department of Employment 2003(b).

Wages, salaries, and other labor income are a key component of total personal income. Lower wages in the region, therefore, contribute to lower income for residents. Personal income in Fremont County, on a per capita basis, lags behind both the statewide and the national average. The 1999 median household income of $32,503 for Fremont County was 86 percent of the statewide average, and 77 percent of the national average. Personal income, reported on a per capita basis, exhibited similar relationships as shown in Table 3.13-20.

Table 3.13-20. 1999 Personal Income - Fremont County, Wyoming, and the U.S.

	Fremont County	Wyoming	U.S.
Median Household Income (1999)	$32,503	$37,892	$41,994
Per Capita Personal Income (1999)	$16,519	$19,134	$21,587

Source: US Census Bureau 2001.

Total personal income of Fremont County residents was $798.0 million in 2000 (Table 3.13-21). Total earnings include non-wage income items like transfer payments. Transfer payments include social security, Medicare and Medicaid, income maintenance, and private retirement benefits. On a per capita basis, income received from transfer payments was $5,788 in Fremont County, 51 percent above the national average. On the other hand, per capita income derived by Fremont County residents from dividends, interest, and rents is 19 percent below the national average; $4,305 compared to $5,304.

Table 3.13-21. Components of Personal Income in 2000.

	Personal Income (Millions)	Per Capita Income	Share of Total
Total Personal Income	$798	$22,267	100%
Sources of Personal Income			
Earnings	$436.3	$12,174	55%
Transfer Payments	$207.4	$5,788	19%
Dividends, Interest and Rents	$154.3	$4,305	26%

Source: US Bureau of Economic Analysis 2002.

The relatively low average wages and higher than average unemployment rates, particularly among American Indians in Fremont County, contribute to local poverty rates for families and individuals that exceed both the statewide and national averages by substantial margins as shown in Table 3.13-22. Poverty rates are more than 50 percent higher in Fremont County than across the state as a whole.

Table 3.13-22. Percent Below Poverty Level in 1999.

	Fremont County	Wyoming	U.S.
Families	13.3%	8.0%	9.2%
Individuals	17.6%	11.4%	12.4%

Source: US Census Bureau 2001.

3.13.5.3 Housing

Demographic and economic data provide important insights into local socioeconomic conditions. For many working households and those on fixed incomes, housing availability and affordability are other important determinants of quality of life.

There were 14,437 housing units in Fremont County in 1990 (Table 3.13-23). Nearly one-half of them were in Lander or Riverton. Another 4,808 dwelling units were located in Fort Washakie, Ethete, and elsewhere within the boundaries of the WRIR. The remainder was in Shoshoni and in the unincorporated areas of the county.

Between 1990 and 2000, the housing stock increased by 7.6 percent with the net addition of 1,104 units (see Table 3.13-23). The largest net gain, 384 units, occurred in Riverton. Substantial gains were also registered in the unincorporated areas of the county outside the WRIR, along with smaller gains in Lander and elsewhere within the WRIR.

Table 3.13-23. Fremont County Housing Stock: 1990 and 2000.

	City of Lander	City of Riverton	Remainder WRIR	Rest of County	County Total
1990 Census	2,890	3,870	4,808	2,869	14,437
2000 Census	3,036	4,254	5,060	3,191	15,541
Absolute Change	146	384	252	322	1,104
Percent Increase	5.1%	9.9%	5.2%	11.2%	7.6%

Source: US Census Bureau 2001, 2002.

Housing in Fremont County is 70 percent single-family residences, according to the 2000 census (Table 3.13-24). This is a net increase of 946 single-family units since 1990. Other housing types in the inventory are 1,513 duplexes and multifamily units (10%) and about 3,100 mobile homes or other types of housing (20%).

Table 3.13-24. Fremont County Housing Stock[1] by Type in 2000.

	City of Lander	City of Riverton	Remainder WRIR	Rest of County	County Total
Single family	2,030	3,018	3,490	2,394	10,932
Multi-family	510	742	77	184	1,513
Mobile home and other	478	453	1,526	639	3,096
Total Units	**3,018**	**4,213**	**5,093**	**3,217**	**15,541**

[1] The estimates of housing stock by type are based on sample data. Thus, the totals differ from the total based on actual unit counts.

Source: US Census Bureau 2002.

Table 3.13-25 presents housing occupancy information from the 2000 census. At the time of the census, 13,545 units, or approximately 87 percent of all housing units, were occupied. Across the county as a whole, nearly 73 percent of all occupied units were owner-occupied, compared to 27 percent renter-occupied. The largest concentration of renter-occupied units, both in absolute and relative terms, was in Riverton.

In addition to the occupied housing units, another 1,996 units in Fremont County were vacant. However, only about two-thirds of those units were classified as for sale or rent, the remaining one-third were held for seasonal, recreational, or occasional use and hence, were not vacant in the traditional sense. Evaluating only those units that are listed for sale, or available to rent yields, adjusted the effective range of vacancy rates from 3.8 percent in Lander, to 13.8 percent in unincorporated areas of the county off the WRIR. The largest numbers of vacant units in Fremont County are those that are being held vacant for seasonal and recreational use, or units that may be second homes or vacation homes. These types of units are located in areas outside of the cities and are not present within the WRIR.

Table 3.13-25. Fremont County Housing Occupancy in 2000.

	City of Lander	City of Riverton	Remainder WRIR	Rest of County	County Total
Total Units	3,036	4,254	5,059	3,192	15,541
Occupied Units	2,794	3,816	4,521	2,414	13,545
Owner Occupied	1,973	2,554	3,485	1,858	9,870
Renter Occupied	821	1,262	1,036	556	3,675
Vacant Units	242	438	538	778	1,996
For Sale or Rent	115	390	393	441	1,339
For Seasonal or Recreational Use	27	48	145	437	657
Effective Vacancy Rate[1]	3.8%	9.2%	7.8%	13.8%	8.6%

[1] The effective rate is the number of vacant units for sale divided by the total units.
Source: US Census Bureau 2002.

Housing value and monthly rent data from the 2000 Census suggest relatively affordable housing conditions within the region. Based on samples of owner-occupied and renter-occupied dwelling units, the median value of an owner-occupied unit was $89,300, $7,300 below the statewide median of $96,600. Housing values tend to be higher in Lander and Riverton and lower elsewhere on the WRIR and in unincorporated areas of the county outside the reservation. Monthly rents in Fremont County are also lower than the corresponding statewide average. The median gross monthly rent reported in the county was $381 per month in 2000, below Wyoming's statewide average of $437 per month.

3.13.5.4 Community Facilities and Services

Community facilities and services that would be directly affected by the Proposed Action and Alternatives include emergency response services (ambulance and fire suppression), law enforcement, and road and bridge maintenance. Road and bridge maintenance services are addressed in Section 3.14, Transportation.

Emergency Response

Shoshoni – Arapaho Joint Tribal Emergency Management Program

Emergency management services on the Wind River Reservation are coordinated by the Emergency Management Coordinator for the Joint Tribal Programs. The coordinator responds to all incidents on the WRIR involving hazardous materials, including train derailments, oil spills and natural gas fires, and incidents involving natural disasters, such as forest and rangeland fires and floods. To date, the agency has responded to few incidents in the three existing WRPA gas development areas.

The US EPA is the regulatory authority for incidents involving hazardous materials on the reservation and the Coordinator is responsible for reporting such incidents to the agency. Reports are also circulated to appropriate state and local agencies.

During emergency incidents on the reservation, the person in charge of the first responders on the scene serves as incident commander, coordinating the activities of other federal, state and local agencies. The nearest hazardous materials response equipment, vehicles and staff are located in Riverton, so response times for hazardous materials incidents can be several hours.

The Coordinator is also responsible for homeland security on the reservation, and is working on a homeland security program, although there are few resources dedicated to the effort at present (Weeks 2004, Aragon 2004).

Fremont County Emergency Response Agency

Emergency management in Fremont County is coordinated by the Fremont County Emergency Management Agency (FCEMA), which operates under Federal Emergency Management Agency (FEMA), Wyoming Emergency Management Agency (WEMA), and EPA guidelines. FCEMA is the agency designated by the Fremont County Commissioners to analyze potential hazards, assess emergency response capabilities, plan for and respond to potential events, and mitigate the effects of emergencies or disasters. FCEMA coordinates emergency planning with response agencies, industry, elected officials, and volunteer agencies.

The Board of Fremont County Commissioners, in concert with the Governor's office and the State Emergency Response Commission, created the Fremont County Local Emergency Planning Committee (LEPC) in 1987. FCEMA has been directed to coordinate the LEPC. The committee is made up of local emergency service officials, private industry representatives, and the local media. The goal of the LEPC is to review chemical facility hazardous material inventories and develop and maintain the county comprehensive emergency response plan.

Fremont County has a Hazardous Material Emergency Contingency Plan which was prepared by the Fremont County LEPC. The plan provides policies and procedures to be followed in dealing with incidents involving the release, transportation, use, storage, or manufacture of hazardous materials (LEPC 2003).

The portion of Fremont County that includes the WRPA is served by a number of emergency response organizations.

Fire Suppression

Volunteer departments at Pavillion and Midvale, each equipped with pumper trucks, provide fire suppression within the WRPA. The Riverton and Fort Washakie Fire Departments, also volunteer organizations, support these departments. The Pavillion and Midvale departments do not have the necessary equipment to extinguish petroleum-based fires, and must rely on the Riverton Fire Department for support in case of petroleum fires. Response times from Riverton can be lengthy and all departments have difficulty raising a full complement of volunteers at times.

Ambulance and Emergency Medical

Ambulance services near the WRPA are based at Pavillion and Morton-Kinnear, and both stations are staffed with volunteer emergency medical technicians. Ambulance and emergency medical services are also provided from the Riverton ambulance station, which has full-time paid EMTs. Patients and accident victims are transported to hospitals in Riverton or Lander. Critically injured patients are transported to hospitals in Riverton or Casper by Life Flight helicopters based in Casper (Lee, K., Fremont County Emergency Management Agency, personal communication, May 7, 2003).

Law Enforcement

Law enforcement on the WRIR is provided by federal, tribal, state, and county officers. The various agencies operate under intergovernmental law enforcement agreements. Typically the first agency on the scene deals with the event and when the other agency arrives, they jointly determine the disposition of the case. The primary consideration for all agencies is timely response (Milward 2004).

The Bureau of Indian Affairs is the primary law enforcement agency on the WRIR, The BIA participates in intergovernmental agreements developed to deal with the various jurisdictions with authority over crimes within the Reservation.. The BIA Wind River Agency Police Department enforces federal law and the Eastern Shoshone and Northern Arapaho Tribal Codes. The department is headquartered in Fort Washakie and has a staff of 11 sworn officers, 2 BIA special agents, 3 communications specialists (dispatchers), 4 detention officers and a secretary. The agency does not routinely provide patrol services within the WRPA, and only responds to incidents and matters involving Tribe members, Tribal property, or other Tribal matters (Noseep 2004).

The Fremont County Sheriff's department provides patrol services within the Pavillion area and other portions of the WRPA. The Sheriff's Department also operates the county's emergency communication system and the county jail. The recently constructed county jail facility has been operating at or above capacity since it opened. Because of recent budget cuts, the department can no longer afford a resident deputy in the Pavillion area and, as of early 2003, has 4 unfilled positions in the dispatch division and 5 at the jail. Patrols are provided, generally on a twice-daily basis. There is a 30 to 45 minute response time for calls within the WRPA.

Recently, the Sheriff's department has seen an increase in the number of requests to intervene in conflicts between surface landowners and oil and gas contractors (Millward, R., Fremont County Sheriffs Department, personal communication, May 8, 2003).

3.13.5.5 Fremont County Fiscal Conditions

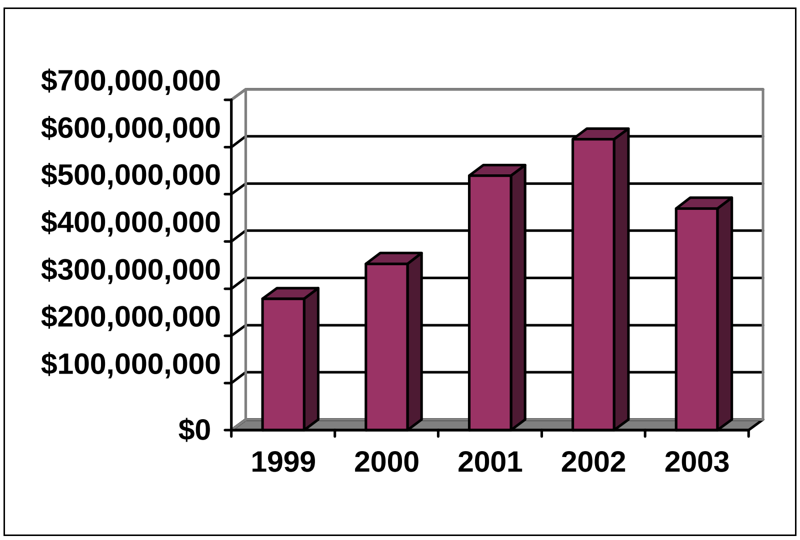
Fiscal conditions most likely to be affected by the Proposed Action and alternatives include the following:

- County, school, and special district ad valorem property tax revenues,
- State, county, and municipal sales and use tax revenues,
- State severance tax revenues, a portion of which are returned to counties,

Ad Valorem Property Tax Revenues

Oil and gas companies pay ad valorem property taxes on production and facilities, with certain exemptions. As shown in Figure 3.13-14, Fremont County 2002 assessed valuation was over $616 million, an increase of 121 percent over 1999 levels, however, 2003 assessed valuation was just under $470 million, 24 percent less than the previous year (Wyoming Taxpayer's Association 2003). Total 2002 property tax revenues to all taxing entities were $45.6 million, but tax revenues for the 2003 – 2004 fiscal year were substantially lower, reflecting the drop in assessed valuation.

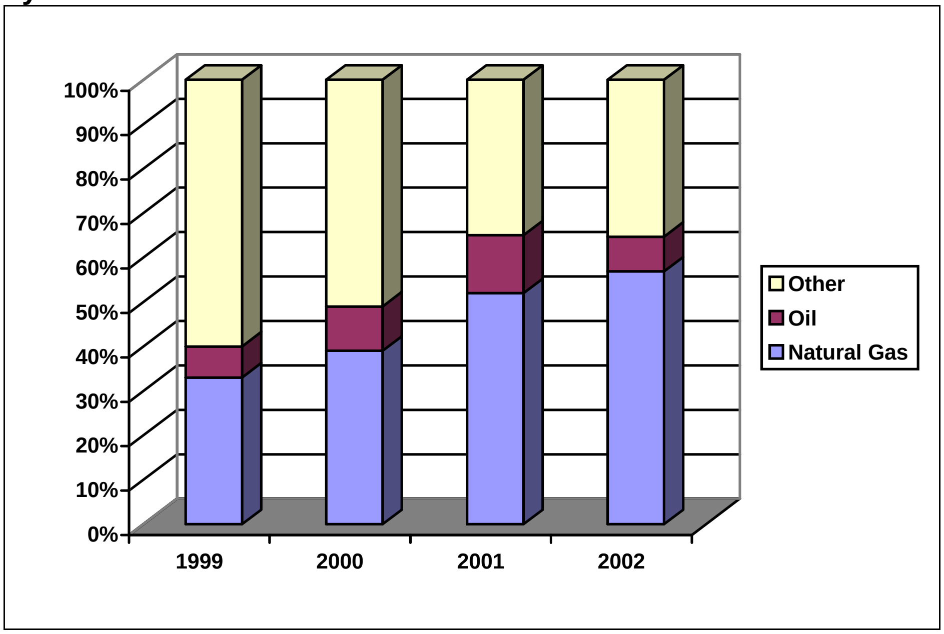
Figure 3.13-14. Fremont Count Assessed Valuation in 1999 – 2003.



Source: WTA 1999 – 2002, Riverton Ranger 2003.

Natural gas is assessed on the previous year's production. As shown in Figure 3.13-15, assessed valuation from the production of natural gas and oil comprised an increasing portion of Fremont County's tax base between 1999 and 2002. In 2002, natural gas valuation was $355.6 million, 58 percent of the total county assessed valuation. Oil valuation was $52.3 million, or 8 percent of the total assessed valuation.

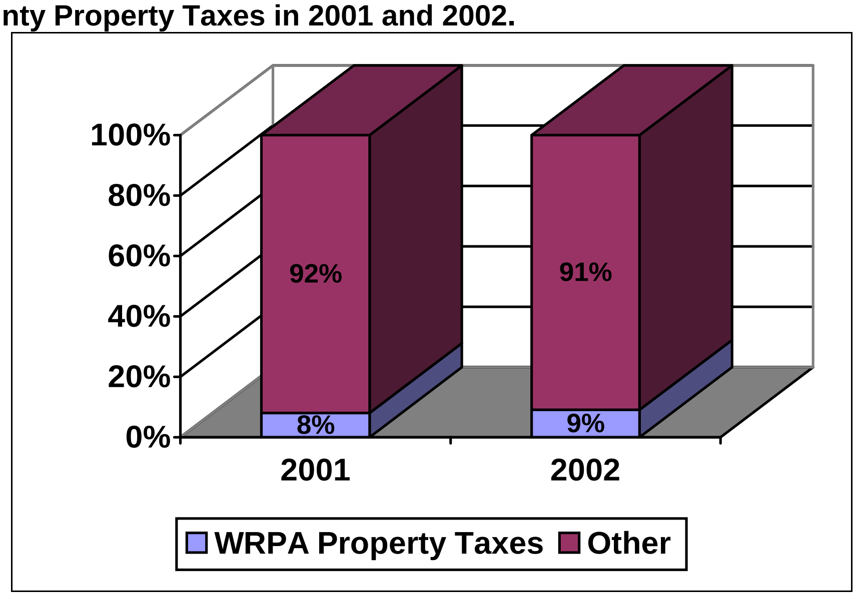
Figure 3.13-15. Natural Gas and Oil Production-Related Valuation as a Percentage of Fremont County Total Valuation in 1999 – 2002.



Source: WTPA 1999-2002.

Revenue from WRPA natural gas production comprises a substantial portion of the Fremont County ad valorem tax revenue. As shown by Figure 3.13-16, WRPA gas production averaged about 8.5 percent of the total county ad valorem tax revenue during 2001 and 2002.

Figure 3.13-16. WRPA Gas Production Tax Revenues as a Percentage of Total Fremont County Property Taxes in 2001 and 2002.



Source: TBI 2003c, WTP 1999 – 2002.

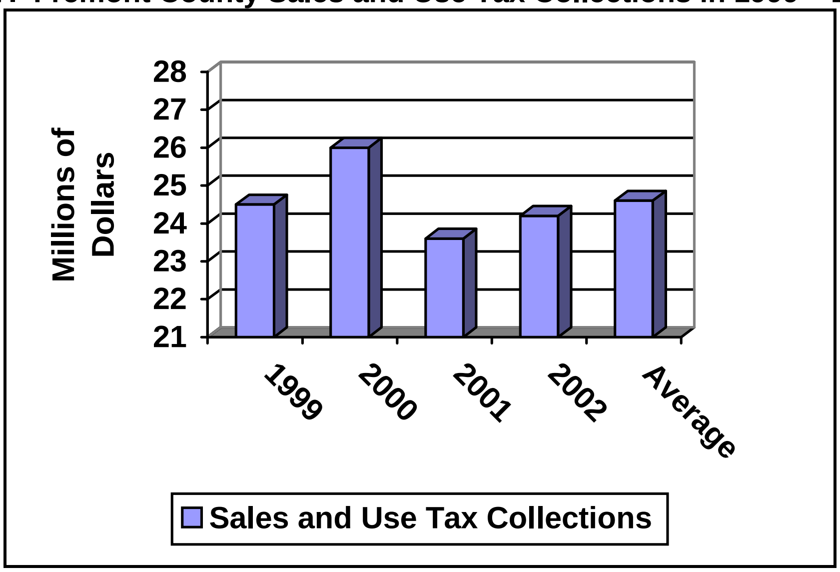
Mill levies within the WRPA ranged between 72.183 (District 2400) and 73.825 (District 600) mills, including 23.245 county-wide mills (12 mills for the county and 11.245 for Central

Wyoming College, solid waste and weed and pest levies), 43 mills for schools (12 for the state foundation fund, 6 for the county school levy and 25 for local schools), 0.5 mills for the Board of Cooperative Education levy, 0.75 mills for a recreation district levy, and 3 mills for a fire district levy. Taxing District 6 had a 2.85 mill school bond levy and a 0.48 cemetery district levy, while District 2400 had 1.588 mills and 0.1 mills for those two levies, respectively.

Sales and Use Tax

Wyoming has a statewide four percent sales and use tax. Between 1999 and 2002, Fremont County sales and use tax collections have been some what volatile, ranging from a high of about $26 million in 2000 to a low of $23.6 million in 2001. As shown in Figure 3.13-17, sales and use tax collections during this four-year period averaged about $23 million dollars annually.

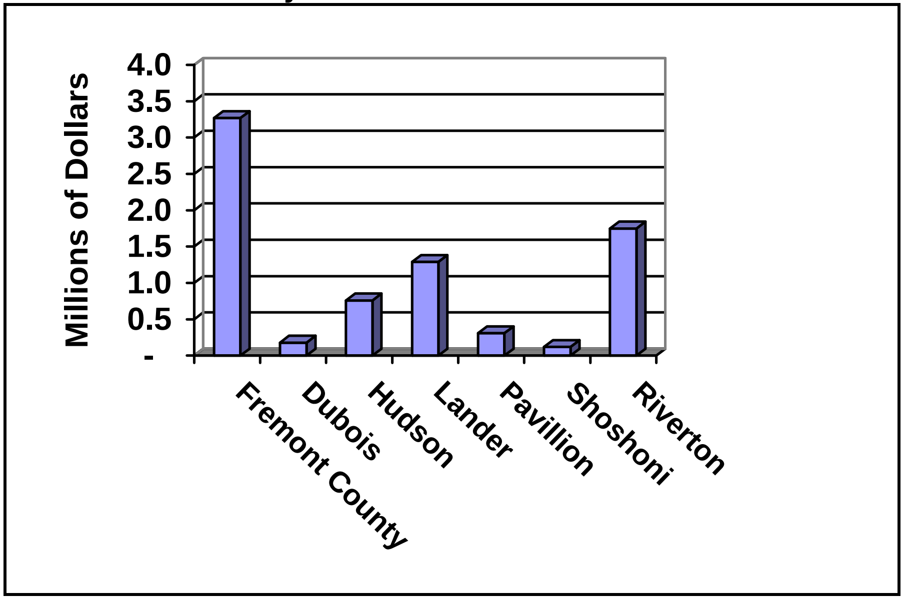
Figure 3.13-17. Fremont County Sales and Use Tax Collections in 1999 – 2002



Source: WDAI 2002.

About 28 percent (less administrative costs) of the statewide four percent sales and use tax collections are distributed to the county and its incorporated municipalities according to a population-based formula. Of the over $24.5 million in sales and use tax revenues collected in Fremont County in FY 2002, about $6.7 million was distributed to county entities. Figure 3.13-18 displays the distribution of 2002 sales and use tax revenues among Fremont County and its incorporated municipalities. Fremont County received the largest share, almost $3.3 million, while Pavillion received the smallest share, about $31,000.

Figure 3.13-18. Fremont County 2002 Sales and Use Tax Distributions.



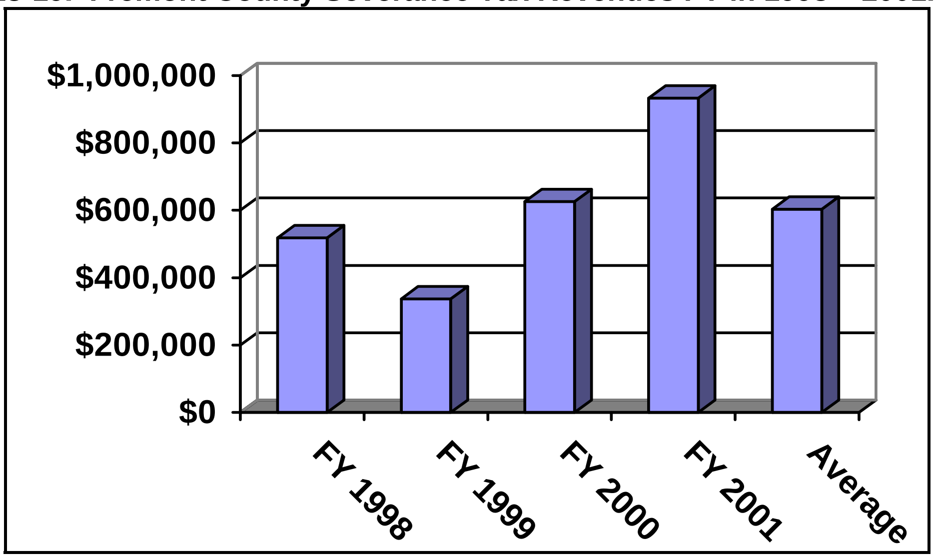
Source: WDOR 2003.

Wyoming Severance Taxes

The State of Wyoming collects a six percent severance tax on oil and natural gas production. Severance tax revenues are distributed to the Wyoming Mineral Trust Fund, General Fund, Water Development Fund, Highway Fund, Budget Reserve Account, and to counties and incorporated cities and towns. In FY 2002, severance tax distributions totaled $299 million (CREG 2003a). Of the total, about 43 percent was attributable to severance taxes on natural gas.

As displayed in Figure 3.13-19, Fremont County severance tax revenues have also been volatile in recent years, ranging form a low of $336,000 (1999) to a high of $933,000 (2001) and averaging about $600,000 between 1998 and 2001.

Figure 3.13-19. Fremont County Severance Tax Revenues FY in 1998 – 2001.



Source: Fremont County 2002.

3.13.6 Split Estate, Agricultural Income and Industrialization in the WRPA Portion of the Midvale Irrigation District

3.13.6.1 Midvale Irrigation District Description

The Midvale Irrigation District (MID), located in the central portion of the WRIR, operates irrigation facilities as part of the Riverton Reclamation Project undertaken by the Bureau of Reclamation (BOR) to promote the settlement of the area using irrigation-supported agriculture. MID was organized under Wyoming Statutes in 1921 and operates under state and federal law and the provisions of the *Amendatory Repayment Contract between the United States of America and the Midvale Irrigation District Covering All Lands of the Riverton Unit*, executed in 1971.

Information for this section was obtained from scoping comments, interviews with local residents, the manager of the MID, Riverton Resource Conservation District staff, the Fremont County Assessor's office and the Fremont County Planning Department. Information was also obtained from secondary sources as cited.

MID is authorized by state law to assess a per-acre levy on irrigated lands to fund operations, maintenance, and construction of facilities. Therefore, the MID's service area and the extent of its powers of taxation are best defined by the irrigated properties it serves rather than by exterior boundaries, because some land within the district is not irrigated. MID has delivered water to an average of about 71,000 acres over the last 10 years, and it currently levies $15.00 per acre, $12.75 of which is dedicated to operations and maintenance and $2.25 to capital facilities repayment (MID 2002a).

Bull Lake dam and reservoir are the principal storage facilities for MID water, and Pilot Butte Reservoir provides supplemental storage. Combined active storage of the two reservoirs is 183,600 acre-feet of water. The Wind River Diversion Dam, the 62.5-mile Wyoming Canal, the 38.2-mile Pilot Canal, and 300 miles of lateral ditches and pipeline distribute irrigation water. The district also operates a 335-mile system of drainage ditches and pipes (MID

2002b). Recently the MID has begun to emphasize conversion from open conduits to water-conserving delivery systems such as pipelines and center pivot or side-roll sprinklers. MID maintains all facilities and delivers water to irrigators. The water rights, reservoirs, canals, and major ditches are owned by the US government.

MID facilities within the WRPA are primarily water distribution and drainage ditches and pipelines, as well as a segment of the Wyoming Canal that crosses the WRPA. Lands in the WRPA that are served by the MID are concentrated in the Pavillion and Sand Mesa areas, including areas where there has been natural gas development in the past.

Of the 141 private parcels of land within the WRPA, the Fremont County Assessor classifies 116 as agricultural and 22 as residential (Table 3.13-26). Most private parcels found in areas of the WRPA where there has been natural gas development in the past are found in the gas development area east of Pavillion.

Table 3.13-26. Private Surface Ownership within the Wind River Project Area.

Private Parcels	Total WRPA	Pavillion Field	Muddy Ridge Field	Sand Mesa Field	Sand Mesa South Field	Coastal Extension Field
Agricultural	116	85	13	13	0	5
Residential	22	20	2	0	0	0
Other	**3**	**1**	**1**	**0**	**0**	**0**
Total	**141**	**106**	**16**	**13**	**0**	**5**

Note: There is some overlap because several parcels are located within two fields.
Source: Fremont County Assessors Office, Buys & Associates.

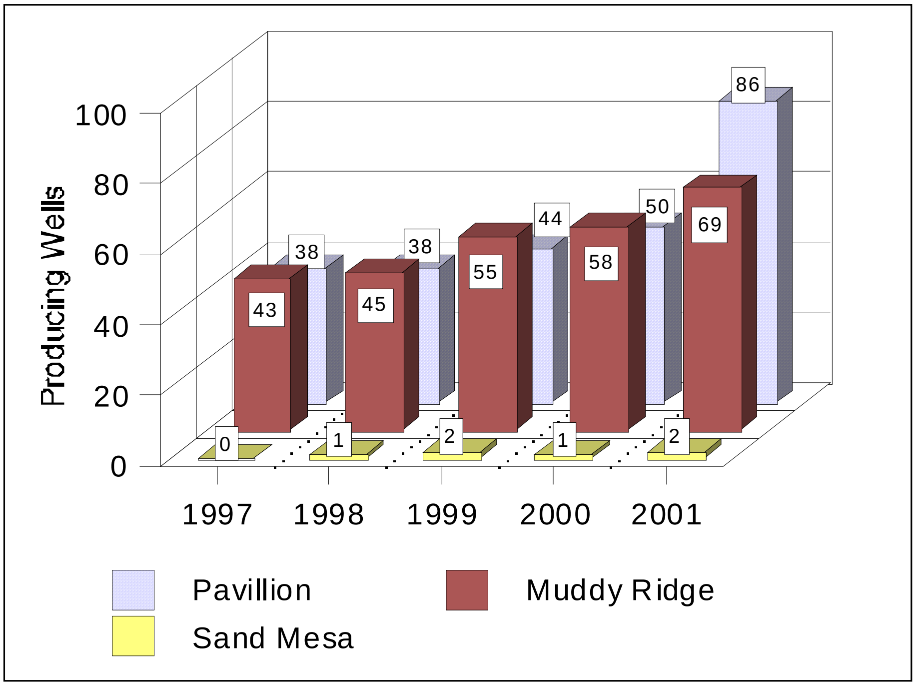
Oil and gas companies and other developers who desire to construct roads, pipelines or other facilities across district canals, ditches, or pipelines, or who need to use district rights-of-way or access roads, must obtain permits and approvals from the Midvale Irrigation District and/or the BOR. MID permits are available at no cost, have an initial term of 25 years, and are renewable. However, they obligate the permit holder to meet specific engineering and design standards and pay for repairing any damages associated with their operations. These permits are also revocable. To date, development of oil and gas leases has not negatively affected MID facilities. Coordination between the proponent and MID has been satisfactory. The proponent has repaired or paid for repairs of damaged MID facilities and the district has contracted to perform some construction activities for TBI.

The district is concerned that land developed for gas extraction, and therefore removed from agricultural production, may reduce district revenues. The BOR classifies land within the district based on its agricultural use. The district may only assess a levy on land used for agricultural purposes, so natural gas or residential development that removes irrigable land from production has the potential to reduce district revenues if the land is reclassified by the BOR (Arrington, L., Midvale Irrigation District, personal communication, May 14, 2003).

3.13.6.2 Oil and Gas Development within the WRPA portion of the MID

Oil and gas development in the WRPA first occurred in the early 1960's, but the pace of field development has accelerated since 1999, especially in the Pavillion field, where much of the surface is in private ownership (see Figure 3.13-20). As natural gas development activity has increased, so have conflicts between surface owners and natural gas developers when wells are drilled and facilities are installed on private lands amidst other established uses, according to the individuals interviewed for this assessment. Currently, there are 102 wells located on 41 private parcels in the Pavillion Field; 22 wells on 6 private parcels in the Muddy Ridge Field; and 2 wells on 2 private parcels in the Sand Mesa Field. No wells have been drilled on private parcels in the Coastal Extension Field, and no wells have been drilled in the Sand Mesa South field.

Figure 3.13-20. Total Number of Producing Wells, Pavillion, Muddy Ridge and Sand Mesa Fields in 1997 – 2001.



Source: WOGCC 1997 – 2001.

3.13.6.3 Experience with Split Estate in the WRPA

As already noted, split estate is the separate ownership of the land surface and of the mineral estate associated with it. A mineral developer typically must occupy and conduct activities on a portion of a surface property to develop the underlying minerals.

Split estate conflicts within the WRPA have included the following:

- Disruption of farming activities and productivity losses associated with well pad, access, and ancillary facility (e.g., pipelines and tank batteries) development, and operation,
- Noise, traffic, visual, and aesthetic impacts associated with the increasing industrialization of areas of agricultural and residential land use,
- Concern about potential effects of gas development on the value of agricultural and residential properties,
- Disagreements over the value of surface damages and sufficiency of compensatory payments made by energy companies.

3.13.6.4 Natural Gas Development, Agricultural Productivity and Income

Disruption of farming activities and productivity losses are frequent consequences of oil and natural gas development on agricultural lands where the mineral estate and surface ownership are separately owned. Under Wyoming law, mineral owners have entry and development rights, provided surface owners are compensated for damages, including the loss of land use and production. The surface disturbance and activity associated with gas development and operations can reduce current farm income from crop sales and increase average production costs for the remaining acreage. The loss of income stems from direct reduction in production associated with disturbances for well pads, production facilities, access roads, and ancillary facilities, and the indirect loss that can occur when the placement of gas facilities interferes with farming practices such as cultivation patterns or the operation of mechanized irrigation systems. The higher production costs would be associated with factors such as reseeding, fence repairs, increased fertilizer application, and equipment operating expenses.

Principal crops grown within the MID include alfalfa and other hay, barley, sugar beets, silage, beans, and hard corn. The exact acreage under cultivation for each crop is not known for the WRPA, but district-wide the largest percentage of irrigated farmland is devoted to alfalfa and hay production, an average of about 57 percent over the last 10 years (MID 2003).

Average gross revenues received for these commodities in 2002 ranged from $181 per acre for barley to $1,081 per acre for alfalfa seed. (Alfalfa seed was grown on only 75 acres in 2002, about 0.1 percent of all acres under cultivation that year). Across the MID gross crop receipts averaged about $241 per acre in 2002; alfalfa hay averaged $360 per acre. Some land within the district is used for pasture. Pastureland within the district yielded from $10.50 to $125 per acre (MID 2003).

Actual per acre gas development-related income losses to farmers are likely less than these gross amounts, because expenditures for seed, fuel, fertilizers, and pesticides are not required on lands taken out of production. Depending on the crop, the loss or reduced productivity may extend over several years until replacement crops establish themselves, mature, and achieve maximum yields.

Surface use agreement compensation typically includes a $6,000 initial payment per well, a $1,500 annual payment (TBI 2002) and $1,000 for subsequent access for well maintenance or recompletion during a crop season or $500 for access during a non-crop season (Fuller 2003).

Recent wells on irrigated land in the Pavillion field have required an average of 2.6 acres of initial disturbance for well pads, access roads and production facilities, and 0.33 acres of residual disturbance.

Assuming that a well was developed in an alfalfa field, initial losses associated with lands removed from production would average $936 and annual losses would total $119, assuming 2002 average per acre prices for alfalfa. Assuming initial surface damage payments of $6,000 and residual payments of $1,500, farmers would be adequately compensated for the income loss associated with lands taken out of production, in the example cited above. Although there would be reclamation costs and costs associated with replacing farm structures such as fences, culverts and irrigation systems, those costs are typically covered by the Operators, as described below.

Compensation amounts would be less adequate in circumstances where placement of gas facilities interferes with farming practices such as cultivation patterns or the operation of mechanized irrigation systems, or if more initial or residual disturbance is required for to accommodate well pads, roads and pipelines, production facilities or other ancillary facilities although there have been circumstances where the Operators have provided compensation for crop losses where drilling interfered with operation of irrigation systems (Jordan 2004).

Additionally, crop production losses on irrigated land in the WRPA have been minimized by the recent Operator practice of drilling during winter months when fields are fallow. Where possible on irrigated lands, the Operators drill and complete wells, install pipelines and production facilities, reclaim disturbed areas, repair irrigation facilities and prepare fields for planting before the spring planting season begins. This practice is designed to take advantage of the frozen surface during these months and to minimize disruption and income loss to landowners.

In recent years, the development of new wells has also included mitigation measures to minimize surface disturbance and disruption of farming activities. Depending on site-specific circumstances, including landowner preferences, mitigation measures at new wells have included:

- Performing work on irrigated land during fallow seasons (see above).
- Hauling in, or purchasing from the surface owner, the fill dirt for pad construction in order to limit the amount of disturbance in fields and pastures, and removing the fill after drilling/completion.
- Completely reclaiming the access road and reclaiming the well pad to an approximate 8 foot x 8 foot disturbed area on irrigated land.
- Containing drill cuttings in tubs and disposing of the cuttings offsite.
- Stockpiling topsoil in accordance with landowner preferences.
- Locating tank batteries and other facilities along property boundaries and roads.
- Using existing flowline rights-of-way when possible.
- Supplying gated pipe to landowners to facilitate ongoing irrigation during the surface disturbance, drilling, and completion phases of development.
- Removal of the reserve pit spoils.
- Locating well pads away from hillsides.
- Minimizing the size of the reserve pit and orienting the pad to minimize disturbance.
- Installing a silt fence on the backside of spoils piles.
- Applying water to access roads to control dust.
- Paying for hotel rooms and meals for surface owner families during drilling and completion, which are periods when activity and noise levels are high.

- Testing water wells before drilling operations to establish a baseline for post-completion testing.
- Planting trees or landscaping around wellheads, according to surface owner preferences.
- Provide surface owners with plats of wells, pipelines, and ancillary facilities.
- Preparing the access road and reclaimed portion of the well pad for cultivation by corrugating, drill seeding, installing watering flowlines, providing compaction equipment, repairing fences, cutting drain ditches, land leveling, and providing additional gated pipe.

Depending on the success of these measures, income losses from lands taken out of production or from interference with cultivation practices or mechanized irrigation systems could be minimized.

3.13.6.5 Industrialization and Rural Character

In land use terms, a rural setting typically includes pastoral views of farms and open land, relative isolation, quiet, and the presence of wildlife, clean air, and relatively little traffic. Different portions of the WRPA provide these characteristics in different measure. The existing excavations associated with reclamation and irrigation facilities, and the location of highways and major roads, diminish the rural setting in some areas of the WRPA. In addition, well drilling, field development, production activities and the presence of well pads, tank batteries, compressor stations and other production facilities have changed the character of portions of the WRPA from a rural setting to one of mixed rural and resource extraction, the latter being a type of low density industrial land use. This change is most apparent in the Pavillion and Muddy Ridge fields.

3.13.7 Environmental Justice

Executive Order (EO) 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" was published in the *Federal Register* (59 FR 7629) on February 11, 1994. EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies and activities on minority populations and low-income populations. Low-income populations are defined as those living below the poverty level.

Implementation of EO 12898 for NEPA requires two steps:

- Identifying the presence of minority and low-income populations in areas that may be affected by the action under consideration.
- Determining if the action under consideration would have disproportionately high and adverse human health or environmental effects on minority or low-income populations.

This section deals with step one of the analysis, identifying whether there is a potentially affected area with a relatively high presence of minority or low-income persons. Step two of the analysis is handled in Chapter 4, Environmental Consequences.

3.13.7.1 Potentially Affected Minority and Low Income Populations

Table 3.13-27 identifies where minority and low-income populations are present in areas that are relevant to an analysis of environmental justice for the proposed Wind River Natural Gas Development Project. The data suggest that the WRIR as a whole is the appropriate area of analysis for Environmental Justice concerns for this assessment for several reasons.

Table 3.13-27. Minority and Low-Income Populations: State of Wyoming, Fremont County, Wind River Indian Reservation and the Wind River Project Area

	% Minority Population1	% Higher or Lower than State Average	% Below Poverty Level	% Higher or Lower than State Average
Wyoming	7.9		11.4	
Fremont County	23.5	+ 15.6	17.6	+6.2
WRIR	32.3	+24.4	20.9	+9.5
WRPA*	6.4	-1.5	14.2	+2.8

* WRPA includes Block Group 1 of Census Tract 9401 and Block Group 1 of Census Tract 9402 as proxy.

As noted previously the WRPA is wholly contained within the WRIR. However historical events have led to different land ownership and population characteristics in the WRPA than in most of the WRIR. Much of the surface area in the WRPA was either opened to non-Indian settlement in the 1905 Act or acquired by the United States in 1953. Therefore few of the residents WRPA are American Indians (see Section 3.13.3). In fact, the 2000 Census showed that the two US Census Block Groups containing the WRPA had about 1.5 percentage points less minority presence than the State of Wyoming as a whole.

In terms of income, the 2000 Census showed that the WRPA contained 2.8 percentage points more presence of persons with income below the poverty level than the statewide average. Although the percentage is slightly higher, it does not indicate a concentration of low-income persons, according to standards applied to other federal actions in this part of Wyoming. The recently completed Supplemental Draft EIS for the Jack Morrow Hills Coordinated Activity Plan used the following standard to determine whether the presence of minority and low-income persons is of concern in a potentially affected area. The standard is the lower of 50 percent of total population or 10 percent higher than the statewide average (USBLM 2003).

The presence of minorities (principally American Indian) is more than 10 percentage point higher in Fremont County and on the Wind River Indian Reservation, compared to the statewide average (15.6 percentage points and 24.4 percentage points higher, respectively). The presence of low-income persons on the WRIR is 9.5 percentage points higher than the statewide average. Although this is slightly less than the 10 percent threshold, it is still considerably higher than the statewide average.

The data suggest that Fremont County as a whole contains substantial minority and low-income populations. However, most of these are concentrated on the WRIR; minority and

1 Includes American Indian, Alaskan Native, Black of African American, Asian, Native Hawaiian and Other Pacific Islander, Hispanic or Latino or people of more than one race. American Indians are by far the largest minority group living on the WRIR.

low-income populations in the remainder of the county are closer to statewide levels (see Section 3.15.5.1 and Figure 3.18-8). Within the WRIR, there are concentrations of minority and low income persons in the communities of Ethete, Arapaho and Ft. Washakie. These areas are at some distance from the WRPA.

3.13.7.2 Public Participation

Public participation by potentially affected minority and low-income groups is also important for environmental justice compliance. The US Environmental Protection Agency (EPA) guidance for incorporating environmental justice concerns in NEPA assessments requires that potentially affected Indian Tribes be offered cooperating agency status under CFR 1508.5 (USEPA 1998). The Eastern Shoshone and Northern Arapahoe Tribes have both agreed to participate in the Wind River Natural Gas Development project EIS as cooperating agencies.

3.14 TRANSPORTATION

Access to the Wind River Project Area (WRPA) is provided by a network of federal and Wyoming State highways and Fremont County roads. Within the WRPA, county roads, Midvale Irrigation District canal roads, and operator maintained roads provide access to leases, wells, and ancillary facilities.

Fremont County is also served by commercial air and rail service and portions of the county and the WRIR are served by public transportation systems. Air and rail traffic and public transportation systems would not be affected by the Proposed Action or alternatives and are therefore not addressed in this assessment.

3.14.1 Federal and State Highways

Federal and state highways providing access to the WRPA include US 26/789 (the segment assessed is from Shoshoni to the north corporate limits of Riverton), US 26 (west corporate limits of Riverton to the junction with WYO 133), WYO 134 (US 26 west to Pavillion) and WYO 133 (US 26 north to Pavillion), as shown on Figure 3.14-1. Table 3.14-1 and Figure 3.14-1 display average annual daily traffic (AADT) and level-of-service information for these highways. Figure 3.14-1 also shows the location of Fremont County Transportation Department bridges within the WRPA.

The Wyoming Department of Transportation (WYDOT) assigns levels of service to highways in the state system. Levels of service (A through F) are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience) that characterize operational conditions within traffic streams and the perceptions of those conditions by motorists. “A” represents the best travel conditions and “F” represents the worst.

Table 3.14-1. Average Annual Daily Traffic and Level of Service on Highways Providing Access to the WRPA in 1991, 2000, and 2001

Highway	Segment	1991 AADT	2000 AADT	2001 AADT	Level of Service
US 26/789	Shoshone west corporate limits	3610 (655)	4000 (610)	3900 (600)	A
	Junction WYO 134	2590 (610)	2900 (570)	3290 (470)	A
	Junction Burma Rd	4090 (595)	4400 (550)	(4600 (530)	A
	Riverton north corporate limits	6140 (655)	6700 600	8120 (600)	A
US 26	Riverton west corporate limits	6240 (265)	8400 (260)	8420 (240)	A
	Junction Eight Mile Rd	2680 (215)	3400 (200)	3,560 (160)	A
	Junction WYO 133	1560 (185)	2200 (190)	1990 160	A
WYO 134	Junction US 26	370 (75)	540 (60)	590 (110)	B
	Midvale	350 (65)	560 (50)	490 (80)	B
WYO 133	Junction US 26	730 (75)	730 (60)	1050 (90)	B
	Junction WYO 134	640 (65)	800 (60)	900 (50)	B
	Pavillion west corporate limits	590 (65)	800 (60)	810 (50)	B

Source: WYDOT 2001; Steele, E., WYDOT, personal communication, July 2003.
[1]Average Annual Daily Traffic, Number of Trucks is in parentheses.

Figure 3.14-1. Transportation and Traffic Count Map for the Wind River Project Area.

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US 26 is a two-lane, all weather highway in Wyoming's primary highway system that provides access to the Riverton area from Casper and Interstate 25 to the east, and Moran Junction and Jackson to the west. The highway also extends to Nebraska to the east and Idaho to the west. US 26 is functionally classified as a principal arterial highway in both rural and urban areas. US 26 traffic on the segment within the study area increased substantially between 1991 and 2000, including a 35 percent increase on the west side of Riverton, where traffic is heaviest. Truck traffic decreased slightly on the highway during the period, except in the area near the junction with WYO 133, where it increased by 3 percent.

Between 2000 and 2001, US 26 traffic in the Riverton area showed modest increases. Outlying points on the highway, such as Shoshoni and the WYO 133 (Pavillion) intersection, showed modest decreases. Truck traffic decreased slightly or remained constant at all these points (WYDOT 2003).

US 26 provides a level of service (LOS) A in the Riverton area, and there are no major service or safety issues associated with the highway, although the large number of turn-offs and highway access points north of Riverton increases opportunities for accidents. The segment north of Riverton is scheduled for reconstruction and conversion to four lanes within the next five to ten years (Steele 2003).

US 134 provides access to the WRPA from Riverton and from US 26 for traffic approaching Riverton from the north and east. The highway was rebuilt within the past ten years and designed to accommodate relatively heavy traffic. Overweight water trucks serving area oil and gas fields resulted in severe rutting in the years following reconstruction, but increased enforcement of weight limits has helped resolve that problem (Steele 2003). Traffic on WYO 134 increased substantially between 1991 and 2000, by 46 percent at the US 26 Junction and by 60 percent at Midvale. The trend continued between 2000 and 2001 at the US 26 intersection, where AADT increased by 9 percent. Traffic at Midvale, however, fell by 12.5 percent. Truck traffic on WYO 134 fell by 20 to 25 percent between 1991 and 2000, but increased substantially between 2000 and 2001, 83 percent at the US 26 junction and 60 percent at Midvale. This increase corresponds with the increase in drilling and field development activities occurring in the WRPA during 2001.

WYO 133 is only lightly used by gas field traffic. AADT on WYO 133 at the US 26 intersection remained constant between 1991 and 2000, but increased by 44 percent between 2000 and 2001. Truck traffic at this point fell by 20 percent during 1991 and 2000 but increased by 50 percent during the following year.

Further north, traffic increased by 25 percent at the WYO 134 intersection and 35 percent at Pavillion between 1991 and 2000. Traffic at the 134 junction increased by another 12.5 percent between 2000 and 2001, but by only one percent at Pavillion. Truck traffic at the US 26 intersection fell by 20 percent during the 1991 to 2000 period and by about 8 percent at points further north. Truck traffic increased 50 percent at the US 26 junction and 17 percent at points north during the following year.

Table 3.14-2 lists accident statistics for affected segments of state and federal highways providing access to the WRPA for the 1997 through 2002 period.

Table 3.14-2. Crash History on Highways Providing Access to the WRPA in 1997 – 2002

	Total Crashes	% Trucks	PDO[1] Crashes	Injury Crashes		Fatal Crashes	
				#	Persons Injured	#	Persons Killed
US 26/789 (Shoshoni to Riverton)							
1997	45	11%	32	13	28	0	0
1998	38	5%	24	13	24	1	2
1999	38	10%	24	11	15	3	7
2000	41	0%	30	10	20	1	1
2001	41	10%	31	10	18	0	0
2002	48	4%	33	15	21	0	0
6-Year Average	42	7%	29	12	21	0.8	1.67
US 26 (Riverton to WYO 133 Junction)							
1997	12	8%	8	3	4	1	1
1998	24	4%	16	8	12	0	0
1999	15	0%	9	6	10	0	0
2000	16	6%	10	5	8	1	2
2001	19	11%	11	7	12	1	1
2002	11	0%	3	8	11	0	0
6-Year Average	16	5%	9.5	6	9.5	0.5	0.66
WYO 133							
1997	6	0%	3	3	3	0	0
1998	3	0%	2	1	1	0	0
1999	4	0%	4	0	0	0	0
2000	3	0%	3	0	0	0	0
2001	3	0%	2	1	2	0	0
2002	4	0%	4	0	0	0	0
6-Year Average	4	0%	4.5	0.8	1	0	0
WYO 134							
1997	7	29%	5	2	2	0	0
1998	6	17%	5	1	2	0	0

Table 3.14-2 (Continued

1999	7	14%	3	4	7	0	0
2000	7	43%	4	3	3	0	0
2001	9	0%	6	2	3	1	2
2002	4	0%	3	1	1	0	0
6-Year Average	7	17%	4	2	3	0.16	0.33

[1] PDO = property damage only.
Source: WYDOT 2003; Adams, S., WYDOT, personal communication, July 7, 2003; BCL calculations.

US 26/789 between Shoshone and Riverton averaged 42 accidents per year over the last 6 years and an average of 7 percent of those involved trucks larger than pick-ups. There were 10 fatalities on this segment during the six-year period. Many of the accidents involved vehicles turning into or out of access points north of Riverton (WYDOT 2003). US 26 west of Riverton averaged 16 crashes per year and 5 percent of those involved trucks. There were 4 fatalities during the period.

US 133 between US 26 and Pavillion averaged 4 accidents per year between 1997 and 2002; none of those involved trucks. There were no fatalities during the period and 48 percent of the 23 accidents that occurred over the six-year period involved deer or livestock.

US 134 averaged 7 accidents per year between 1997 and 2002 and 17 percent involved trucks, although one of the three truck-related accidents that occurred during 2000 involved a passenger car running into a parked truck. There were two fatalities associated with one accident during the six-year period and 43 percent of the accidents involved wildlife or livestock.

3.14.2 County Roads

Table 3.14-3 lists Fremont County roads within the WRPA. County roads that provide access to the Pavillion and Muddy Ridge fields include Eight Mile Road, also known as Fremont County Road (FCR) 385 and Gabe's Road (FCR 412), both of which provide access from US 26 to WYO 134 for traffic coming from Riverton. Tunnel Hill (FCR 427), North Portal (FCR 431), Indian Ridge (FCR 341), Harris Bridge (FCR 306) and East Powerline (FCR 424) roads all provide access to the Pavillion, Muddy Ridge and proposed Coastal Extension fields. The Bass Lake Road provides access to the Sand Mesa and proposed Sand Mesa South fields from US 26/789 and the Sand Mesa Road provides access within the Sand Mesa field. Burma Road (FCR 320) and Two Valley Road (FCR339) also provide access to the WRPA from Riverton.

Within the three existing oil and gas development areas in the WRPA, there are a total of 38.05 miles of Fremont County roads, including 27.25 miles in the Pavillion Field, 5.2 miles in the Muddy Ridge Field and 5.6 miles in the Sand Mesa Field (Johnson 2003).

Table 3.14-3. Fremont County Roads Providing Access to and within the WRPA

Road #	Road Name	Total Mileage	Oil	Gravel	ROW Width	Class
3	Picket	1.5		1.5	60'	RC
12	Williams	2.2	1.8	0.4	60'	RA
306	Harris Bridge	3.5		3.5	60'	RA
320	Burma	8.1	8.13		60'	P
325	Pattison Farm	3.1		3.1	60'	RA
326	Two Mile	2.0		2.0	60'	RC
330	E. Pavillion	5.5	5.51		60'	S
339	Two Valley	5.4	3.8	1.6	60’	S
341	Indian Ridge	3.5		3.5	60'	RA
385	Eight Mile	9.3	8	1.3	60 to 100'	P
412	Gabe’s	7.4		7.4	60"	S
420	S. Muddy	5.7		5.7	60'	RA
421	N. Muddy	6.6		6.6	60'	RA
422	Sand Mesa	10.3		10.3	60'	RA
424	E. Powerline	5.0		5	60'	RA
425	W. Powerline	5.3		5.3	60'	RA
426	Sheep Camp	3.4		3.4	60'	RC
427	Tunnel Hill	14.2	4	10.2	60'	S
428	N. Pavillion	9.8	2	7.8	60'	S
430	Bass Lake	11.5	9	2.5	60'	S
431	N. Portal	6.9	5	1.9	60'	P
433	Disneyland	1.6		1.6	60	RA
434	Teachers	3.6		3.6	60	RA
468	Ocean View	2.5		2.5	60'	RC

Source: Fremont County 1999.

The Fremont County Engineer rates paved roads within the county using a pavement condition index (PCI), with 100 being the highest rating. Lower ratings indicate roads with poor pavement conditions. The paved roads, which provide access to and within the WRPA, are listed below.

Table 3.14-4. Condition of Paved Fremont County Roads Providing Access to the Wind River Project Area

Road #	Road Name	PCI Rating
12	Williams	14
320	Burma	31
330	E. Pavillion	8
339	Two Valley Road	59
385	Eight Mile	72
427	Tunnel Hill	48
428	N. Pavillion	47
430	Bass Lake	23
431	N. Portal	34

Source: Pendleton D., personal communication, January and July 2003.

The paved and graveled roads in the WRPA were not designed to accommodate large volumes of heavy truck traffic. Heavy truck traffic results in accelerated deterioration of paved roads, and corresponding acceleration of road maintenance requirements. The county transportation department attempts to keep paved roads in good repair with an ongoing program of maintenance, including overlays, chip seal projects, and crack repair. However, as of summer 2003, the Fremont County Transportation Superintendent had identified paved road reconstruction and maintenance needs totaling $34 million throughout the county.

Gravel roads providing access to the WRPA are similarly affected by large volumes of heavy truck traffic. The county transportation department attempts to maintain the roads by blading, graveling, filling potholes, and the application of magnesium chloride to harden the road and suppress dust. Moreover, continued heavy use of gravel roads within the WRPA has resulted in a reduction in fines (fine material) in roadbeds, which makes road maintenance and efficient use of magnesium chloride more difficult.

The FY 2003 - 2004 Fremont County budget contains $1 million in the Special Projects Fund and an additional $800,000 in the Road Construction Fund for a total of $1.8 million in construction funds. The Fremont County General Fund contains an appropriation of $1.9 million for maintenance and repair of 900 miles of paved, gravel and dirt roads. In total, Fremont County has budgeted $3.7 million for road construction and maintenance during the 2003 – 2004 fiscal year.

Fremont County Transportation Department bridges within the WRPA are listed in Table 3.14-5.

Table 3.14-5. Fremont County-Maintained Bridges within the Wind River Project Area

Fremont Cty Road	Road No.	Drainage	Sufficiency Rating	Construction Type	Load Limit	Replacement Date
North Pavillion	428	Five Mile Creek	38	Simple span timber	7, 13, and 14 tons	
Indian Ridge	341	Pavillion Drain	95	Pre-stressed concrete span	HS-25	-----------
Tunnel Hill	427	Wyoming Canal	49	Railroad boxcar	14, 26 and 30 tons	
North Portal	431	Five Mile Creek	22	Simple span timber	5, 9 and 10 tons	May 2005
North Portal	431	Muddy Creek	30	Simple span timber	Detour	May 2005
Bushwacker	432	Five Mile Creek	85	Concrete span	HS-20	------------
Bass Lake	430	Five Mile Creek	47	Simple span timber	19, 32, and 35 tons	
Bass Lake	430	Muddy Creek		Concrete box culvert	HS-30	July 2004

Source: Pendleton 2004

Several bridges on roads serving the WRPA are in need of reconstruction. Problems on some of these bridges include holes in the decking, dry rot in the underlayment, and leaning timbers. WYDOT assigns sufficiency ratings to bridges with spans over 20 feet. A newly constructed bridge is given a sufficiency rating of 100. Two bridges on North Portal Road have sufficiency ratings in the 20 to 30 percent range and WYDOT has scheduled to let bids for the reconstruction of these bridges in 2004. North Pavillion Road also has a bridge with a low sufficiency rating and the bridge over Five Mile Creek on Bass Lake Road has a sufficiency rating of 47. In July 2003, a grass fire damaged the Muddy Creek Bridge on Bass Lake Road and the Fremont County Transportation Department replaced it with a concrete box culvert. There is an old railroad boxcar bridge on Tunnel Hill road that needs replacing and the approach to the bridge needs to be re-aligned. Because Fremont County must compete statewide for bridge reconstruction funds, it may be 10 to 15 years before all of these bridges will be replaced. Table 3.14-6 displays the bridge replacement priority list for Fremont County. Of the bridges listed as the top 10 priorities, bridges located within the WRPA occupy the first three slots.

Table 3.14-6. Fremont County Bridge Replacement Priority List

Priority	Fremont County Road	Road No.	Drainage Crossing	Estimated Replacement Cost
1	Bass Lake	430	Five Mile Creek	$273,000
2	North Pavillion	428	Five Mile Creek	$405,000
3	North Tunnel Hill	427	Wyoming Canal	$171,000
4	Diversion Dam	298	Wyoming Canal	$374,000
5	West Wilderness	314	Big Wind River	$303,000
6	Diversion Dam	298	Dry Creek	$233,000
7	Leseberg	800	Big Wind River	$471,000
8	Diversion Dam, East End	298	Wyoming Canal	$303,000
9	Diversion Dam	298	Big Wind River	$1,736,000
10	Kingfisher	239	Big Wind River	$308,000
	Total WYDOT Estimated Replacement Cost			**$4,577,000**

Source: Pendelton 2004

There are no recent traffic counts for county roads serving the WRPA. However, much of the heavy truck traffic is associated with gas field development and operations. In addition to large volumes of heavy truck traffic, excessive speed and use of gravel roads during wet conditions in the spring all contribute to accelerated road deterioration and road maintenance needs (Pendleton, D., Fremont County Transportation Department Superintendent, personal communication, January and July 2003).

3.14.3 Tribal and BIA Roads

There are no tribal or BIA maintained roads within the WRPA.

3.14.4 Operator-Maintained Roads

The extensive network of county roads has helped minimize the length of resource roads (i.e., access roads to wells and ancillary facilities) within the three existing development areas of the WRPA. It is estimated that there are a total of 36.26 miles of operator-maintained resource roads within the three existing development areas, including 14.76 miles in the Pavillion Field, 15.3 miles in the Muddy Ridge Field, and 6.2 miles in the Sand Mesa Field (Johnson 2003).

3.15 HEALTH AND SAFETY

In general, existing health and safety concerns associated with natural gas exploration and production in the WRPA include occupational hazards associated with construction, operation, and maintenance activities at natural gas well pads and associated facilities. Other health and safety issues include traffic-related accidents, manmade wildfires, potential natural gas and hydrogen sulfide leaks, and accidental spills or releases of hazardous substances.

The construction of well pads, roads, pipelines, compressors, and other natural gas facilities and operation and maintenance of those facilities involves the use of heavy equipment, drill rigs, trucks, welding equipment, power tools, and other machinery that inherently exposes workers to risks for accidents and injuries. To date, occupational accidents in the WRPA from existing gas development have been limited in number.

Truck and other vehicle traffic using roads serving natural gas wellfields create a risk of traffic accidents and hazards. Recent data regarding increased traffic and vehicle accidents in the WRPA are presented in Section 3.14. Natural gas exploration and production to date has not caused any significant wildfires in the WRPA, nor have any accidents involving leaks of natural gas or hydrogen sulfide been reported.

Various hazardous materials are used in the construction, operation, and maintenance of natural gas exploration and production projects, including, diesel fuel and gasoline, various oils and lubricants, and cleaners. In addition, natural gas production can produce liquid hydrocarbons, or condensate, that may contain compounds deemed hazardous if spilled or ingested. A Hazardous Materials Management Plan, prepared by the Operators in the WRPA, is provided in Appendix E.

3.16 NOISE

3.16.1 Introduction

The ambient noise level can be defined as the cumulative effect from all noise generating sources in the area and constitutes the normal or existing level of environmental noise at a given location. Discussions of environmental noise do not focus on pure tones because commonly heard sounds have complex frequency and pressure characteristics. Accordingly, sound measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. The range of audible frequencies for a young person typically ranges between 20 and 20,000 Hertz (Hz). Sound at frequencies below 16 Hz is termed infrasound and is felt more than heard. Frequencies above 20,000 Hz are termed ultrasound and are not audible. As a person is exposed to excessive noise over their lifetime, the ability to hear higher frequencies is reduced. Older adults may have an effective high frequency cutoff of 10,000 Hz or less.

Noise also has a time component. Three types of time-dependent noises are defined here: steady-state, periodic, and impulsive. Steady-state noise levels are relatively constant over time. A good example is an idling automobile. Periodic noise consists of short durations of relatively high noise levels followed by steady-state or no noise, repeated over time. Examples of periodic noise include that from pile-drivers and industrial stamping machines. Impulsive noise is very short in duration and is often very loud. An example of impulsive noise would be noise from a gunshot. Research has shown that periodic and impulsive noises are more unpleasant than steady-state noises. As ambient noise levels approach background values, they are generally no longer considered disturbances.

The propagation of noise is a function of several environmental factors that might enhance or attenuate sound propagation, the most important being the distance from the noise source, the presence or absence of terrain that may inhibit sound propagation, and the wind. The distance between a noise source and a receiver influences the perceived noise intensity. As the distance between a source and a receiver doubles, the noise intensity decreases by a factor of four. Sound is best propagated in the same direction the wind is blowing. Stable air conditions and calm winds between 2 and 11 miles per hour (1 and 5 meters per second) are most conducive for sound propagation.

The decibel (dB) is the measurement unit commonly used to describe sound levels. Correction factors for adjusting actual sound pressure levels to correspond with human hearing have been determined experimentally. For measuring noise in ordinary environments, A-weighted correction factors are utilized. The A-weighted decibel (dBA) scale is a logarithmic function that emphasizes the audio frequency-response curve audible to the human ear and thus more closely describes how one perceives sound. Table 3.16-1 presents the A-weighted noise level of some common noise sources.

Table 3.16-1. Typical Noise Levels.

Noise Source	Noise Level (dBA)
Amplified Rock Band / Pain Threshold	120
Commercial jet takeoff at 200 feet	110
Community warning siren at 100 feet	100
Busy urban street	90
Construction equipment at 50 feet	80
Freeway traffic at 50 feet	70
Normal conversation at 3 to 6 feet	60
Typical office interior	50
Soft radio music	40
Typical residential interior	30
Night at a quiet rural location	20
Typical whisper at 6 feet	20
Human breathing	10
Threshold of hearing	0

3.16.2 Background Noise Levels

Background noise measurements are not available specifically for the Wind River Project Area (WRPA). However, previous studies in the region, including the Draft Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project (BLM 1999a), have sampled background noise levels and found these levels to be typical of EPA's "Farm in Valley" category (EPA 1971). The background noise levels for this category are 39 dBA for daytime/evening and 32 dBA during the nighttime. These background levels may be affected by jet aircraft overflights, agricultural operations, localized vehicular traffic, and oil and gas operations.

The nearest comprehensive surface and corresponding upper air meteorological data are recorded about 35 miles south-southwest of the WRPA at the Lander/Hunt Field Station for the years 1985,1987,1988,1990, and 1991 (EPA 2003). The wind data are tabulated in Tables 3.4-3 and 3.4-4, while Figure 3.4-4 presents a wind rose depicting wind speed and direction for all five years of data. Note that the data represent the direction from which the wind is blowing (Wind Direction Origin). As shown in Figure 3.4-4, winds originate predominately from the west to southwest 26.9 percent of the time, with an average wind speed of 7.8 miles per hour (3.47 meters/second). Calm winds are observed 17.6 percent of the time, with stable atmospheric conditions occurring the majority of the time (33.6 percent) followed by neutral (26.7 percent) and turbulent conditions (22.1 percent).

Therefore, favorable atmospheric conditions for sound propagation are the norm in the WRPA.

3.16.3 Existing Noise Disturbances

Ambient noise levels for typical oil and gas operations were measured as part of the Continental Divide/Warmsutter II EIS (BLM 1999b). Measurements were taken at 1-minute intervals for a period of 5 minutes at each location and at variable distances from noise sources. The noise levels measured are estimated to be typical of noise levels from existing oil and gas operations within the WRPA for these types of activities. The greatest noise levels were from drilling and flaring operations, which had noise levels (measured at the source) of 77.5 and 97.9 dBA, respectively. Drilling rig noise was 50.1 dBA at 0.25 miles, and flaring noise was 66.3 dBA at 0.1 miles. Noise levels from on-location production facilities averaged 47.5 dBA at the source, and noise from compression facilities was 63.8 dBA at the source and 39.5 dBA at 0.25 miles.

During oil and gas development activities, it is likely that several noise sources will be operating simultaneously. The simultaneous operation of two equal noise sources results in a combined noise level that is approximately 3 dBA greater than the individual value. If the difference in noise levels between two sources is greater than 10 dBA, the cumulative impact is essentially that of the louder source (Thumann and Miller 1986).

Given the limited scope of current industrial development within and surrounding the WRPA, the frequency of high winds is expected to be the most prevalent sound disturbance in the area. Ambient noise levels from wind-generated disturbances are expected to be in the range of 30-50 dBA, with variances due to differences in temperature and humidity (BLM 1999b).

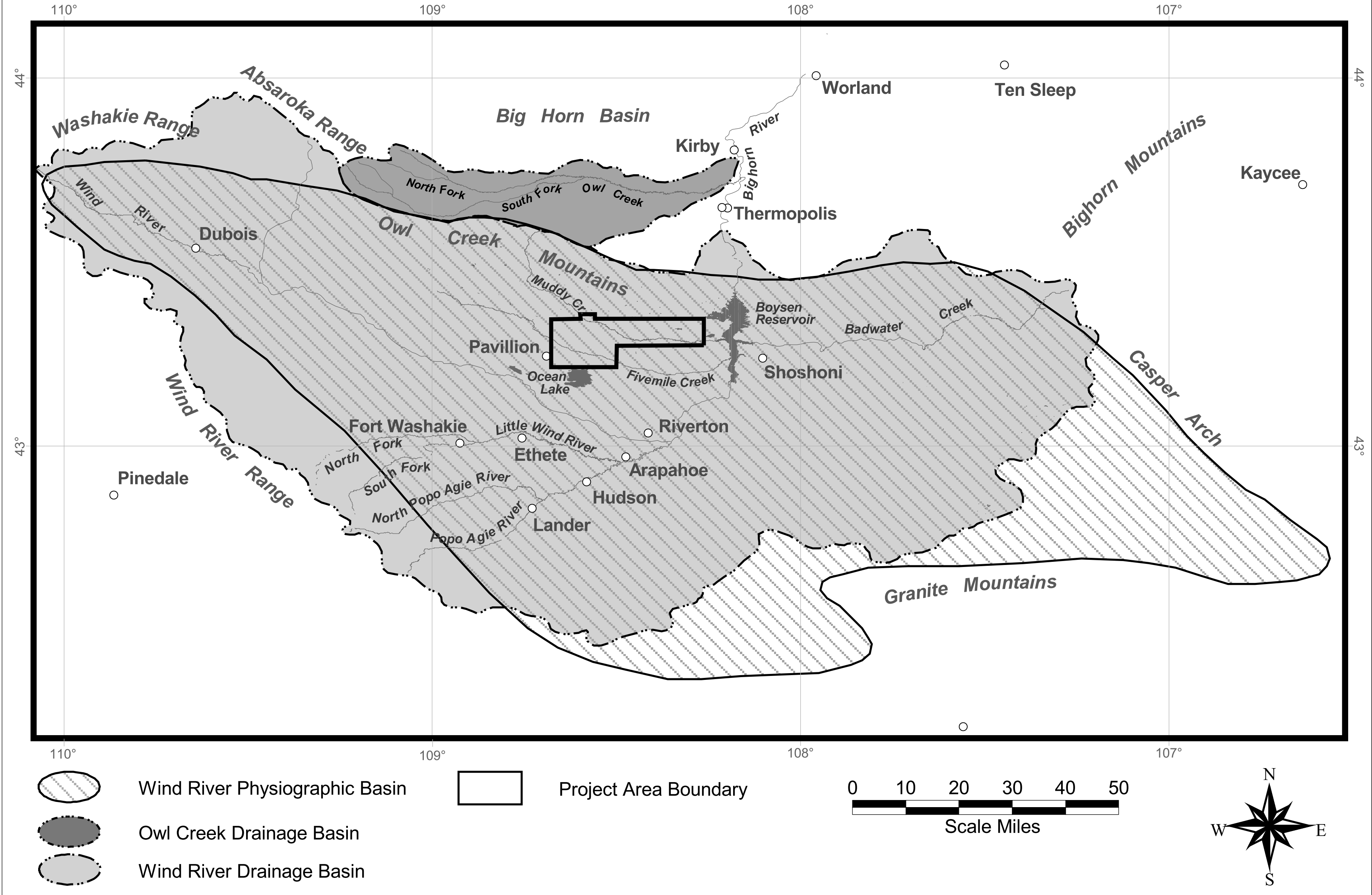


Figure 3.2-1. Location of the Wind River Project Area and Drainage Basins.

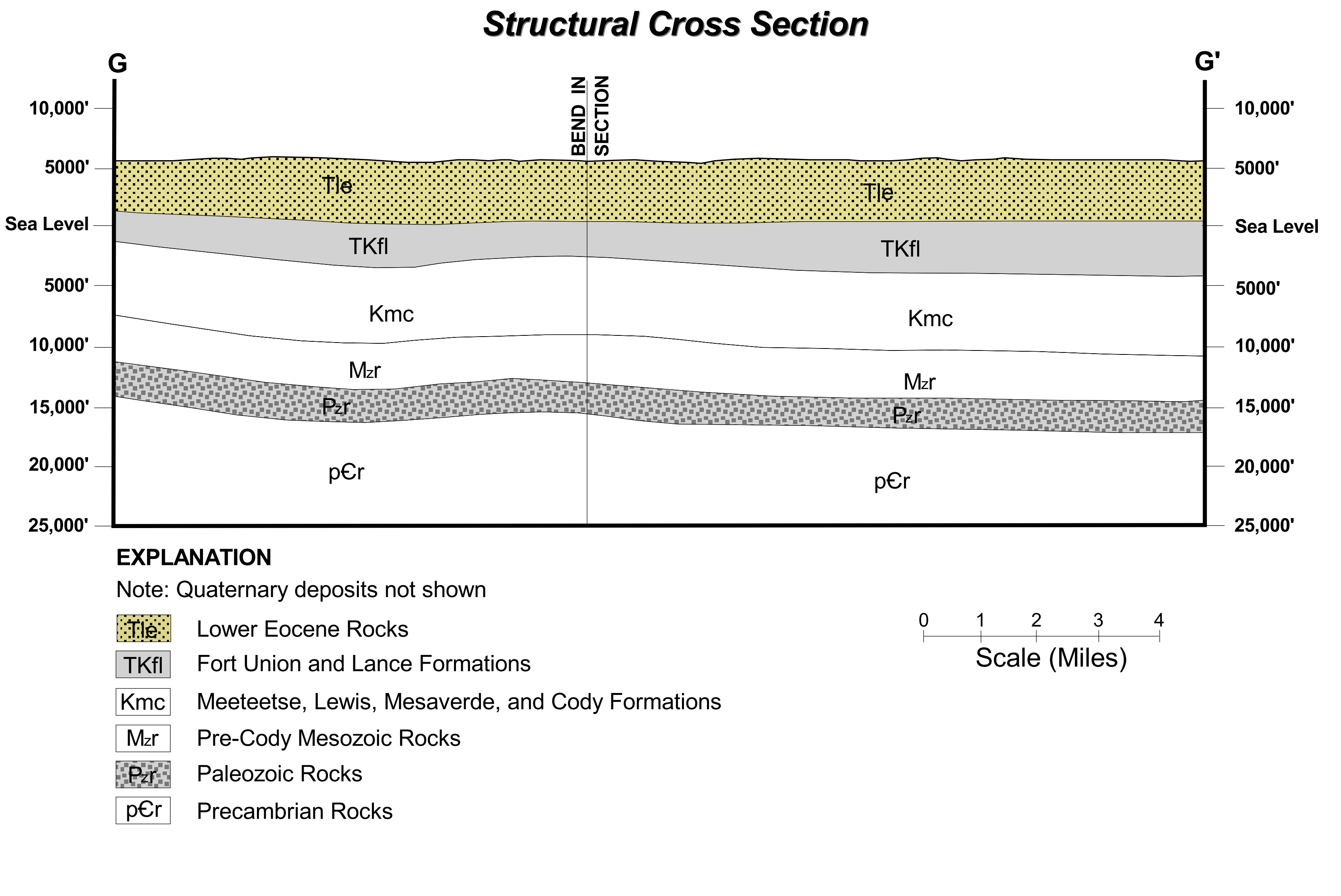


Figure 3.2-3. Structural Cross-section Across the Wind River Project Area (Modified from Keefer et al. 1970).

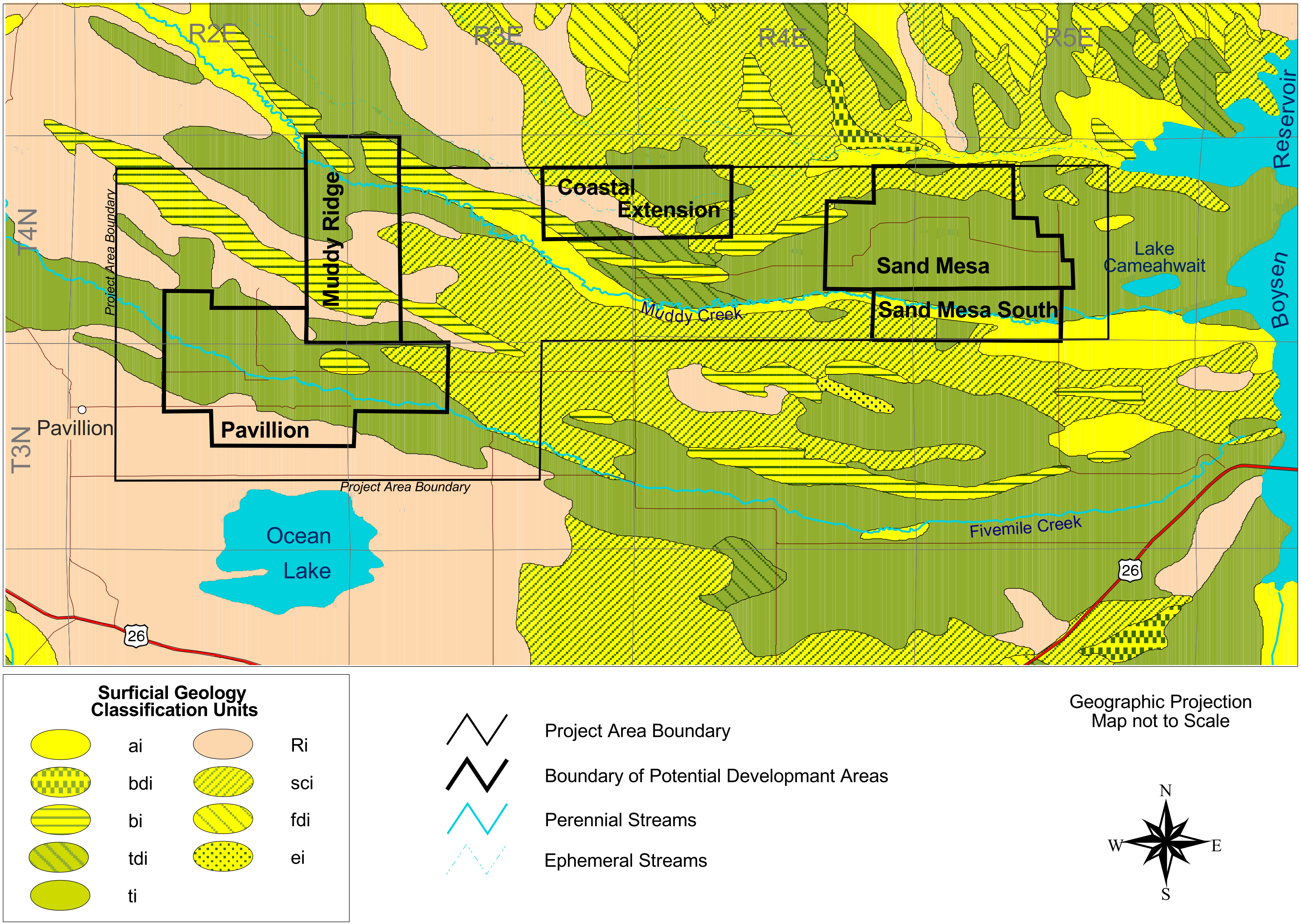


Figure 3.3-1. Surficial Geology within and adjacent to the Wind River Project Area (Case et al. 1998).

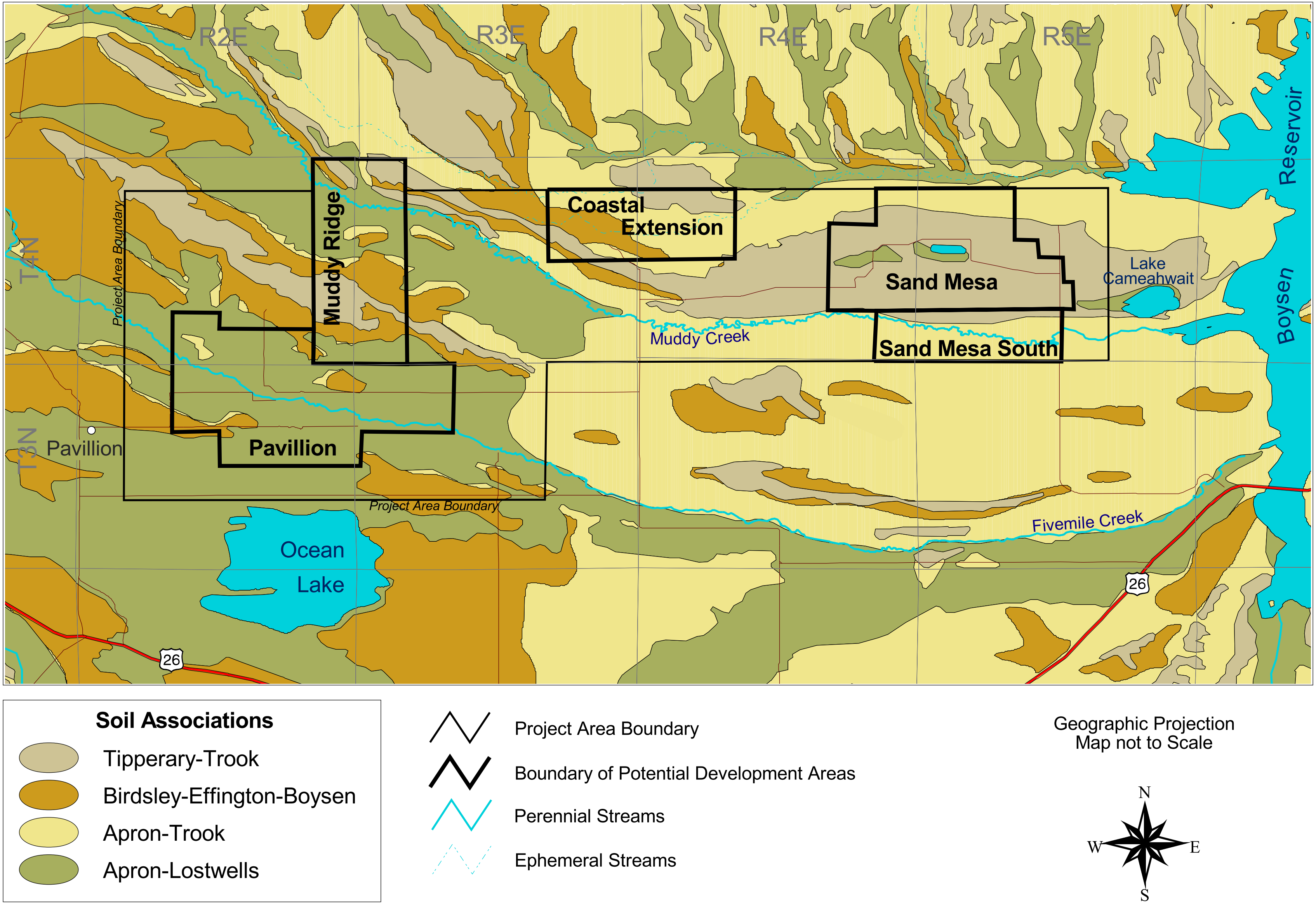


Figure 3.3-2. Soil Types within and adjacent to the Wind River Project Area (Modified from Munn and Arneson 1999).

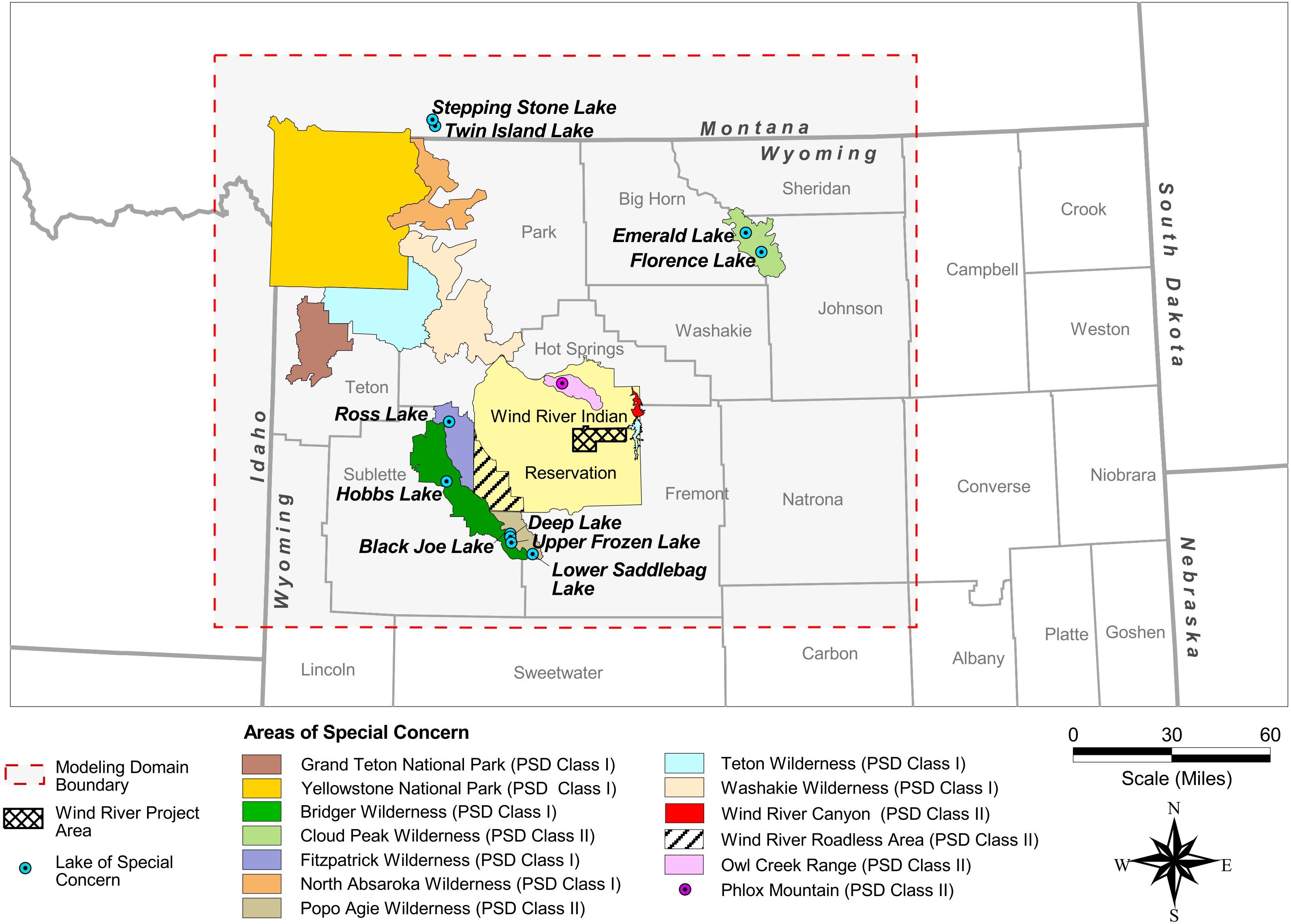


Figure 3.4-5. Wind River Project Area with nearest PSD Class I and Class II Areas and Sensitive Lakes.

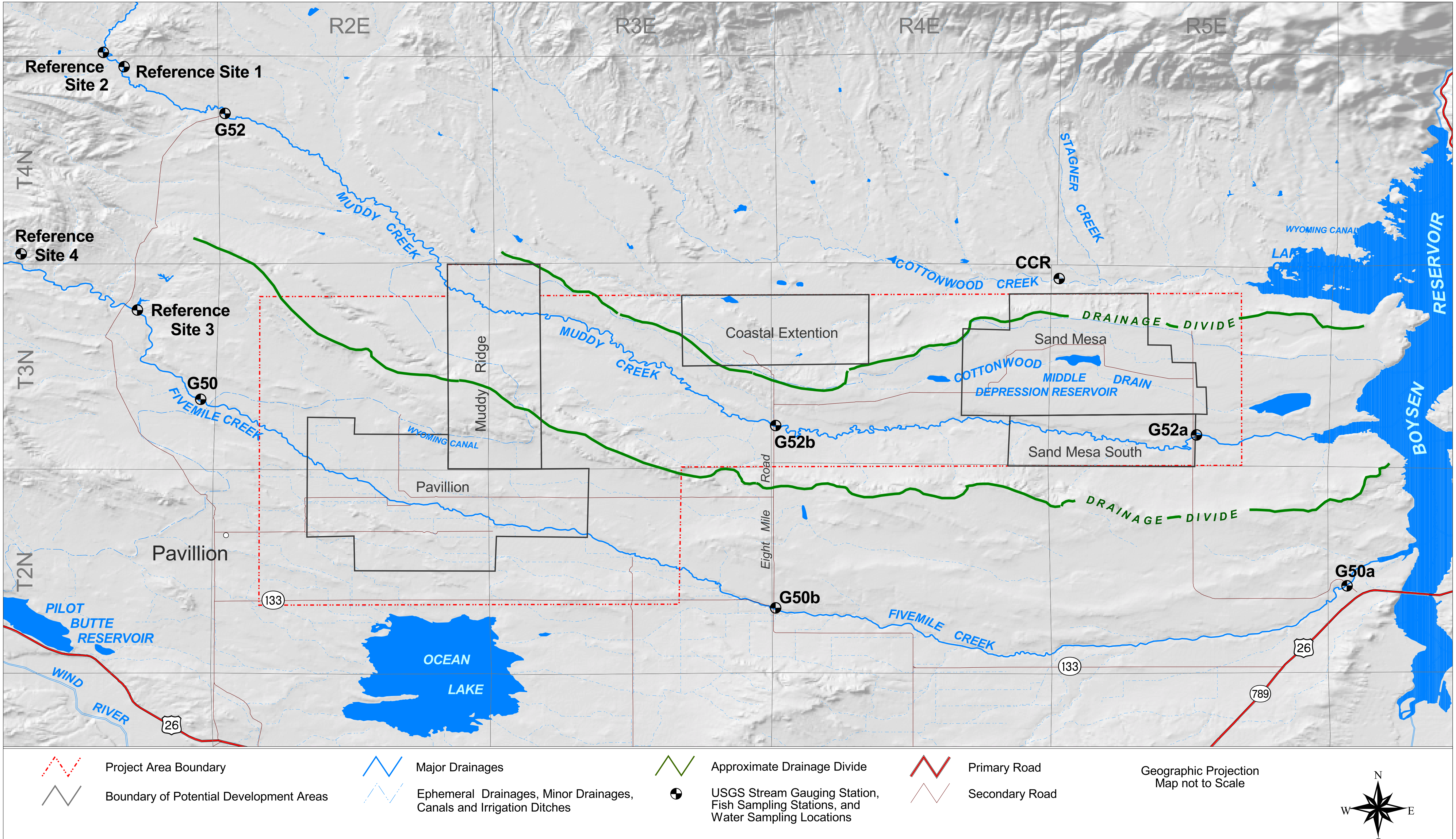


Figure 3.5-1. Drainages and Water Quality Sampling within and near the Wind River Project Area (WREQC 2003).

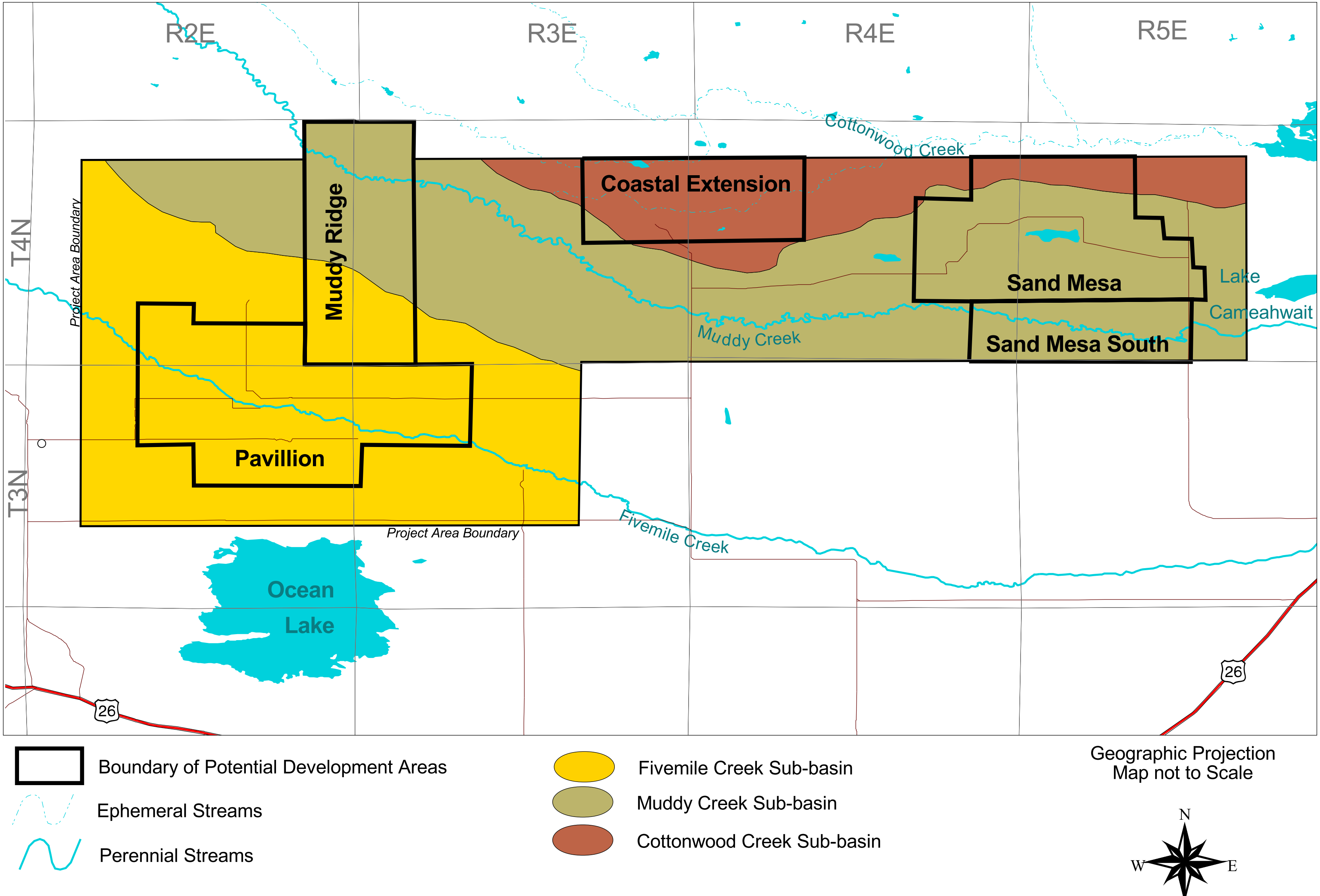


Figure 3.5-2. Sub-basins within the Wind River Project Area.

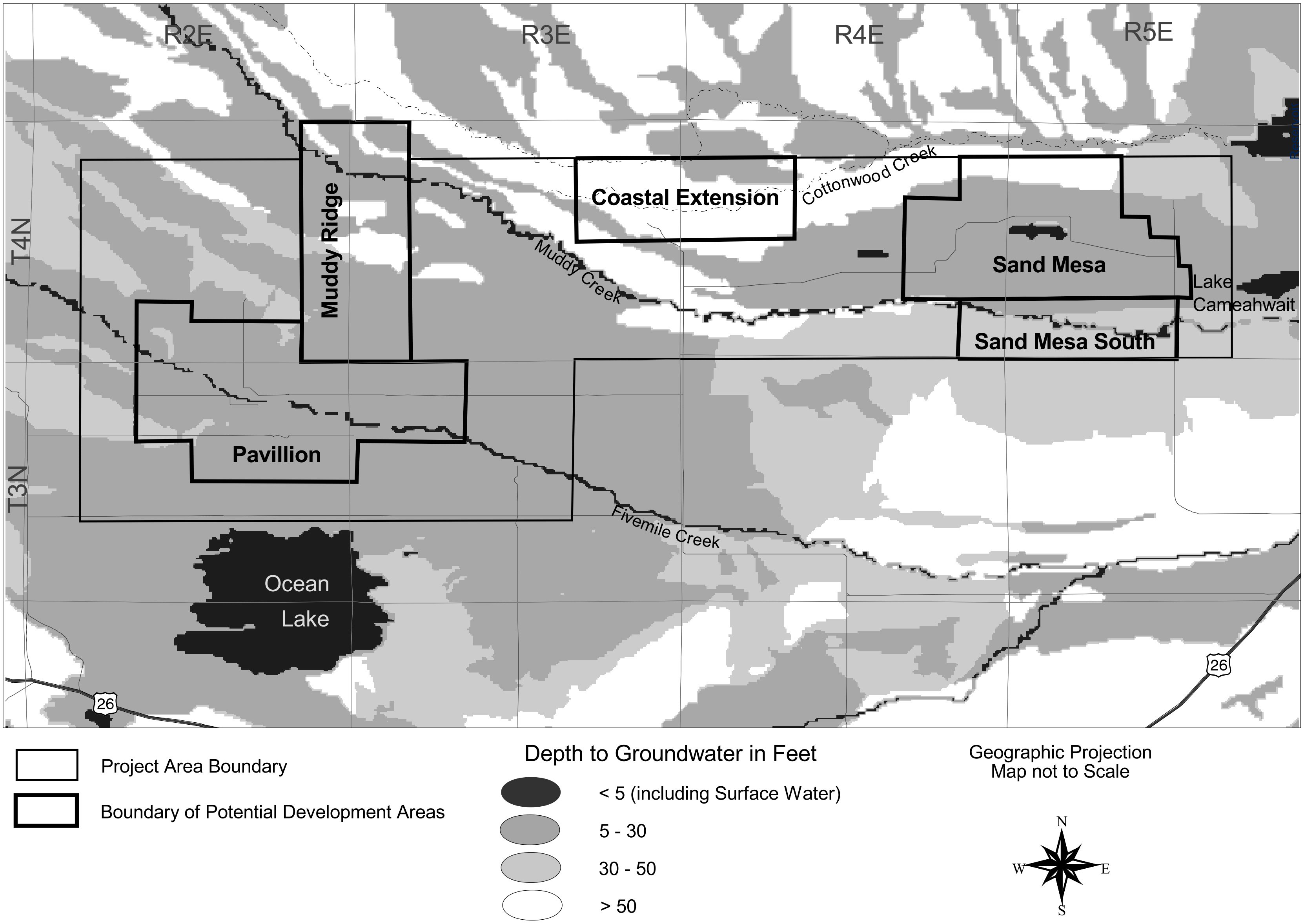


Figure 3.5-8. Depth to Groundwater within and adjacent to the Wind River Project Area (Wyoming Water Resources Center 1998).

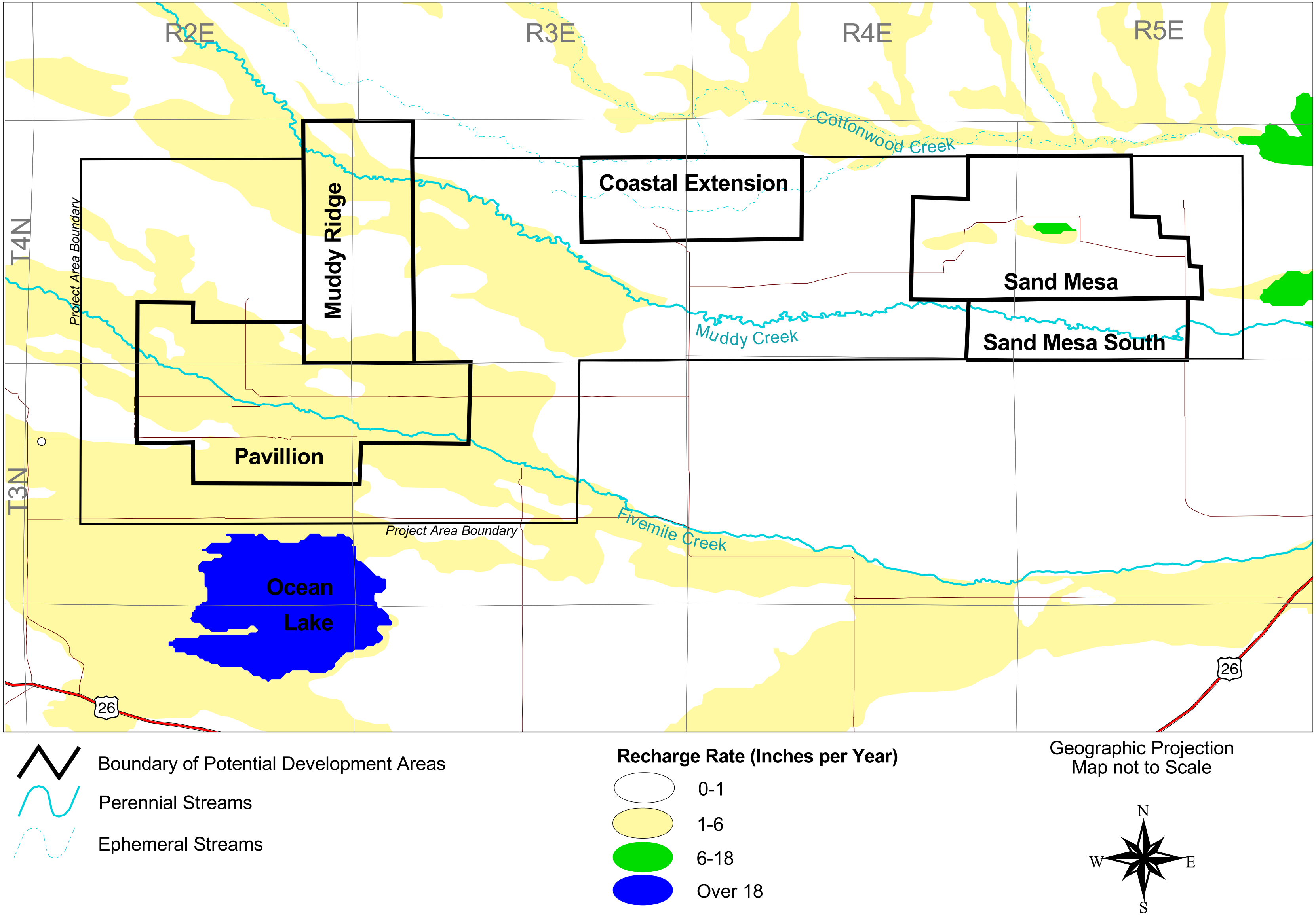


Figure 3.5-9 . Groundwater Recharge Rate within and adjacent to the Wind River Project Area (Munn and Arneson 1998).

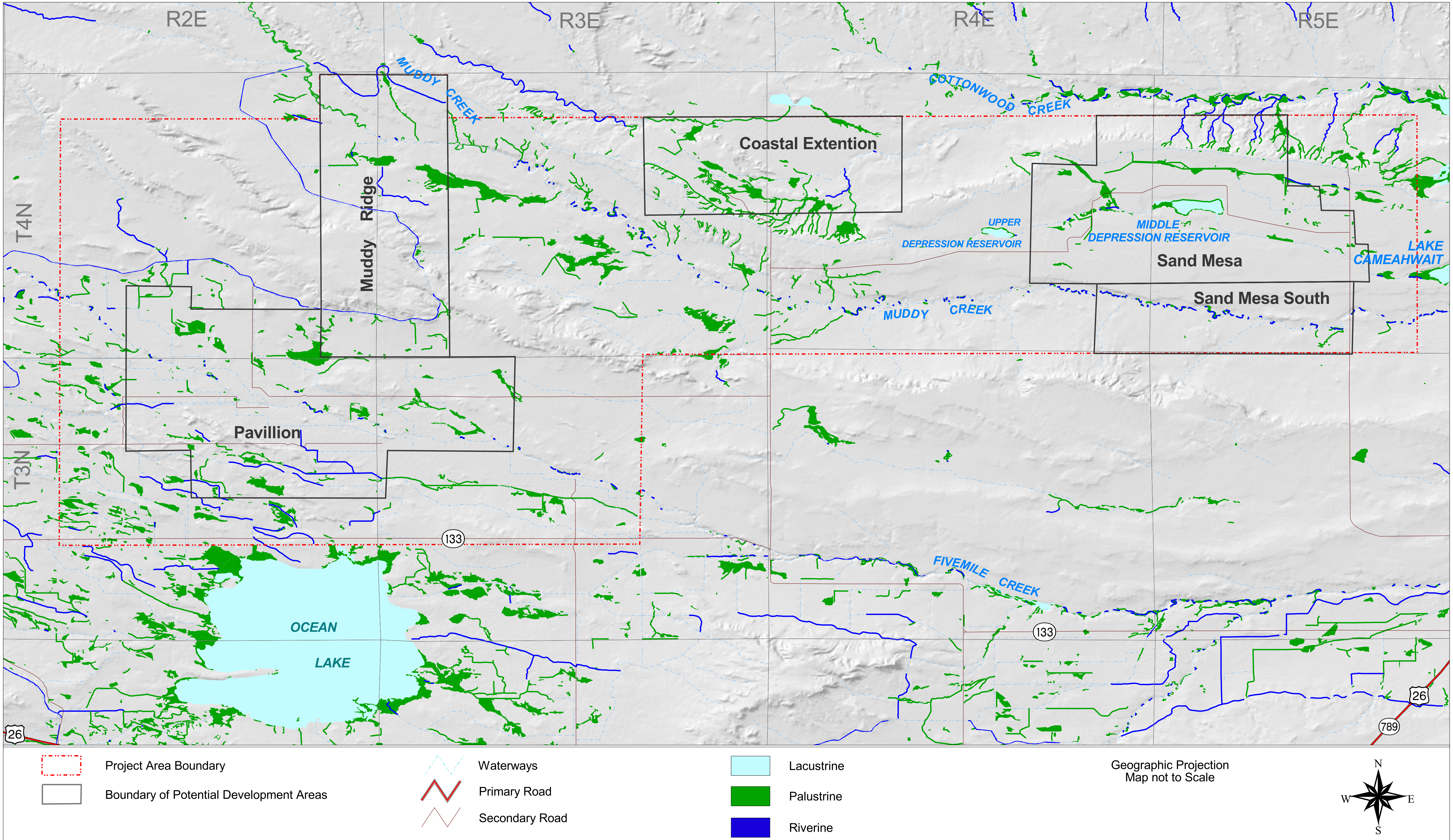


Figure 3.6-3. Wetland Types within and near the Wind River Project Area (From U.S. Fish and Wildlife Service National Wetlands Inventory 1997)

INVASIVE SPECIES

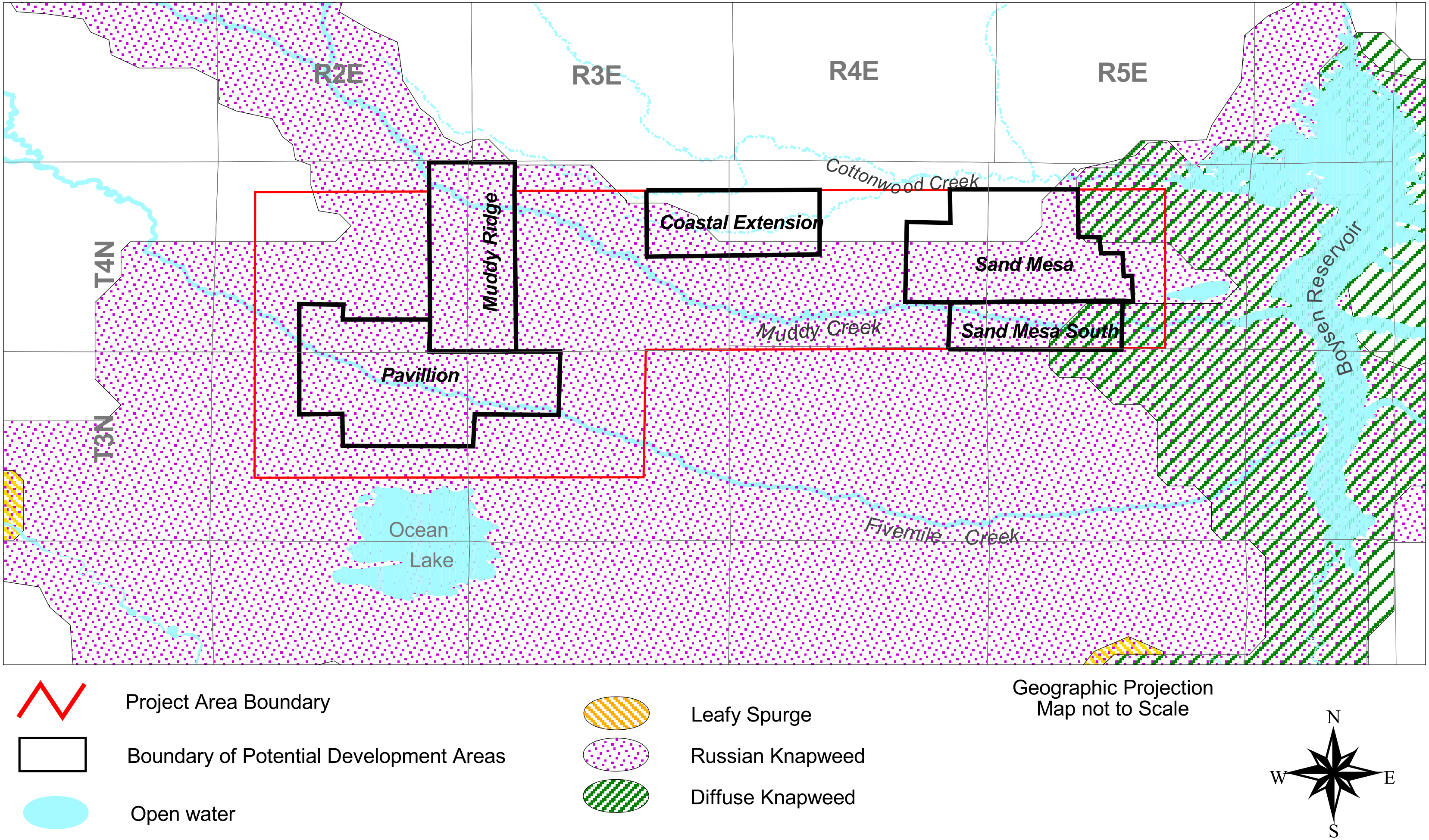


Figure 3.6-4. Areas within and adjacent to the Wind River Project Area where Invasive Plant Species have been observed (From Wyoming Geographic Information Science Center).

PRONGHORN ANTELOPE

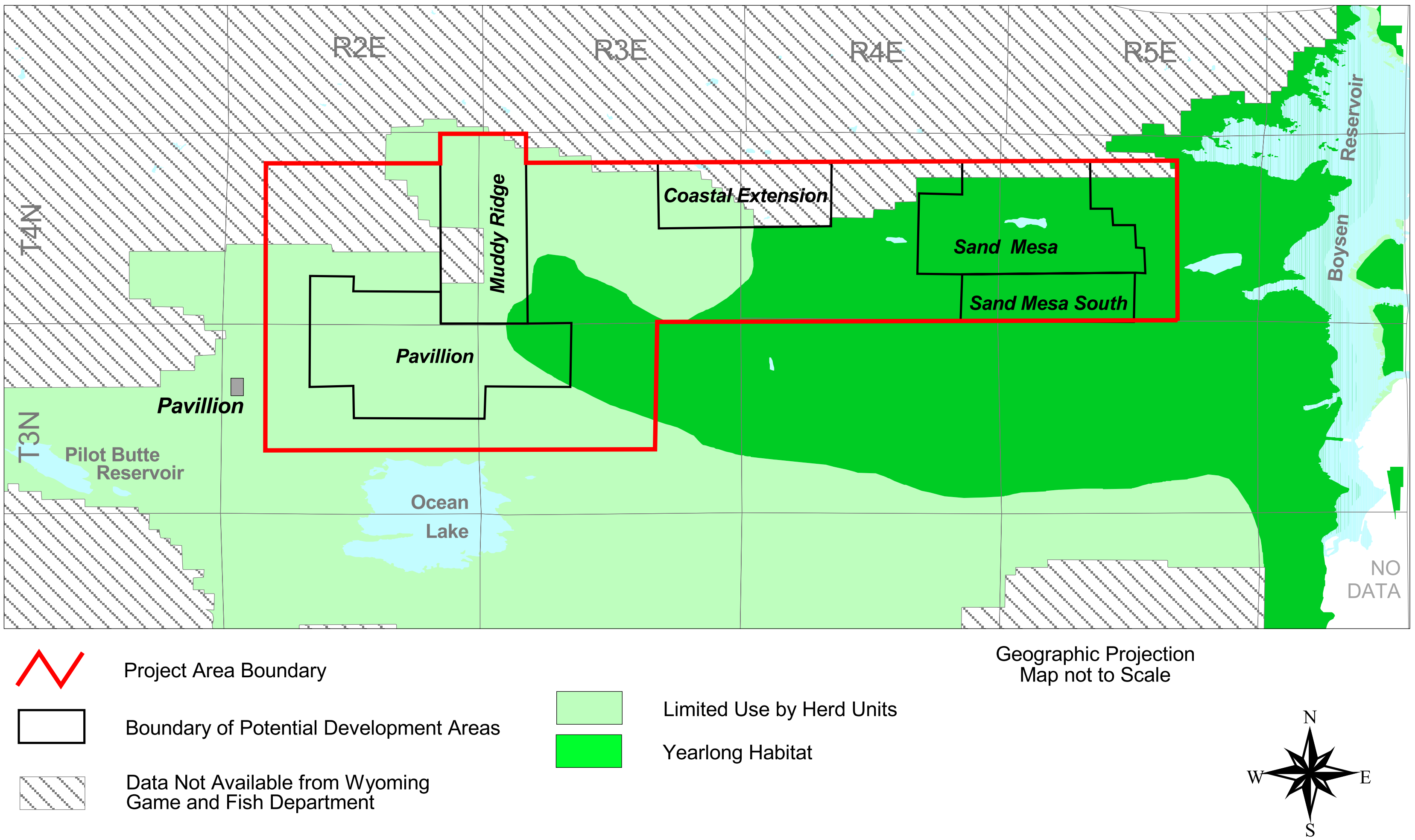


Figure 3.8-1. Seasonal Pronghorn Antelope Ranges within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 1999).

MULE DEER

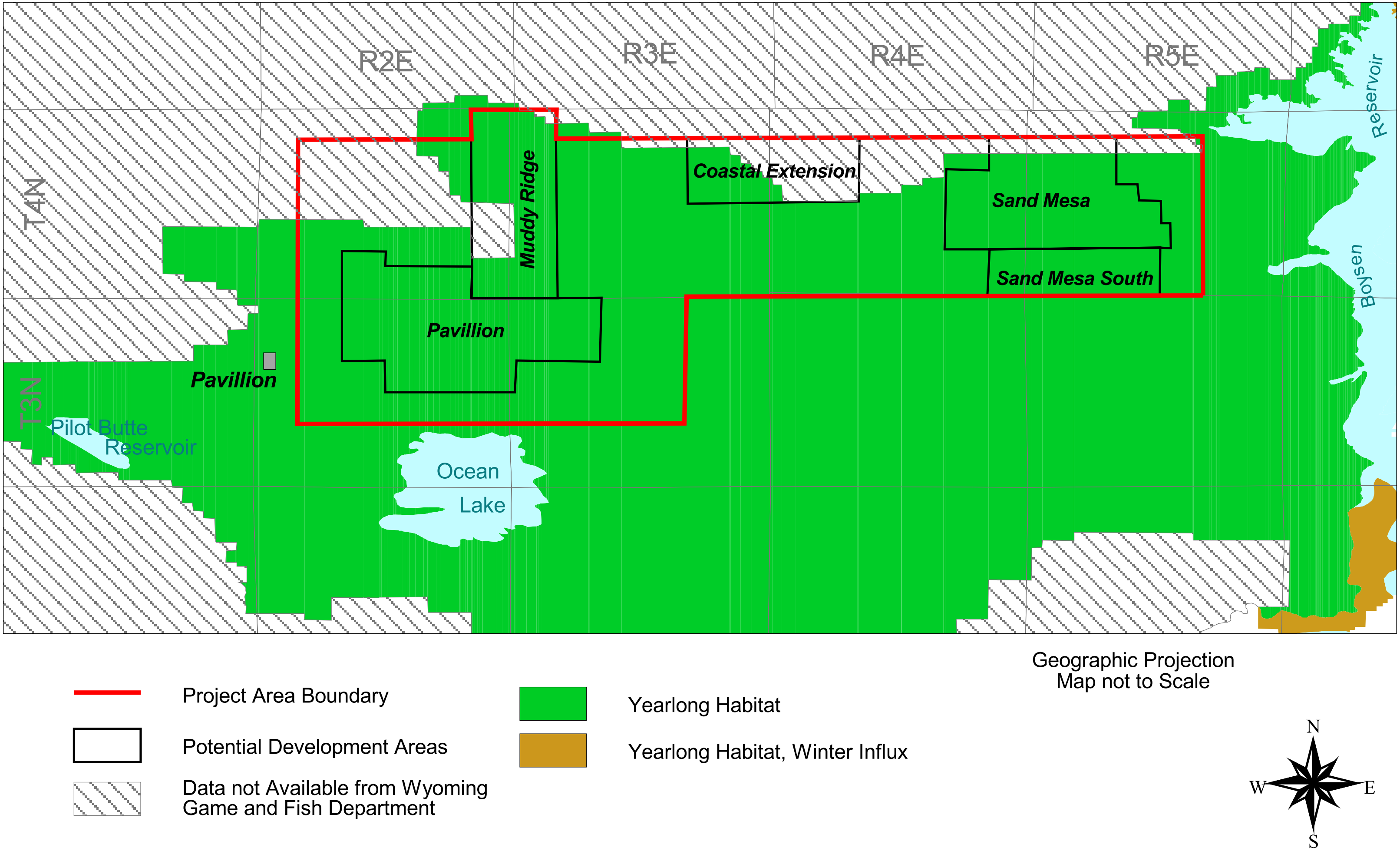


Figure 3.8-2. Seasonal Mule Deer Ranges within and near the Wind River Project Area (Modified From Wyoming Game and Fish Department 1999).

WHITE-TAILED DEER

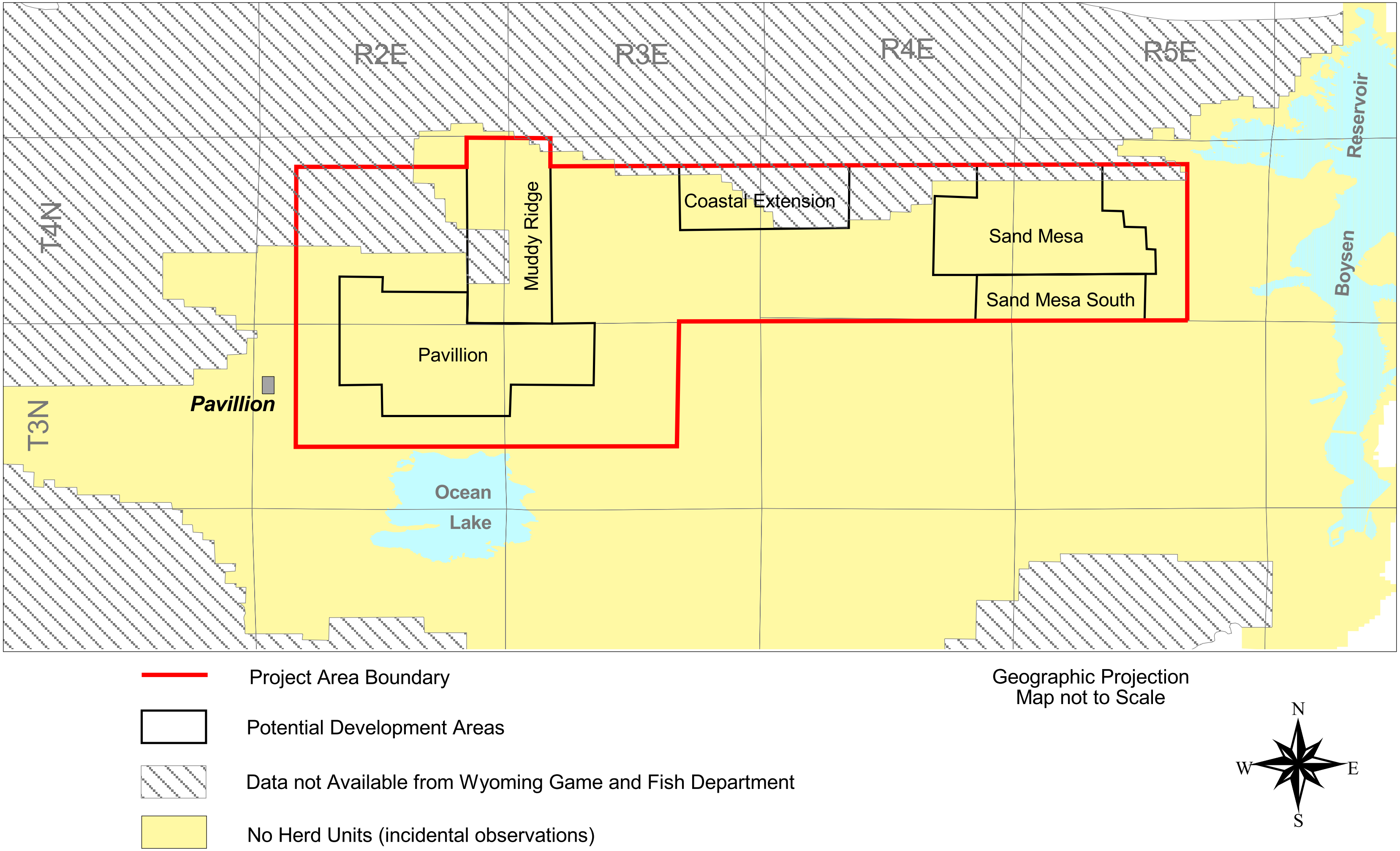


Figure 3.8-3. Seasonal White-tailed Deer Ranges within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 1999).

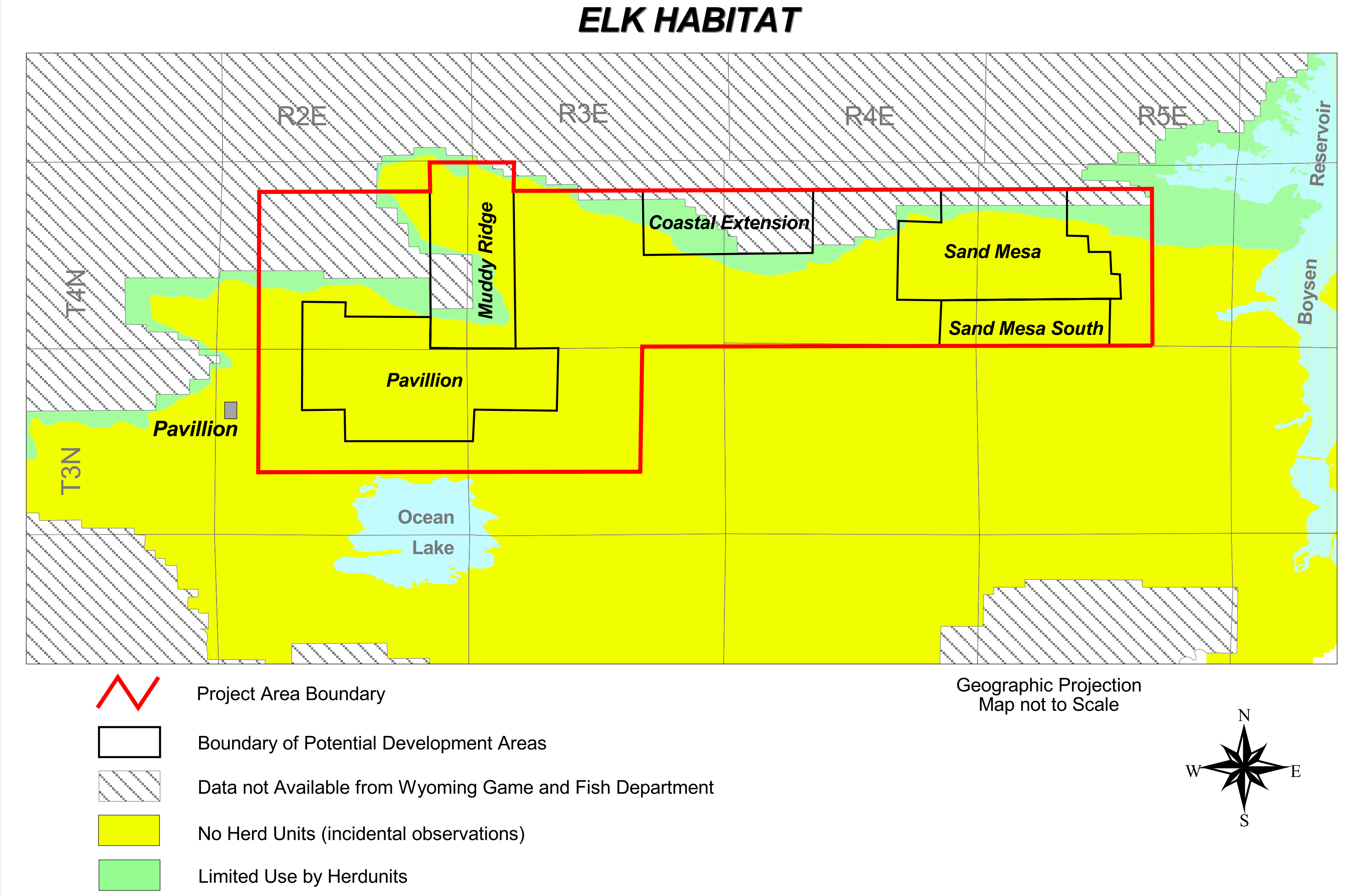


Figure 3.8-4. Seasonal Elk Ranges within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 1999).

MOOSE HABITAT

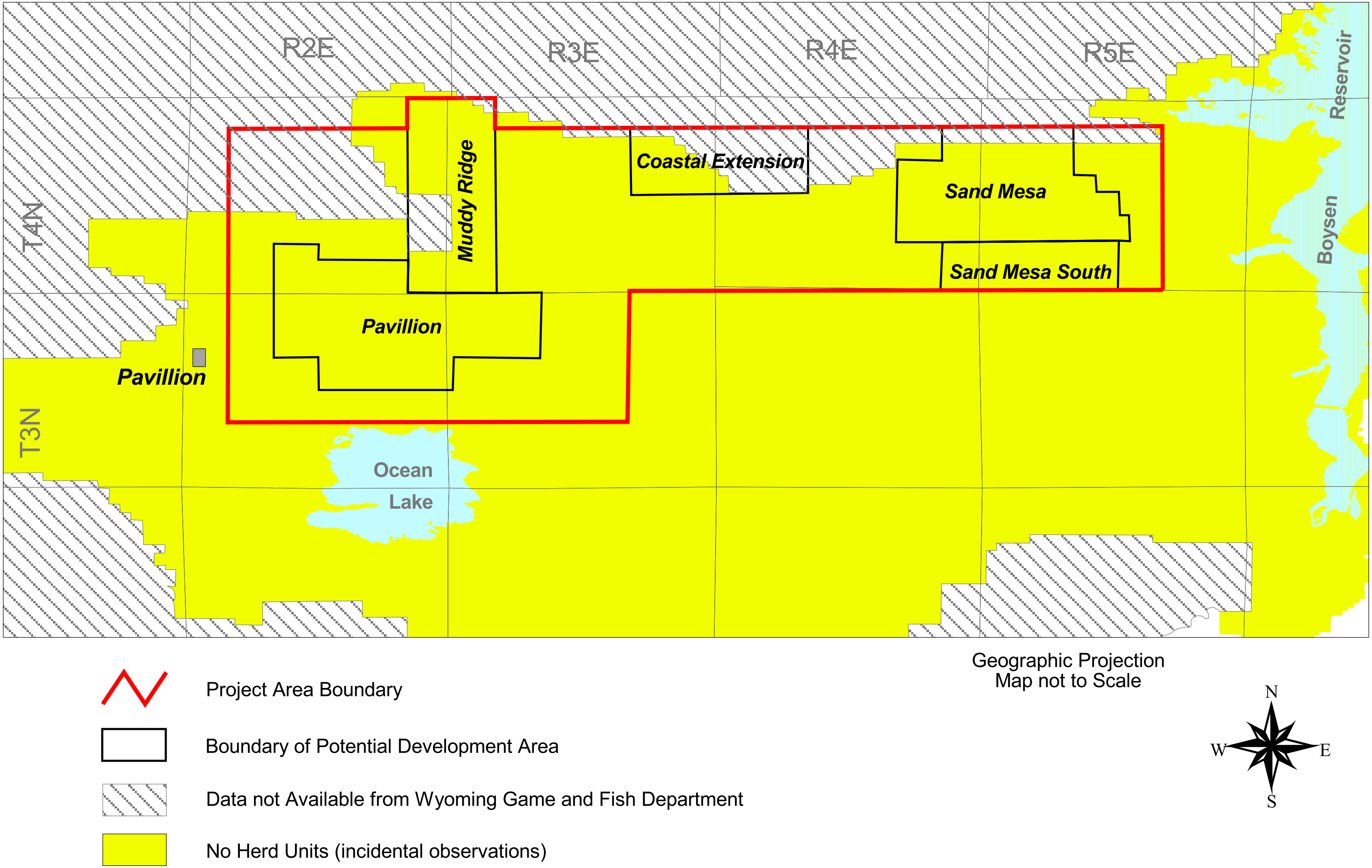


Figure 3.8-5. Seasonal Moose Ranges within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 1998).

RAPTOR NESTING LOCATIONS

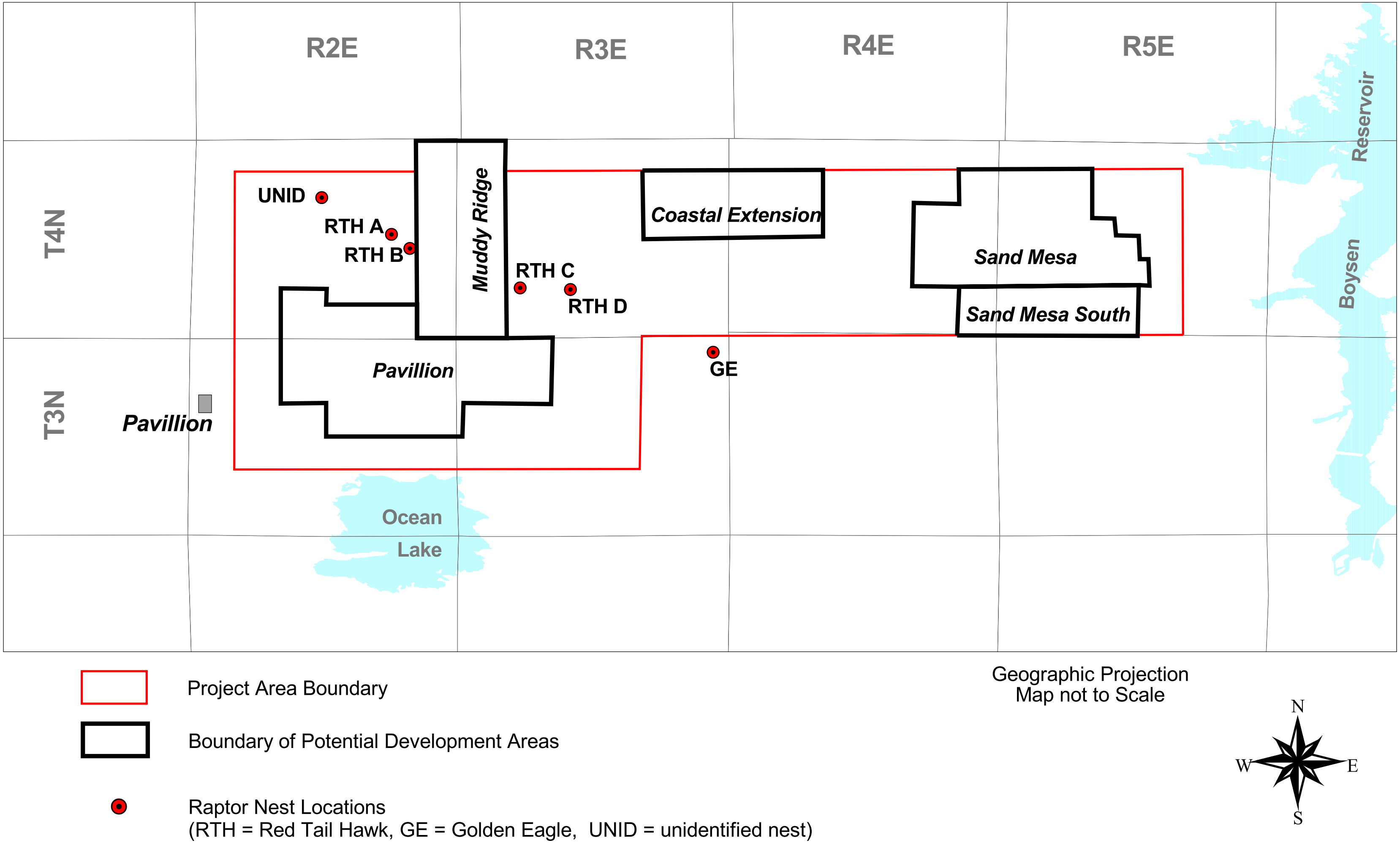


Figure 3.8-6. Raptor Nest Locations within the Wind River Project Area (Buys and Associates 2003).

PRAIRIE DOG HABITAT

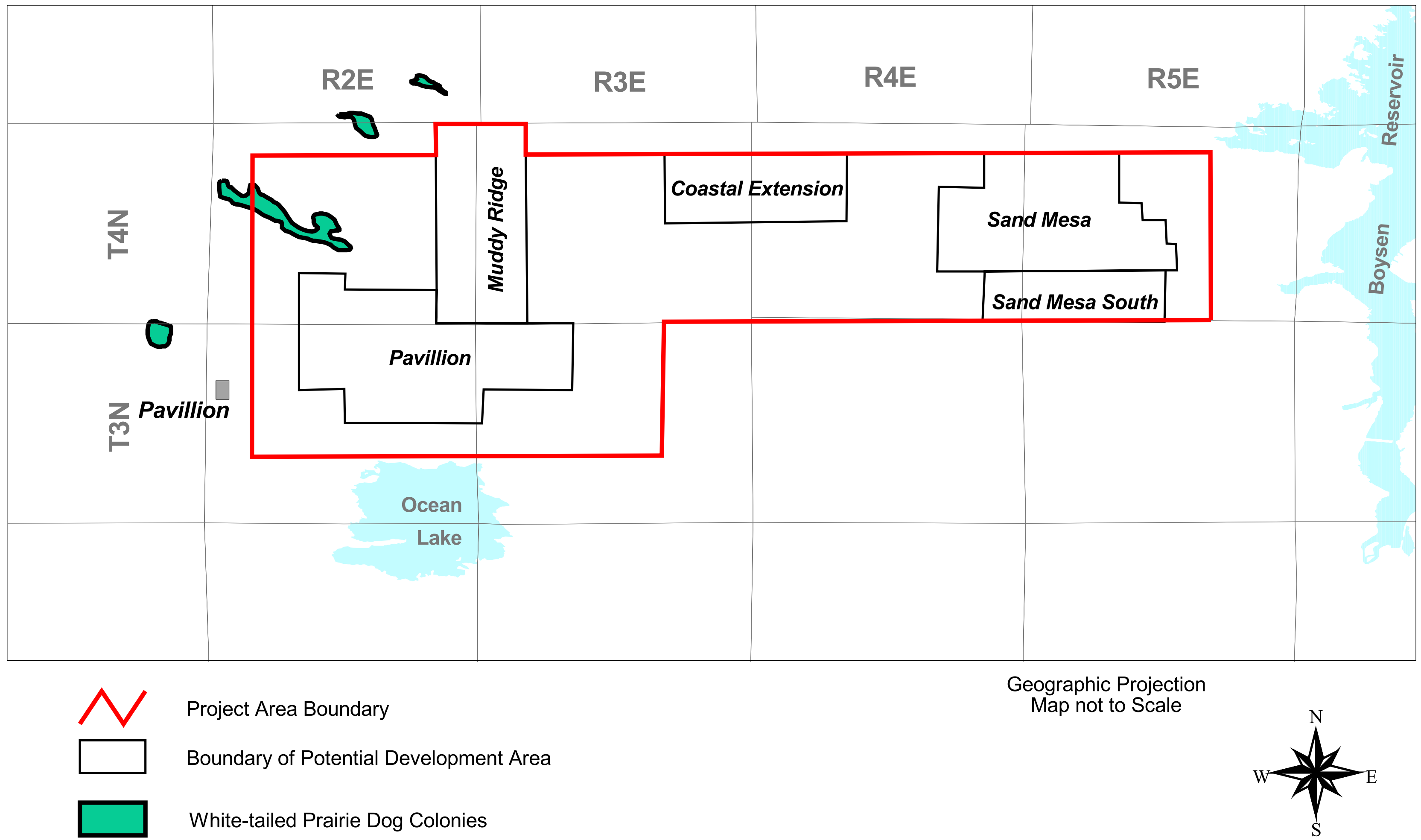


Figure 3.9-1. White-tailed Prairie Dog Colonies within and Adjacent to the Wind River Project Area (From Buys and Associates 2003).

MOUNTAIN PLOVER

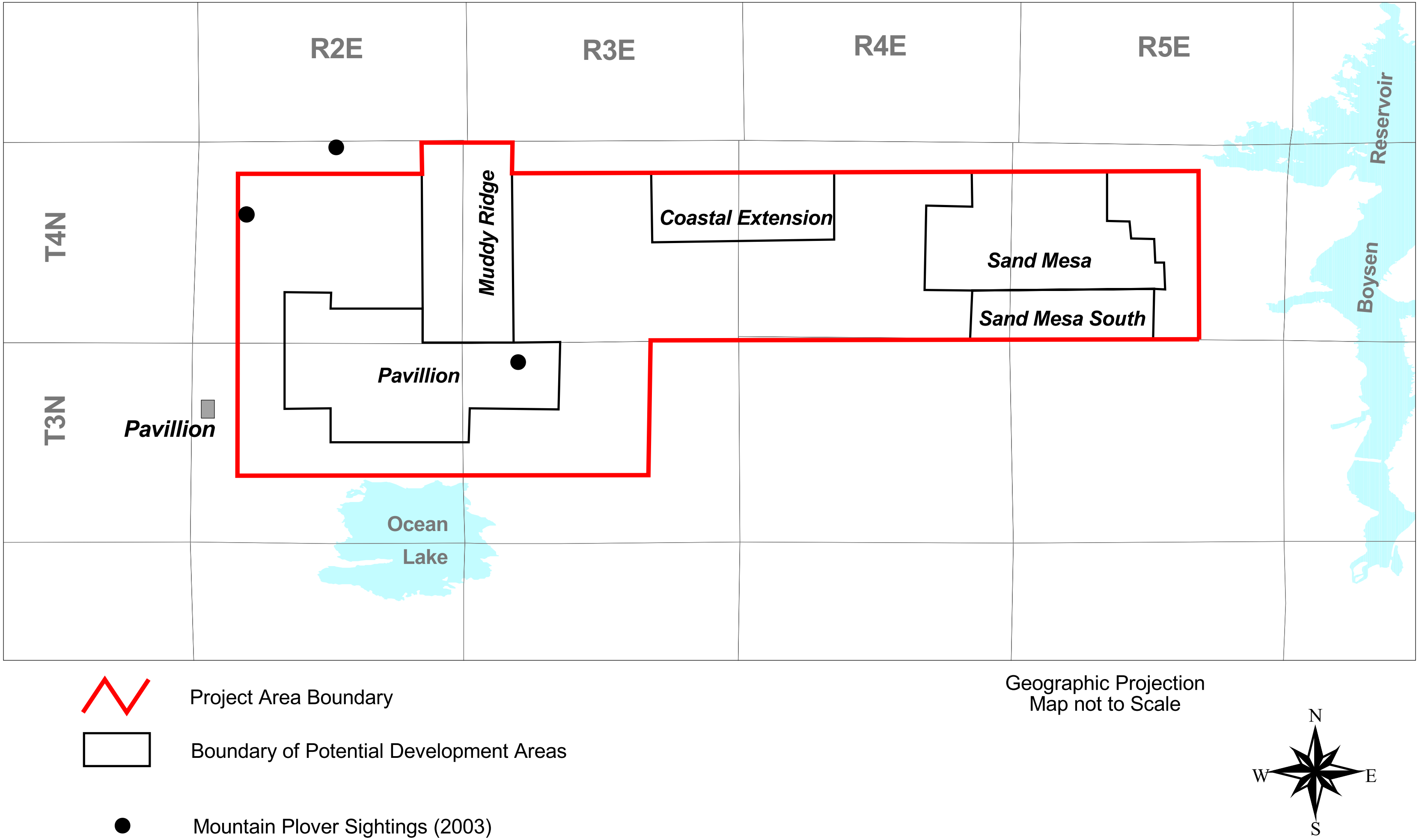


Figure 3.9-2. Potential Mountain Plover Habitat and Sightings of Mountain Plovers within the Wind River Project Area (Buys and Associates 2003).

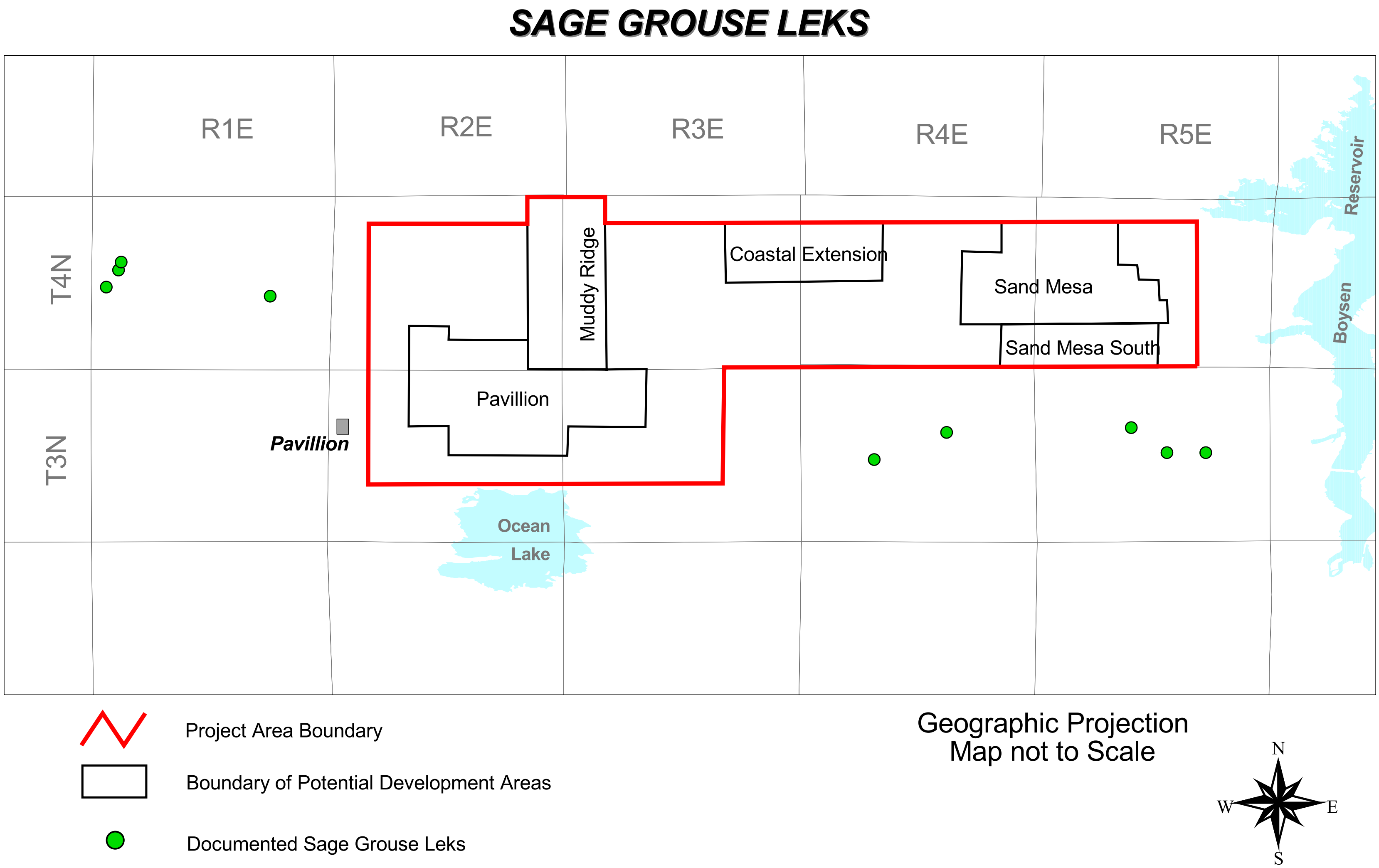


Figure 3.9-3. Sage Grouse Leks near the Wind River Project Area (From US Fish and Wildlife Service and Wyoming Game and Fish Department 2003).

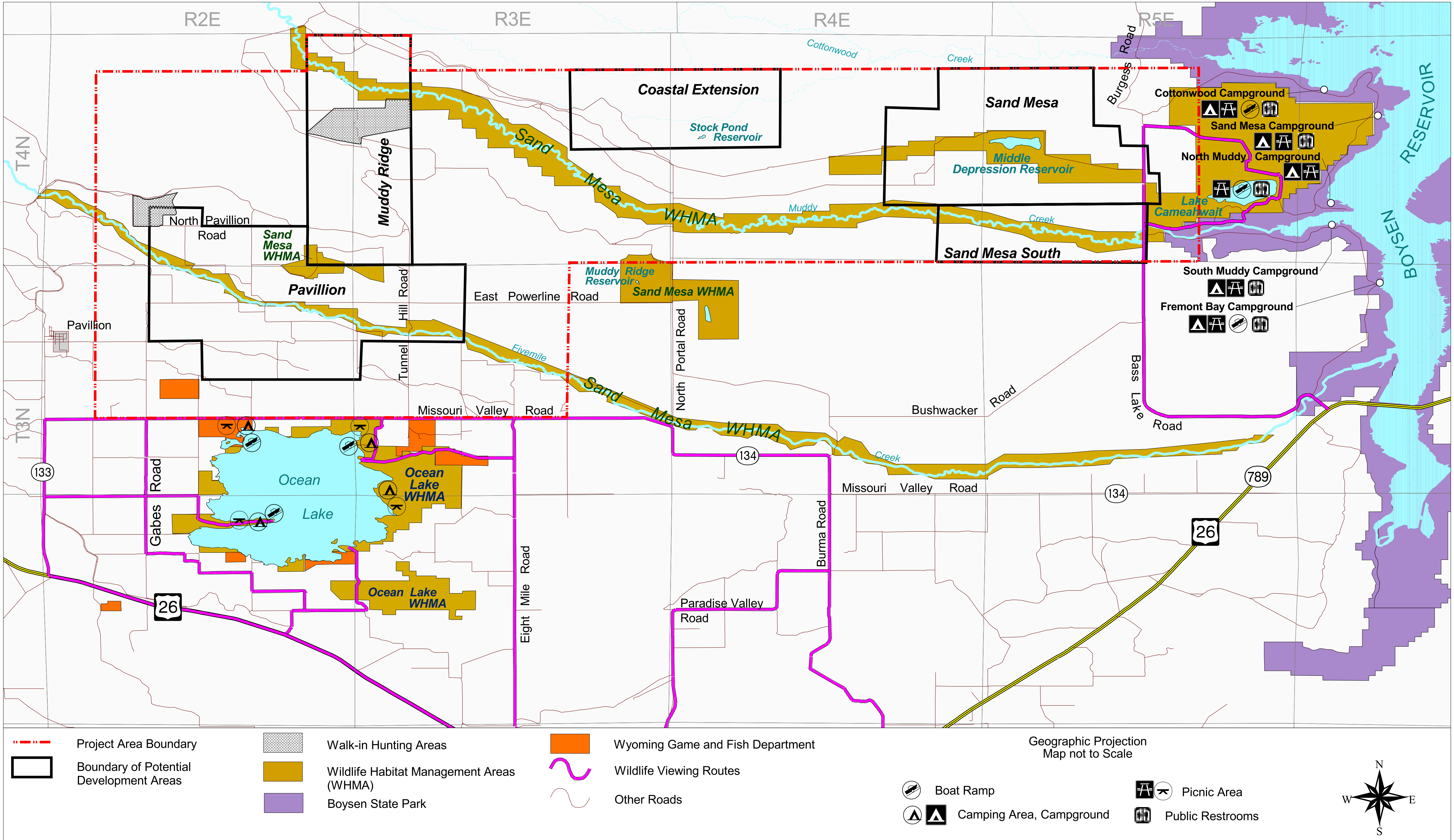


Figure 3.10-1. Recreation Resources in and near the Wind River Project Area.

PRONGHORN ANTELOPE, DEER AND SMALL GAME HUNTING AREAS

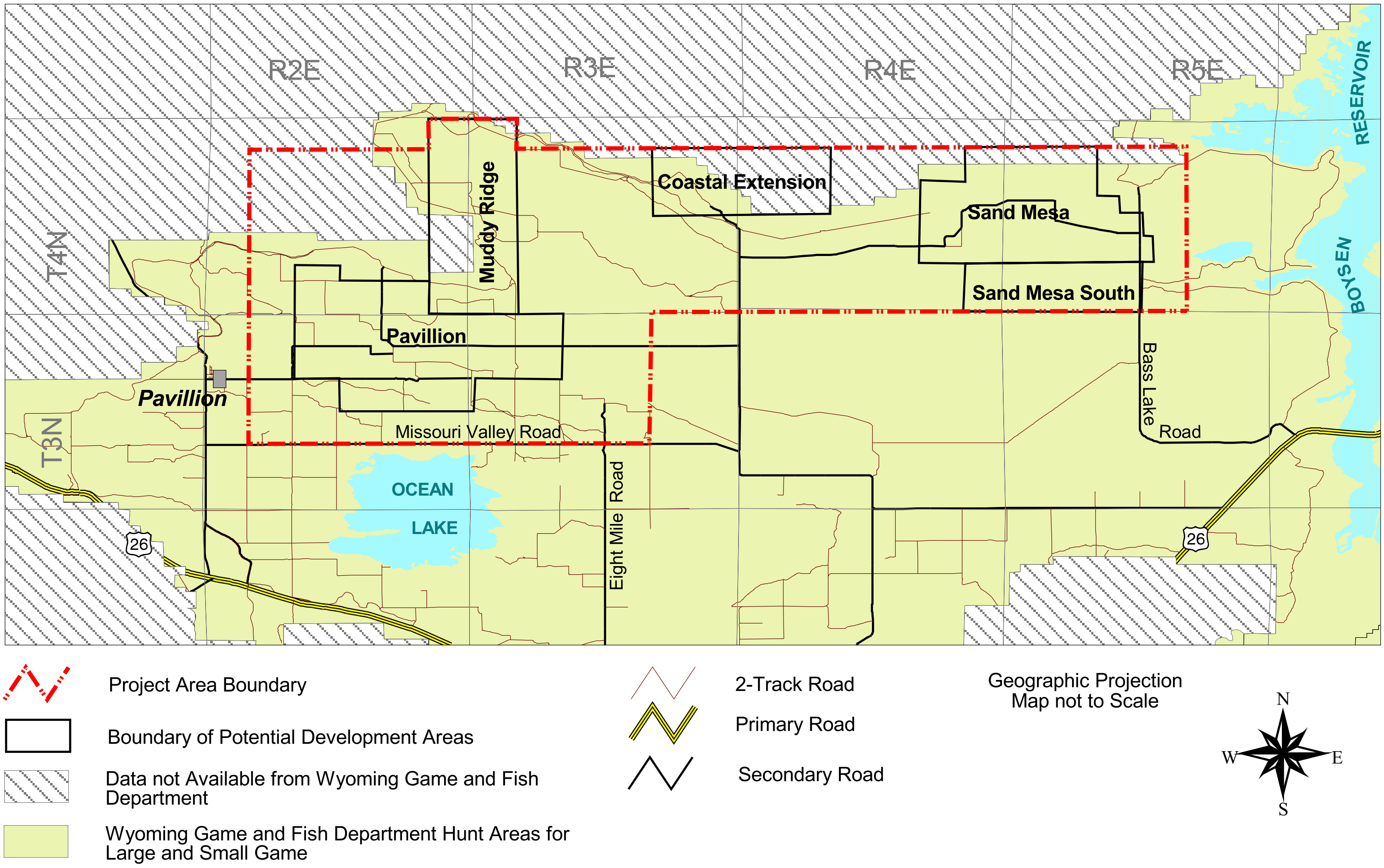


Figure 3.10-2. Pronghorn Antelope, Deer, and Small Game Hunting Areas within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 2003).

WATERFOWL HUNTING AREAS

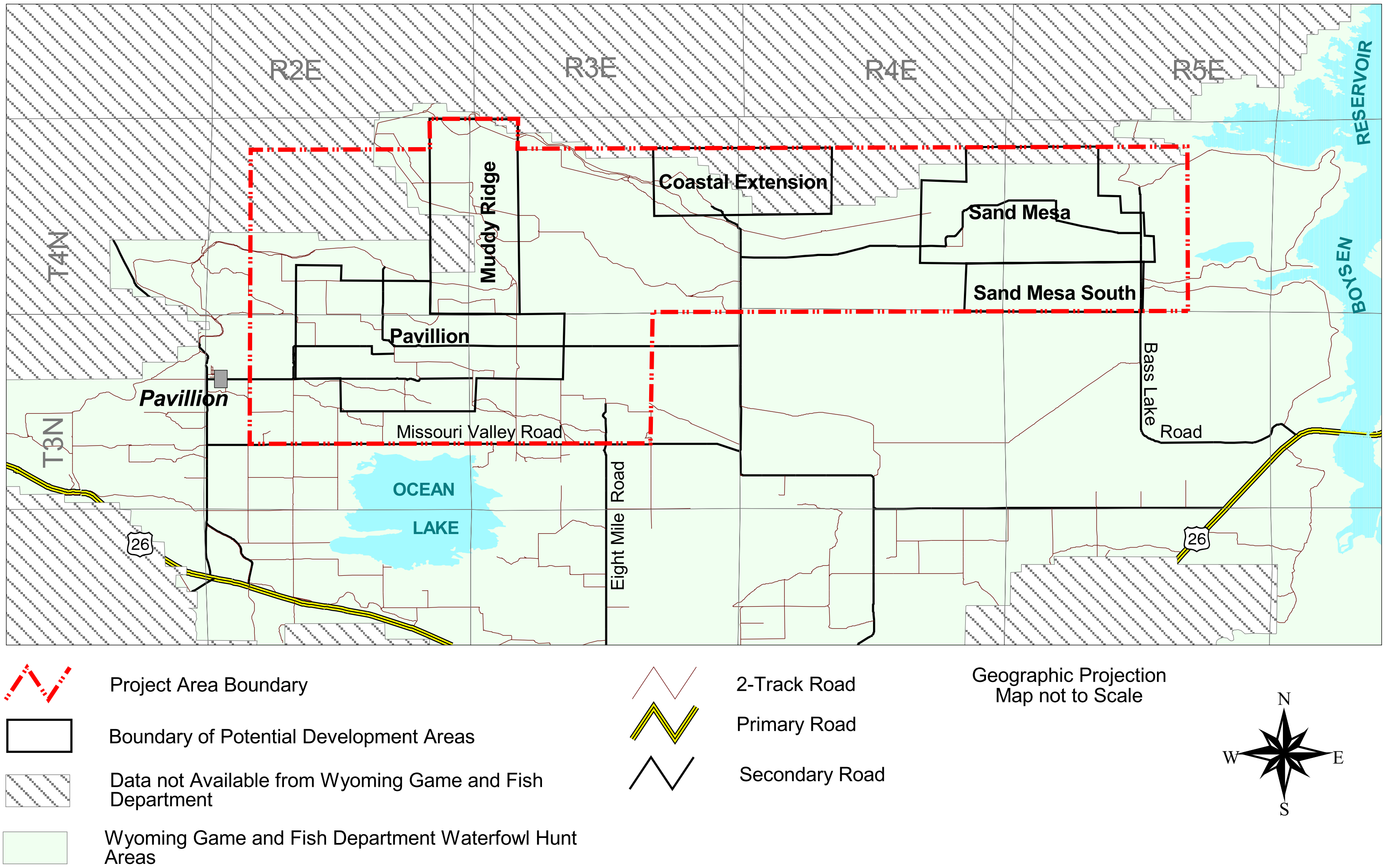


Figure 3.10-3. Waterfowl Hunting Areas within and near the Wind River Project Area (Modified from Wyoming Game and Fish Department 2003).

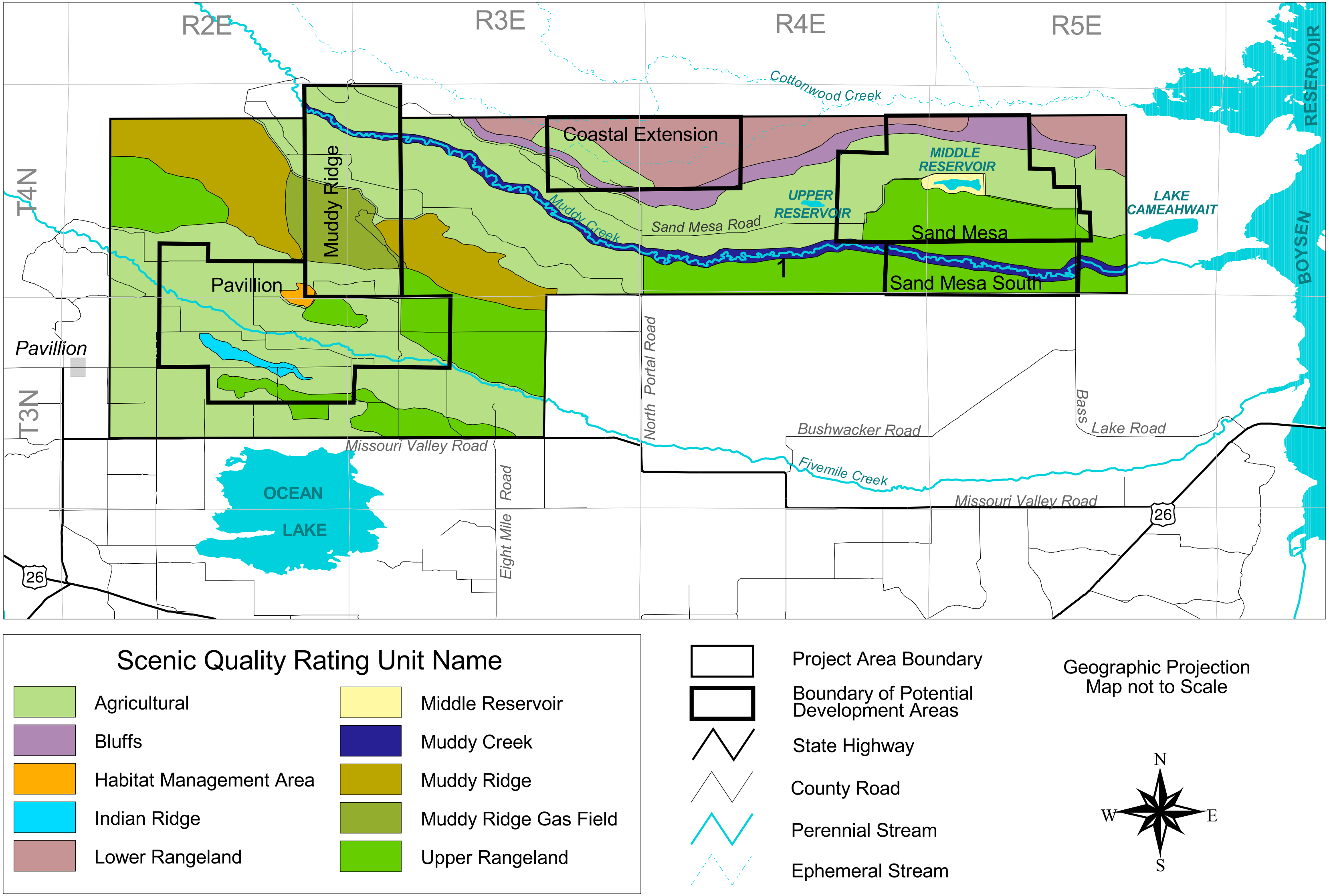


Figure 3.11-1. Scenic Quality Rating Units and Scenic Quality Rating Unit Names in the Wind River Project Area.

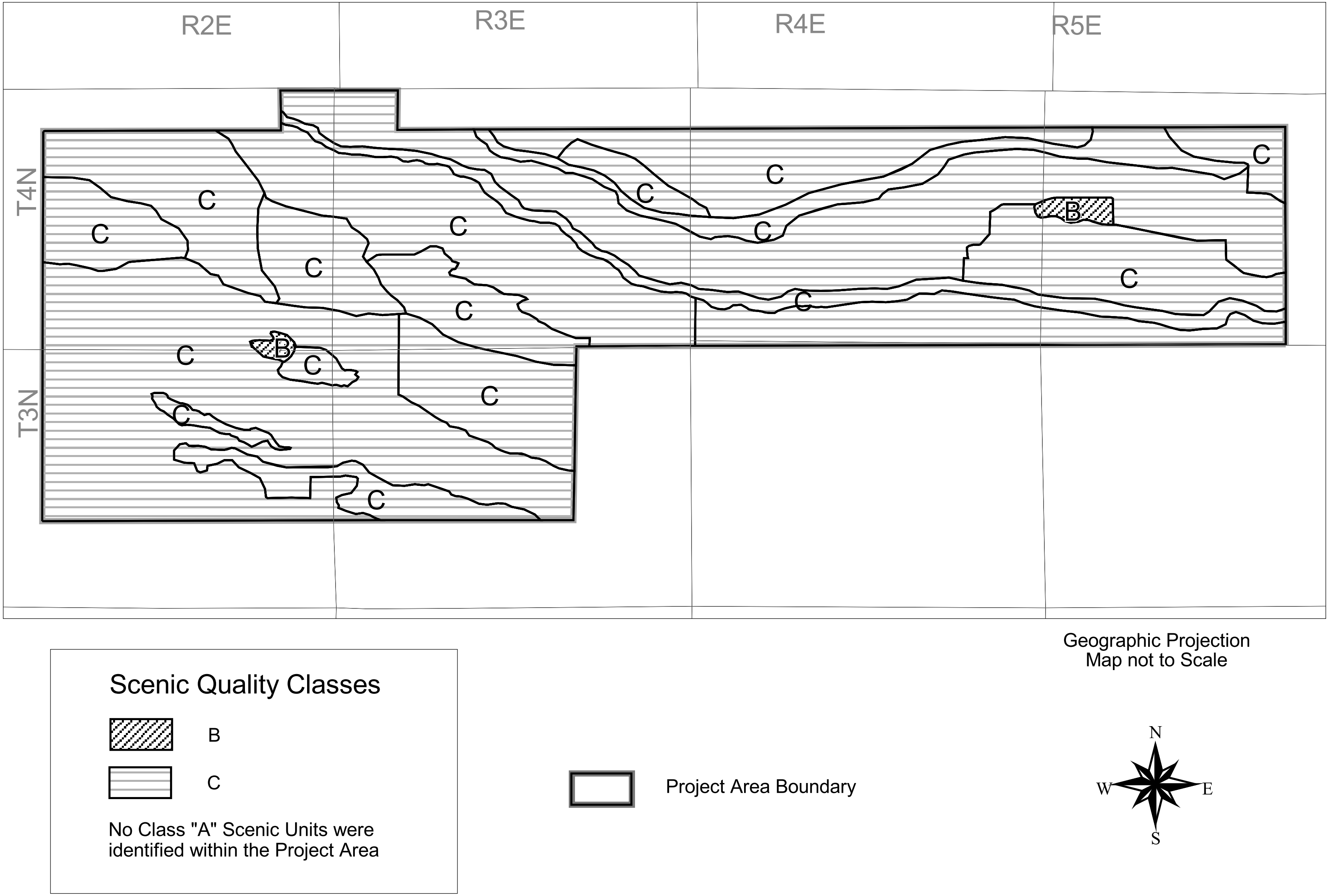


Figure 3.11-2. Scenic Quality Classes in the Wind River Project Area.

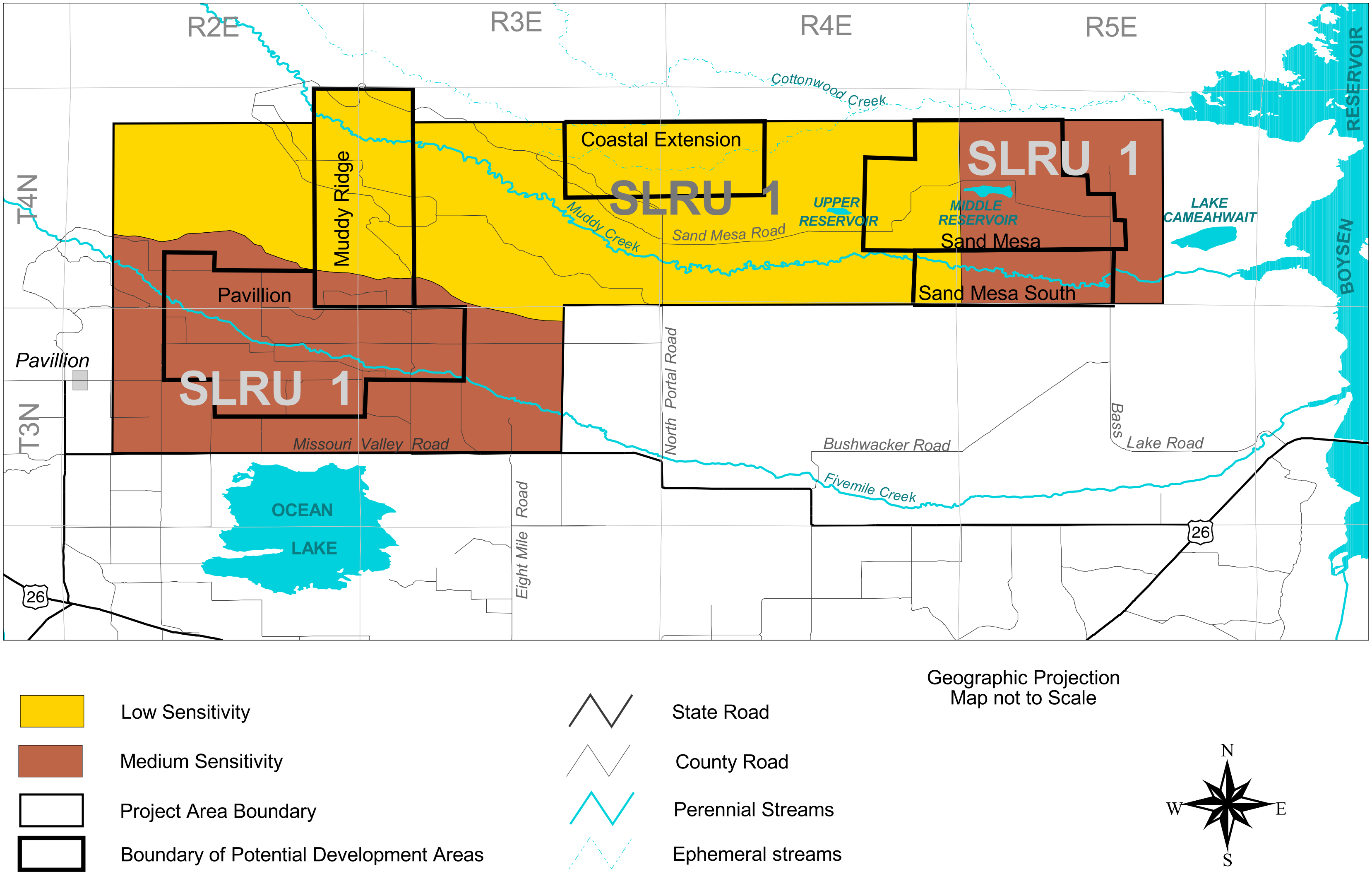


Figure 3.11-3. Sensitivity Level Rating Units within the Wind River Project Area.

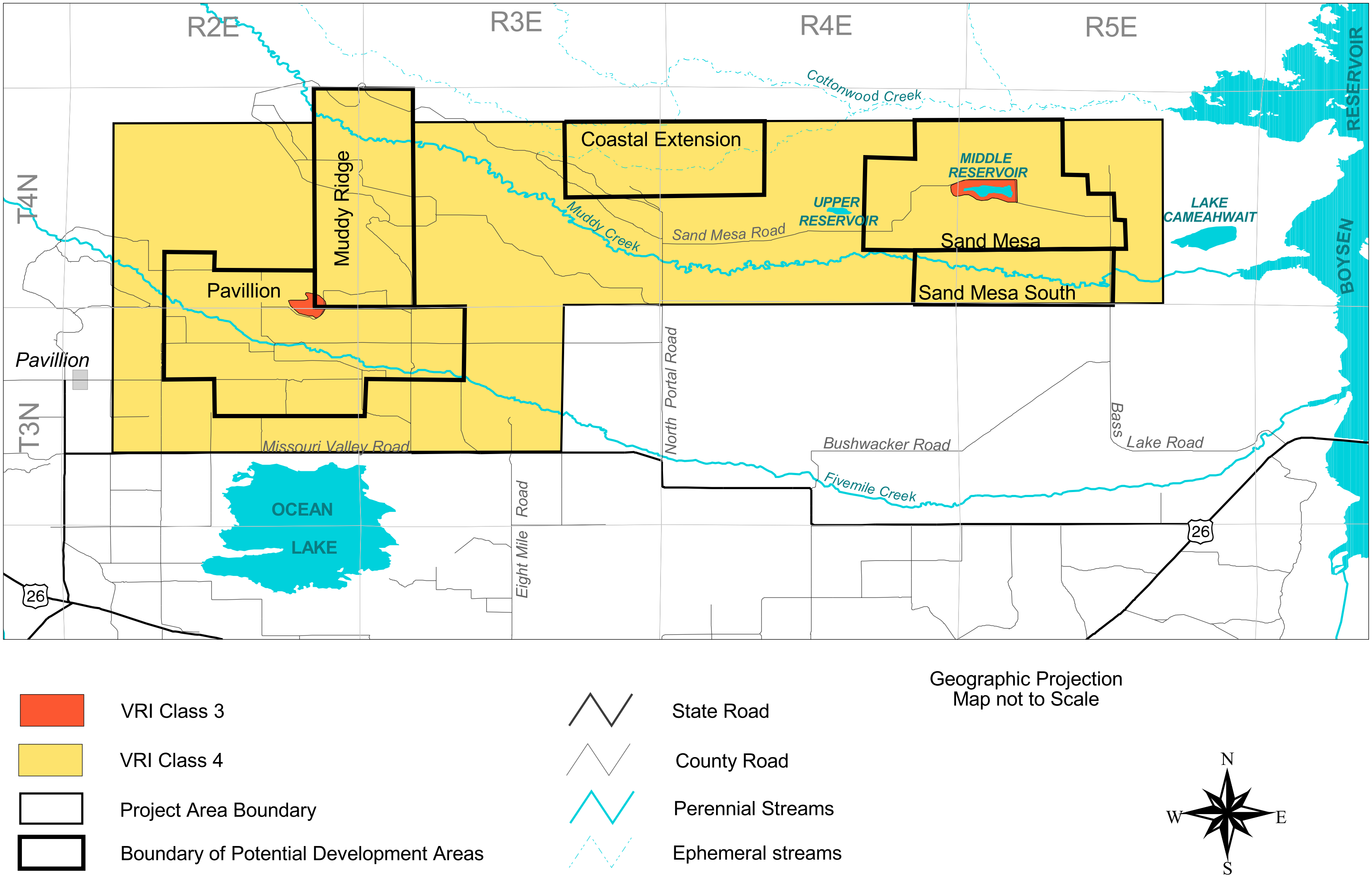


Figure 3.11-4. Visual Resource Inventory Areas (VRI) in the Wind River Project Area.

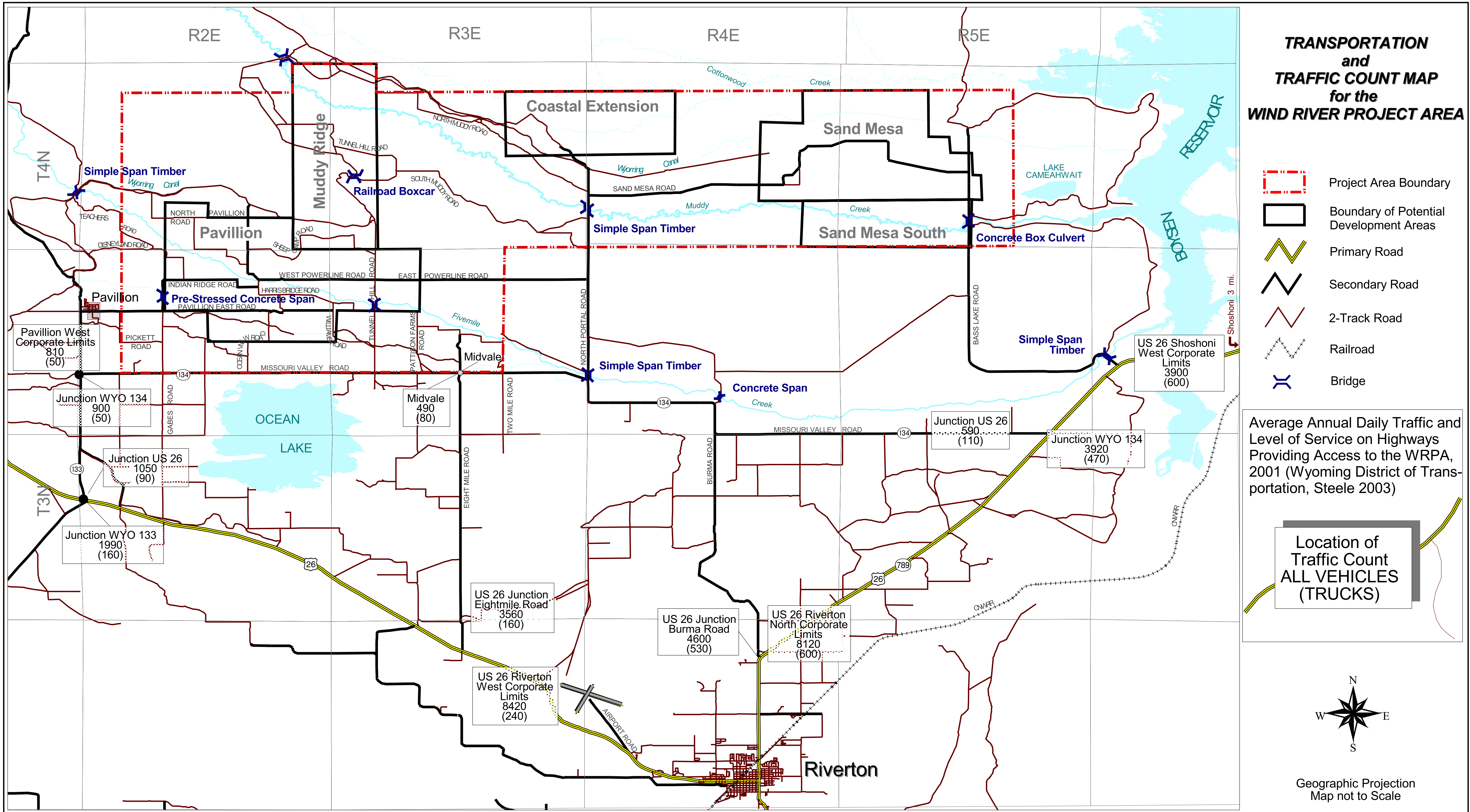


Figure 3.14-1. Map showing all Traffic on Highways and Roads and location of Bridges providing Access to the WRPA (Steele, Wyoming District of Transportation, 2003).

4.0 ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter of the Environmental Impact Statement (EIS) provides an analysis of the potential environmental consequences from the implementation of the Wind River Natural Gas Field Development Project. Four alternatives will be evaluated, including the Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action).

The evaluation of environmental consequences in this chapter is based on the assumption that the mitigation measures, identified in Chapter 2 of this EIS, recommended or required by the Bureau of Indian Affairs, Arapaho and Shoshone Tribes, Bureau of Land Management, Bureau of Reclamation, US Fish and Wildlife Service, and other agencies would be implemented. Mitigation measures, proposed by the Operators (Section 2.3), would also be implemented, as appropriate.

The impacts (i.e., environmental consequences) of the Proposed Action and Alternatives on the natural resources, land use, and human health and safety, as well as the impacts of noise, are evaluated in this chapter. Below is a list of the topics that will be evaluated for environmental consequences.

- Geological, Mineral, and Paleontological Resources
- Soils
- Air Quality
- Water Resources
- Vegetation and Wetlands
- Land Uses
- Wildlife Resources
- Threatened, Endangered, and State-Sensitive Species
- Recreation
- Visual Resources
- Cultural Resources
- Socioeconomics
- Transportation
- Health and Safety
- Noise.

The evaluation of impacts in this chapter also takes into consideration the existing oil and gas development within the WRPA, where oil and gas operations have been conducted in and adjacent to the WRPA since 1960. There are currently 178 producing gas wells in the WRPA, along with 100.7 miles of existing pipelines and 14,600 horsepower (hp) of existing compression (see Chapter 2, Table 2-2). The majority of the existing wells are located in the Pavillion and Muddy Ridge fields. There are presently only three producing wells in the Sand Mesa field. The total disturbance from the existing operations is 410.5 acres, or 0.45 percent of the WRPA (see Chapter 2, Table 2-2). The residual disturbance in the Pavillion, Muddy Ridge, and Sand Mesa fields is specified below:

- Pavillion – 159 acres or 1.35%
- Muddy Ridge – 182 acres or 2.41%
- Sand Mesa – 33 acres or 0.35%

There also are a few producing wells outside the proposed development areas.

In this Chapter the impacts of the Proposed Action and Alternatives on each resource are evaluated based on magnitude (negligible, minor, moderate, and major) and duration (short term or long term). The definitions of these terms are provided below and are also provided in the glossary at the end of the EIS. A summary of the impact determinations for each resource is provided in Section 2, Table 2-17.

Effects (Impacts)

The definitions of effect and impact, as used in the CEQ regulations, are synonymous (40 CFR 1508.8).

Direct impacts – Effects that are caused by the action and occur at the same time and place (40 CFR 1508.8).

Indirect impacts **–** Effects, which are caused by the action, but occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include reduced reproduction, population density, or growth rate in wildlife. Other effects may be related to induced changes in the patterns of land use and effects on air, water, and other natural systems, including ecosystems (40 CFR 1508.8).

Magnitude

No Impacts – No changes in resource condition, quality, or quantity.

Negligible Impacts – Changes in resource condition, quality, or quantity are slightly above the level of detection.

Minor Impacts – Changes in resource condition, quality, or quantity are measurable, but small and localized.

Moderate Impacts – Changes in the resource condition, quality, or quantity are measurable, and result in consequences that would be relatively localized.

Major Impacts – Changes in resource condition, quality, or quantity are measurable, have substantial consequences at the regional level.

Duration

Short-term impacts – Effects of short duration that would occur during construction, drilling, completion, and reclamation of a well.

Long-term impacts – Effects that persist beyond the construction, drilling and reclamation phases, or continue for the life of the project.

Mitigation – Mitigation of impacts may involve any one of the five actions listed below.

- Avoiding the impact by not taking a certain action or parts of an action.
- Minimizing the impact by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

4.2 PHYSIOGRAPHY/GEOLOGY/MINERALRESOURCES / PALEONTOLOGY

4.2.1 Introduction

Impacts could occur to the geologic environment (including geology, mineral resources, and paleontology) by project construction and operations associated with the Proposed Action or its alternatives. These impacts could include alteration of existing topography, initiation of mass movements including landslides, subsidence, acceleration of erosion, or flooding. Site-specific work performed while constructing well pads and ancillary facilities could also result in minor changes to the geologic environment, including disturbance of soils and the underlying parent material.

All alternatives involve the drilling of gas wells and construction of supporting infrastructure, and as a result, potential direct and indirect impacts are similar for the Proposed Action and its alternatives. The magnitude of the potential impacts will vary proportionally with the number of wells ultimately drilled under each alternative and the total amount of associated surface disturbance. The magnitude of potential impacts to the geologic environment (geology, minerals, and paleontology) can be reduced by the implementation of project-wide resource mitigation measures described in Section 2.7.2.14.

4.2.2 Geology

Impacts to the geologic environment resulting from the Proposed Action and alternatives are discussed in the following section and summarized in Table 2-17 (Section 2).

4.2.2.1 Proposed Action (325 Wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to surficial geology as a result of the Proposed Action could include damage to the Earth's surface, such as alteration of existing local topography that causes mass movements, including, landslides, or results in flooding, or accelerated erosion, subsidence. Potential direct and indirect impacts to subsurface geology as a result of the Proposed Action could include damage to subsurface geological formations as a result of drilling fluid invasion, withdrawal of fluids and subsidence, cross-contamination of aquifers or reservoir rocks, or initiation of fault movements.

Earthquake-induced ground shaking could result in damage to above-ground structures. However, because the likelihood of earthquakes is low as indicated by the absence of recorded epicenters in the area, the Proposed Action have a negligible impact on the risk of fault generated earthquakes. Buried structures would only be affected if shaking induces ground failure or subsurface rupture.

Application of the project-wide mitigation measures described in Section 2.7.2.12 would lessen the chance that the Proposed Action would contribute to impacts to surficial or subsurface geology. The impact from the Proposed Action on surface runoff, surface erosion, and collapse, piping or gulling is considered to be minor and short term.

Drilling in accordance with BLM, BOR, and BIA regulations on federal and trust lands, and in accordance with the Wyoming Oil and Gas Conservation Commission on state and private lands, would lessen the chance that the Proposed Action would contribute to impacts to subsurface geology.

4.2.2.2 Alternative A (485 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to the surficial and subsurface geology as a result of implementation of Alternative A are similar to those discussed above for the Proposed Action. Alternative A, however, includes a provision for drilling an additional 160 wells and building the necessary infrastructure to support these wells. As a result, the area affected by disturbance would be greater for Alternative A than the Proposed Action or Alternative B and a greater impact to surficial and subsurface geology could occur.

The impact from Alternative A on surface runoff, surface erosion, and collapse, piping or gulling is considered to be moderate and short term.

4.2.2.3 Alternative B (233 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to surficial and subsurface geology as a result of implementation of Alternative B are similar to those discussed above for the Proposed Action. Alternative B, however, includes provision for drilling 92 fewer wells and building less associated infrastructure than the Proposed Action or Alternative A. As a result, the area affected by disturbance for Alternative B would be less than for the Proposed Action or Alternative A and a lesser impact to surficial and subsurface geology could occur.

The impact from Alternative B on surface runoff, surface erosion, and collapse, piping or gullying is considered to be minor and short term.

4.2.2.4 Alternative C (No Action, 100 wells – Direct and Indirect Impacts

Potential direct and indirect impacts to surficial and subsurface geology as a result of implementation of Alternative C (No Action) are similar to the Proposed Action and Alternative B. Since only 100 wells may be drilled in the Pavillion field on private minerals minor, short-term impacts would be anticipated to surface and subsurface geology.

4.2.2.5 Impacts Summary

Minor adverse impacts to surficial or subsurface geology are anticipated under the Proposed Action and Alternative B or C if mitigation discussed in Section 2.7.2.11 is adopted and applicable drilling procedures and regulations are followed. Moderate impacts may occur to surficial or subsurface geology under Alternative A.

4.2.2.6 Additional Mitigation Measures

No additional mitigation measures are required to protect surficial and subsurface geologic resources.

4.2.2.7 Residual Impacts

No residual impacts to surficial or subsurface geology as a result of the Proposed Action, Alternative A, Alternative B or Alternative C are anticipated.

4.2.3 Mineral Resources

Inventory of mineral resources in the WRPA revealed no major mineral resources that would be impacted by implementation of the Proposed Action or its alternatives other than petroleum (oil and gas) resources. Successful completion and production of proposed oil and gas wells would both beneficially and detrimentally affect petroleum resources underlying the WRPA.

The Proposed Action, Alternative A, and Alternative B would recover federal trust and private oil and natural gas resources, as allowed by 43 CFR 3162 "Requirements for Operating Rights Owners and Operators." Drainage, specific to federal or Indian mineral resources, is discussed in 43 CFR 3162.2-2 and 43 CFR 3162.2-3. These requirements provide for effective management of the resource to maximize production and minimize draining of federal oil and gas resources from non-federal lands. Private and public revenues would be generated if drilling associated with the Proposed Action, Alternative A, Alternative B, or Alternative C leads to wells being successfully completed with significant production of oil and gas.

Depletion of petroleum resources would invariably result from successful drilling and completion of wells as described for the Proposed Action, Alternative A, or Alternative B. Although this might be considered an adverse impact, the purpose of this project is to extract these resources.

Construction materials (sand and gravel) may be indirectly affected in that they are likely to be used from local sources for surfacing materials for proposed oil and gas facilities and access roads. If development is extensive, known accumulations of local materials may become depleted and additional sources outside of, or within, the WRPA would need to be identified and used. The magnitude of impacts depends on the number of access roads, well pads, and other facilities built.

4.2.3.1 Proposed Action (325 wells) - Direct and Indirect Impacts

Other than depletion of petroleum (oil and gas) resources, no direct impacts to mineral resources have been identified as a result of the Proposed Action. As described above construction materials may be indirectly affected by being utilized for anticipated facilities. However, overall the impacts would be negligible.

4.2.3.2 Alternative A (485 wells) - Direct and Indirect Impacts

Potential direct and indirect impacts to mineral resources as a result of implementation of Alternative A are similar to those discussed above for the Proposed Action. Alternative A, however, includes a provision for drilling an additional 160 wells and building the necessary infrastructure to support these wells. As a result, petroleum resources may be depleted faster. Although the need for construction materials may be greater than for the Proposed Action or Alternative B, the overall impacts are anticipated to be negligible.

4.2.3.3 Alternative B (233 wells) - Direct and Indirect Impacts

Potential direct and indirect impacts to surficial and subsurface geology as a result of implementation of Alternative B are similar to those discussed above for the proposed action. Alternative B, however, includes a provision for drilling 92 fewer wells and building less associated infrastructure than the Proposed Action or Alternative A. As a result, petroleum resources may not be depleted as fast and the need for construction materials may be less than for the Proposed Action or Alternative A.

4.2.3.4 Alternative C (No Action – 100 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to mineral resources as a result of implementation of Alternative C (No Action) are similar to those discussed above for the Proposed Action. Alternative C, however, included a provision for drilling up to 100 wells and building less associated infrastructure than the Proposed Action or Alternative B. As a result, petroleum resources would not be depleted as fast and the need for construction materials would be less than for the Proposed Action, Alternative, A or Alternative B. Therefore the impacts are expected to be negligible.

4.2.3.5 Impacts Summary

No significant adverse impacts to mineral resources (other than depletion of petroleum resources and potentially to local construction materials) are anticipated under the Proposed Action, Alternative A, Alternative B or Alternative C, if mitigation discussed in Section 2.7.2.12 is adopted.

4.2.3.6 Additional Mitigation Measures

No additional mitigation measures are required to protect mineral resources.

4.2.3.6 Residual Impacts

No residual impacts to mineral resources as a result of the Proposed Action, Alternative A, Alternative B, or Alternative C are anticipated.

4.2.4 Paleontology

Inventory of paleontology resources in the WRPA documented the presence of sedimentary deposits of the Early Eocene Wind River Formation that contains plant, invertebrate, and vertebrate fossils of scientific interest and significance. Of particular interest are fossils of terrestrial vertebrates that record the appearance of modern orders of mammals in North America and provide crucial information about their relationships and evolution during the early part of the Cenozoic Era.

Several institutions, chiefly The American Museum of Natural History (New York), Carnegie Museum (Pittsburgh), and Geology Department of the University of Wyoming (Laramie), have documented vertebrate fossils in the formations in the Wind River Basin in areas adjacent to the WRPA. The WRPA itself has not been studied in detail, but field reconnaissance conducted for this project led to the identification of five new fossil localities in the Wind River Formation. For these reasons, the Wind River Formation satisfies BLM Paleontology Condition 1, which includes areas that are known to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. Mitigation of potential impacts to paleontological resources is necessary on BLM lands that satisfy Paleontology Condition 1. This mitigation also is required by the BIA on tribal lands.

The BLM in Wyoming have begun to implement a more detailed classification scale similar to that used by the US Forest Service, termed Potential Fossil Yield Classification (PFYC), to allow an estimate of the potential for discovering significant fossils during any surface-disturbing activity. This scale is based on specific geologic formations and utilizes a scale of 1 through 5. Class 5 is assigned to formations with the highest paleontological potential and Class 1 is assigned to formations with the lowest paleontological potential. The BLM considers the Wind River Formation to be a Class 5 formation.

Construction of well pads, access roads, and production facilities, and the excavation of pipeline trenches, could result in the exposure and possible destruction of fossil resources, along with associated loss of scientific information. However, construction-related disturbances could also result in new fossil resources being discovered.

The magnitude of impacts associated with the destruction of fossil resources would be reduced by the implementation of paleontological mitigation measures described in Section 2.7.2.11.

4.2.4.1 Proposed Action (325 wells)– Direct and Indirect Impacts

Direct impacts to fossils that could result from the Proposed Action include damage or destruction of scientifically significant fossils during construction, with subsequent loss of scientific information. Adverse indirect impacts would include fossil damage or destruction by accelerated erosion due to surface disturbance. In addition, improved access and increased visibility may result in unauthorized fossil collection or vandalism. However, these impacts are anticipated to be minor.

Excavation could reveal fossils of scientific significance that would otherwise have remained buried and unavailable for scientific study. Newly discovered fossils would be available for future scientific study, if they are properly collected and catalogued into the collections of a museum repository along with associated geologic data. In this way, beneficial results, including the unanticipated discovery of previously unknown scientifically significant fossils, could result.

4.2.4.2 Alternative A (485 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to fossil resources as a result of implementation of Alternative A are the same as those discussed above for the Proposed Action. Alternative A, however, includes a provision for drilling an additional 160 wells and building the necessary infrastructure to support these wells. As a result, the surface area affected by disturbance would be greater for Alternative A than the Proposed Action and Alternative B and proportionally more impact to fossil resources could occur.

4.2.4.3 Alternative B (233 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to surficial and subsurface geology as a result of implementation of Alternative B are the same as those discussed above for the proposed action. Alternative B, however, includes a provision for drilling 92 fewer wells and building less associated infrastructure than the Proposed Action or Alternative A. As a result, the surface area affected by disturbance for Alternative B would be less than for the Proposed Action and Alternative A and proportionally less impact to paleontology resources could occur.

4.2.4.4 Alternative C (No Action – 100 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to fossil resources as a result of implementation of Alternative C, are similar to those discussed above for the Proposed Action. Alternative C, however, includes a provision for drilling up to 100 wells and building less associated infrastructure than the Proposed Action, Alternative A or Alternative B. As a result, the surface area affected by disturbance for Alternative B would be less than for the Proposed Action and Alternative A and proportionally less impact to fossil resources would occur.

4.2.4.5 Impacts Summary

The Proposed Action, Alternative A, Alternative B and Alternative C could result in direct and indirect impacts to fossil resources caused by surface disturbance, especially where disturbances will affect the Wind River Formation, a formation known to have a high potential to contain fossils of scientific importance (BLM Paleontology Condition 1, Paleontology Class 5). Increased surface disturbance under Alternative A could result in potentially more impact (both adverse and beneficial) to fossil resources over the Proposed Action, dependent upon where individual wells and associated facilities are sited and where rights-of-way are located. Likewise, decreased surface disturbance under Alternative B and even less under Alternative C could result in potentially less impact to fossil resources.

With the appropriate pre-disturbance surveys required for the Wind River Formation, a high probability occurrence areas for paleontology resources (Paleontology Condition 1 and Paleontology Class 5 areas), the likelihood that significant fossil resources would be damaged or destroyed would be decreased.

4.2.4.5 Additional Mitigation Measures

No additional mitigation measures are required to protect mineral resources.

4.3 SOILS

4.3.1 Introduction

Impacts resulting from drill pad, access road, facility site, and pipeline right-of-way construction could include removal of vegetation, exposure of the soil, mixing of soil horizons, soil compaction, loss of topsoil productivity, and increased susceptibility of the soil (and underlying bedrock) erosion by wind and water.

Potential impacts to soils are similar for all alternatives, because all the alternatives involve the drilling of oil and gas wells and building of supporting infrastructure. The magnitude of the potential impacts will vary proportionally with the number of wells ultimately drilled under each alternative and the total amount of associated disturbance. Construction disturbance is greatest for Alternative A, less for the Proposed Action, and the least for Alternative B, and least for Alternative C. Cumulative post-reclamation disturbances are relatively low for all alternatives--Proposed Action (422.7 acres), Alternative A (611.9 acres), and Alternative B (325.1 acres), and Alternative C (79.3 acres) (See Appendix D).

The following criteria were used to determine the significance of impacts to soils within the WRPA:

- Non-compliance with existing Resource Management Plans.
- Increased soil erosion that cannot be reduced by 50 percent after one year and by 75 percent after five years of soil disturbance.
- Failure to have successful revegetation within three to five years of implementation.
- Reduction in soil productivity to a level that minimizes or prevents the disturbed area from recovering to pre-disturbance soil productivity levels.
- Location and construction of project facilities on sensitive soils (soils having one or more of the following characteristics: difficult reclamation potential, high erosion hazard, and slope gradients greater than 25 percent) without the use of special construction methods.

The magnitude of impacts to soils can be reduced by the implementation of the project-wide resource mitigation measures described in Section 2.7.2.12.

4.3.2 Proposed Action (325 wells) – Direct and Indirect Impacts

The Proposed Action could result in adverse direct impacts to soils including the removal of vegetation and exposure of the soil, with resultant soil compaction, loss of topsoil productivity, and increased susceptibility of the soil to erosion by wind and water. These impacts could indirectly increase runoff, erosion, and off-site sedimentation, as well as initiating gullying, subsidence, and other mass movement.

Characteristics of the six soil associations mapped in the WRPA are described in Section 3.3.2 and additional information on site-specific soils are provided in Appendix F. Details on the limitations of each soil association for urban and recreational usage based on their physical properties, are provided in detail by Young (1981, Tables 3 and 4).

Soil compaction caused by equipment traffic or by increased rain impact after loss of surface cover may decrease infiltration and water storage capacity, increase runoff, and reduce soil productivity. Increased surface runoff and erosion would occur primarily in the short term and would decline in time due to natural stabilization. Increases in surface runoff would also depend on the success of mitigation measures and success of reclamation.

Topsoil quality in the WRPA ranges from unsuitable to good, but is generally poor to fair. High contents of coarse fragments, sand, clay, shallow topsoil depths, and high alkalinity are the primary limitations to successful reclamation. Areas such as badlands have a very low reclamation potential because of high clay content and/or salinity concerns. In addition to these limitations, low annual precipitation and erosion by wind and water could make successful reclamation more difficult. Therefore, the overall potential for successfully stabilizing disturbed soils is poor to fair. Field reconnaissance and review of existing reclamation in the WRPA suggests that successful reclamation can be attained with aggressive reclamation measures and follow-up monitoring and remediation.

Increased soil susceptibility to erosion would be most likely to occur in newly disturbed areas, because, with the exception of along the major surface water drainages, field reconnaissance did not reveal any major areas where erosion is currently a serious problem. However, deep gullying was noted in Sections 6 and 7, T5N, R2E, where soils of the Pesayo-Oceanet Association, occur along the steeply sloping badlands adjoining Muddy Ridge. These soils are particularly subject to piping, subsidence, and gullying.

Erosion by wind would also be an adverse impact of project development given the dominant sandy texture of the soils in portions of the WRPA. Soil loss due to wind could add to the water erosion estimates. Chronic and severe erosion by wind could occur in limited areas where roads and/or pipelines traverse sandy soil areas. Because these areas are particularly susceptible to “blow outs,” special efforts to avoid such areas would be applied. Where avoidance is not feasible, special erosion control and soil stabilization measures would be applied as discussed in Appendix D and Section 2.7.2.12.

Given the potential importance of soil erosion, the Revised Universal Soil Loss Equation (RUSLE) was used to evaluate land management practices and the potential soil erosion (sheetwash and rill erosion only) in the WRPA, based on soil texture and average slope for three general conditions: (1) no management/bare, no disturbance; (2) rough/bare fresh disturbance; and (3) range grass, 4 years since last disturbance. Clay loam and sandy loam textured soils have the greatest potential soil loss to sheetwash and rill erosion on steeper slopes. In addition, rough/bare, fresh disturbance areas of each soil texture would yield the highest soil loss to sheetwash and rill erosion (see Appendix F).

Successful revegetation would reduce the potential for soil productivity loss. Soil erosion is likely to be the primary adverse impact of these project effects. Erosion can impede successful revegetation, result in a loss of site productivity, and impair water quality if eroded sediment is transported to surface water bodies.

Proposed project facilities would be constructed with surface runoff, erosion, and sedimentation controls in place that would reduce erosion rates. Control measures that could be utilized include the use of mulch, water bars, water turnouts, and effective revegetation. Applying control measures, and assuming a reasonable success rate of 60 percent for reclamation, erosion from newly disturbed areas could be reduced for drill sites, pipelines, and roads. Erosion would continue to decrease due to effective reclamation, natural stabilization, and maturing vegetative cover. By the fifth year after construction, erosion in reclaimed areas would likely be reduced substantially. Erosion reductions for well pads and roads would be less than reductions for pipeline corridors because exposed earth material that comprises the surface of these features would continue to be exposed to erosion. Soil erosion could be reduced to non-significant levels with application of aggressive reclamation following the control measures recommended in Appendix D and Section 2.7.2.12.

Of particular importance to potential soil impacts would be soils with shallow water tables and/or surface inundation. Bearing strengths in these soils is generally low and facilities placed in such areas could be subjected to damage. Placement of project facilities should avoid these areas. In order to preclude significant impacts, access roads, drilling/well sites, and pipelines should not be placed in areas with slopes greater than 25 percent or in areas with badland soils.

4.3.3 Alternative A (485 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to the soils as a result of implementation of Alternative A are the same as those discussed above for the Proposed Action. Alternative A, however, includes a provision for drilling an additional 160 wells and building the necessary infrastructure to support these wells. As a result surface disturbance during construction and post-reclamation surface disturbance area would be greater for Alternative A than the Proposed Action or Alternative B and a greater impact to soils could occur.

4.3.4 Alternative B (233 wells)– Direct and Indirect Impacts

Potential direct and indirect impacts to soils as a result of implementation of Alternative B are similar to those discussed above for the Proposed Action. Alternative B, however, includes a provision for drilling 92 fewer wells and building less associated infrastructure than the Proposed Action or Alternative A. As a result, surface disturbance during construction and cumulative post-reclamation disturbance would be less for Alternative B than for the Proposed Action and Alternative A and lesser impact to soils could occur.

4.3.5 Alternative C (No Action 100 wells) – Direct and Indirect Impacts

Potential direct and indirect impacts to soils as a result of implementation of Alternative C are similar to those discussed above for the Proposed Action. Alternative C, however, includes a provision for drilling up to 100 wells and building less associated infrastructure than the Proposed Action or Alternatives A and B. As a result, surface disturbance during construction and cumulative post-reclamation disturbance would be less for Alternative C than for the Proposed Action, and lesser impact to soils would occur.

4.3.6 Impact Summary

Implementation of the Proposed Action, Alternative A, Alternative B, and Alternative C involve the development of surface and subsurface facilities, and, as a result, has the potential for direct and indirect impacts to soils. These impacts include removal of vegetation, increased erosion, and increased soil compaction. However, the total area of residual disturbance is less than 0.46 percent of the total land area within the WRPA for the Proposed Action, 0.67 percent for Alternative A, 0.35 percent for Alternative B, and 0.09 percent for Alternative C. The residual disturbance by development area would be 1.11 percent (Proposed Action), 1.61% (Alternative A), 0.86% (Alternative B), and 0.67 (Alternative C) (see Table 2-3).

4.3.7 Additional Mitigation Measures

Mitigation measures are discussed in Section 2.7.2.12 and the reclamation methods, recommended in Appendix D for tribal or federal lands included in the Proposed Action, Alternative A, and Alternative B, would reduce potential direct and indirect impacts to soils. With these measures and additional measures proposed for vegetation, wetlands, and water resources, no additional mitigation measures for soils are recommended.

4.3.7 Residual Impacts

No residual impacts to soils, as a result of the Proposed Action, Alternative A, Alternative B, or Alternative C are anticipated.

4.4 AIR QUALITY

4.4.1 Introduction

As an unavoidable result of various Project-related activities, additional pollutants would be emitted to the atmosphere. Potential sources of emissions would include fugitive dust and vehicle exhaust from construction activities, exhaust from drill rig engines, and exhaust emissions related to well operations and gas compression. These project related emissions have the potential to affect air quality on both a local and a regional scale. The magnitude of the potential impacts would vary proportionally with the number of wells ultimately developed under each alternative. To assess potential air quality impacts, emission inventories were developed for the Proposed Action and alternatives. Potential emissions for the existing development within the Wind River Project Area (WRPA) and each of the alternatives are summarized in Table 4.4-1. Potential emissions for the Proposed Action and alternative are in addition to the emissions resulting from the existing development. Detailed documentation of the emission inventories is provided in a separate report: Emissions Inventory for the Wind River Natural Gas Field Development Project (Buys & Associates 2004).

Table 4.4-1. Summary of Potential Project Emissions.

Pollutant	Existing Development [178 Wells 14,550 hp] (tons/yr)	Proposed Action [325 Wells 32,800 hp] (tons/yr)	Proposed Action Post-Construction[1] [325 Wells 32,800 hp] (tons/yr)	Alternative A Increased Development [485 Wells 46,050 hp] (tons/yr)	Alternative B Reduced Development [233 Wells 22,700 hp] (tons/yr)	Alternative C No Action [100 Wells 3,200 hp] (tons/yr)
NO_X	546	518	338	664	414	45
CO	303	719	656	988	516	72
VOC	518	906	779	1,224	681	204
SO_X	0.04	3.2	0.04	3.4	3.2	0.18
PM_{10}	128	597	24	629	589	87
$PM_{2.5}$	19	113	24	127	106	16
Formaldehyde	4.4	22	22	31	15	2.2
Benzene	0.41	3.4	3.4	5.4	2.5	0.20
Toluene	0.65	1.3	1.2	1.7	0.93	0.18
Ethylbenzene	0.04	0.09	0.08	0.11	0.06	0.03
Xylenes	0.23	0.44	0.43	0.60	0.32	0.04
n-Hexane	2.7	2.6	2.5	3.6	2.1	0.26

[1] Proposed Action Post-Construction is shown as an example of the reduction of pollutant levels after completion of construction

4.4.1.1 Significance Criteria

In order to evaluate potential air quality impacts, a scale of measurement, or significance criteria, must be defined. Potential impacts to air quality that could result from the implementation of this project were compared to the following significance criteria:

- The most stringent Wyoming or national ambient air quality standards (WAAQS or NAAQS);
- Prevention of Significant Deterioration (PSD) Class I or Class II increments;
- Hazardous Air Pollutant (HAP) exposure thresholds for both acute and chronic exposures;
- A lifetime incremental cancer risk of one additional incident per million exposures;
- Incremental nitrogen (N) and sulfur (S) terrestrial Depositional Analysis Thresholds (DAT);
- Total nitrogen (N) and total sulfur (S) USFS designated “Green Line” and “Red Line” terrestrial deposition Levels of Concern (LOC);
- Lake Acid Neutralizing Capacity (ANC) Levels of Acceptable Change (LAC).
- Visibility impact LACs of 0.5 and 1.0 Δ dv (delta deciview or change in deciview).

Wyoming and National Air Quality Standards

Wyoming and National Ambient Air Quality Standards (WAAQS and NAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. Within tribal lands, the EPA has jurisdiction for environmental issues including air quality and therefore the NAAQS have precedence. Within Wyoming state lands, the WDEQ-AQD has jurisdiction for air quality issues and the WAAQS have precedence. The WAAQS are as stringent, or in the case of SO_2 more stringent, than the NAAQS.

The Clean Air Act (CAA) established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Pollutants for which standards have been determined include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter ($PM_{2.5}$). The applicable ambient air quality standards are summarized in Table 4.4-2. It should be noted that the recently promulgated standards for $PM_{2.5}$ and ozone (8-hour) will not be enforced by the Wyoming Department of Environmental Quality (WDEQ) until the EPA issues implementation rules. Therefore, it is not appropriate to demonstrate compliance with these standards at this time.

Table 4.4-2. Wyoming and National Ambient Air Quality Standards.

Pollutant And Averaging Time	Wyoming Ambient Air Quality Standard ($\mu g/m^3$)	National Ambient Air Quality Standard ($\mu g/m^3$)
Carbon Monoxide (CO)		
1-hour	40,000	40,000
8-hour	10,000	10,000
Nitrogen Dioxide (NO_2)		
Annual	100	100
Ozone (O_3)		
1-hour	235	235
8-hour	157	157
Particulate Matter (PM_{10})		
24-hour	150	150
Annual	50	50
Particulate Matter ($PM_{2.5}$)		
24-hour	65	65
Annual	15	15
Sulfur Dioxide (SO_2)		
3-hour	1,300	1,300
24-hour	260	365
Annual	60	80

Note: The U. S. Supreme Court upheld the proposed 8-hour ozone and $PM_{2.5}$ standards on February 27, 2001. The State of Wyoming will not enforce compliance with these standards until an implementation rule is issued by the EPA (Cara Casten, WDEQ, personal communication, February 2004).

Prevention of Significant Deterioration Increments

Under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act (CAA), incremental increases of specific pollutant concentrations are limited above a legally defined baseline level. Many national parks and wilderness areas are designated as PSD Class I. The PSD program protects air quality within Class I areas by allowing only slight incremental increases in pollutant concentrations. Areas of the state not designated as PSD Class I are classified as Class II. For Class II areas, greater incremental increases in ambient pollutant concentrations are allowed. The PSD increments for both Class I and II areas are presented in Table 4.4-3.

Throughout this analysis all comparisons with PSD increments are intended only to evaluate a level of concern and do not represent a regulatory PSD increment consumption analysis. PSD Increment consumption analyses are applied to large industrial sources and are solely the responsibility of the State and the Environmental Protection Agency.

Table 4.4-3. Prevention of Significant Deterioration Class I and Class II Increments.

Pollutant and Averaging Time	PSD Class I Increment (μg/m³)	PSD Class II Increment (μg/m³)
Carbon Monoxide (CO)		
1-hour	n/a	n/a
8-hour	n/a	n/a
Nitrogen Dioxide (NO_2)		
Annual	2.5	25
Ozone (O_3)		
1-hour	n/a	n/a
8-hour	n/a	n/a
Particulate Matter (PM_{10})		
24-hour	8	30
Annual	4	17
Particulate Matter ($PM_{2.5}$)		
24-hour	n/a	n/a
Annual	n/a	n/a
Sulfur Dioxide (SO_2)		
3-hour	25	512
24-hour	5	91
Annual	2	20

Acute and Chronic HAP Exposure Thresholds

There are no applicable Federal or Wyoming ambient air quality standards for assessing potential HAP impacts to human health. Therefore, reference concentrations (RfC) for chronic inhalation exposures and Reference Exposure Levels (REL) for acute inhalation exposures are applied as significance criteria. RfCs represent an estimate of the continuous, i.e. annual average, inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without an appreciable risk of harmful effects. The REL is the acute (i.e. one hour average) concentration at or below which no adverse health effects are expected. Both the RfC and REL guideline values are for non-cancer effects. Reference Exposure levels and reference concentrations are shown in Table 4.4-4.

Table 4.4-4. Reference Exposure Levels and Reference Concentrations.

Hazardous Air Pollutant	Reference Exposure Level [REL 1-hr Average] (μg/m³)	Reference Concentration [3] [RfC Annual Average] (μg/m³)
Benzene	1,300[1]	30
Toluene	37,000[1]	400
Ethylbenzene	350,000[2]	1,000
Xylenes	22,000[1]	100
n-Hexane	390,000[2]	200
Formaldehyde	94[1]	9.8

1 EPA Air Toxics Database, Table 2 (EPA 2002)
2 Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
3 EPA Air Toxics Database, Table 1 (EPA 2003)

Incremental Cancer Risk

Traditional risk assessment methods can be applied to assess the incremental risk resulting from long term exposure to carcinogenic HAP emissions. The calculated risk for the most likely exposure (MLE) scenario can be compared to the significance criterion of one additional cancer incident per one million exposures (1 x 10^{-6}). Two carcinogenic HAPs typically associated with oil and gas operations are evaluated, benzene and formaldehyde. The chronic (annual) inhalation cancer risk factors applied for the analysis are listed Table 4.4-5.

Table 4.4-5. Carcinogenic Unit Risk Factors.

Hazardous Air Pollutant	Carcinogenic Unit Risk Factor [Annual Inhalation Exposure] ($1/\mu g/m^3$)
Benzene	7.8 x 10^{-6}
Formaldehyde	5.5 x 10^{-9}

EPA Air Toxics Database, Table 1 (EPA 2003)

Terrestrial Acid Deposition

Incremental project-level Deposition Analysis Thresholds (DATs) for Class I areas have been established jointly through the National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS). DATs are incremental amounts of deposition that trigger management concerns. However, deposition rates in excess of the DATs do not necessarily constitute an adverse impact to the environment. The DAT in western Class I areas, developed as a function of natural background deposition, has been set at 0.005 kg/ha/yr for nitrogen (N) and sulfur (S) species individually (National Park Service 2003).

Total terrestrial deposition levels of concern (LOC) have also been estimated for several Class I areas, including the Bridger Wilderness (Fox et al. 1989). Estimated total terrestrial deposition LOC include the “red line” (defined as the total deposition that the area can tolerate) and the “green line” (defined as the acceptable level of total deposition). Total deposition LOC for Bridger Wilderness include a “red line” set at 10 kg/ha/year for nitrogen and 20 kg/ha/year for sulfur, and a “green line” set at 3 to 5 kg/ha/year for nitrogen and 5 kg/ha/year for sulfur. Since Bridger Wilderness is the only area of special concern considered in this analysis that is also represented in the Fox et al. (1989) study, the Bridger Wilderness LOC were applied for all evaluated areas of special concern.

Aquatic Acid Deposition

For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a Level of accepted change (LAC) of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC.

Visibility Criteria

Potential visibility degradation can be evaluated in terms of the change in deciview or Δdv. There are no applicable federal, state, tribal, or local visibility standards. Therefore, predicted visibility impacts are compared to Levels of Acceptable Change (LAC) utilized by Federal Land Managers. A LAC threshold of a 10% change in the reference background extinction or 1.0 Δdv is utilized. Comparisons to a LAC threshold of 0.5 Δdv were also computed and are presented separately in the Far-Field report included in the technical Support Document (Buys & Associates, Inc., 2004b).

4.4.1.2 Distance Scales Utilized for Assessment

Potential impacts to air quality were assessed on two scales: near-field and far-field. The near field assessment analyzed potential impacts that could occur within, and 30 miles (50 km) beyond, the boundaries of the WRPA. The far-field analysis analyzed potential impacts for 13 areas of special concern located between 12 miles and 170 miles (20 to 270 km) from the WRPA. Both the near- and far-field analyses were conducted in accordance with an air quality assessment protocol specifically prepared for the project. The analysis protocol was refined though input received from regulatory agencies and stakeholders including the Bureau of Indian Affairs (BIA), the Wind River Environmental Quality Council (WREQC), the Environmental Protection Agency (EPA) Region VIII, the Bureau of Land Management (BLM), the National Park Service (NPS), the U.S. Forest Service (USFS), and the Wyoming Department of Environmental Quality (WDEQ).

4.4.2 Near-Field Air Quality

The near-field analysis (Buys & Associates 2004a) considered potential impacts to air quality that may occur within 30 miles (50 km) of the WRPA. The analysis considered short-term activities such as well pad and road construction, well drilling, and well completion activities that would not only be geographically separated, but would generally not occur simultaneously. A reasonable emissions scenario was developed for each short-term activity that reflected potential air quality impacts with the assumption that other activities potentially occurring at the same time would be separated spatially. The near-field analysis also assessed impacts from long-term activities including production operations and natural gas treatment and compression.

4.4.2.1 Proposed Action (325 Wells) – Direct and Indirect Impacts

<u>**Proposed Action - Potential Particulate Matter Impacts**</u>

Particulate matter emissions would be generated primarily during the construction and development phases of the Project as a result of earth-moving activities and vehicle traffic on unpaved roads. Predicted PM_{10} impacts that could result during the construction and development phases are summarized in Table 4.4-6. In all cases the maximum impacts were predicted to occur 200 meters (650 feet) from the well access roads. The results indicate that the greatest fugitive dust concentrations would occur during the construction of well pads and roads. However, these impacts would be short-term at any one location since construction activities would typically last between two to four days. Potential PM_{10} impacts resulting from drilling and completion activities would persist for longer periods of time, from 12 to 90 days at any one location. As summarized below, predicted PM_{10} impacts would be below the ambient air quality standards.

Table 4.4-6. Proposed Action – Near-Field Particulate Matter Impacts.

Pollutant and Averaging Time	Construction Activity	Maximum Predicted Impact ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Background Plus Impact ($\mu g/m^3$)	WAAQS/ NAAQS Standard ($\mu g/m^3$)	Impact Percentage of WAAQS/ NAAQS
PM_{10} 24-hour Average	Well Pad and Road Construction	81.0	61	142.0	150	95%
	Well Drilling Activities	7.3	61	68.3	150	46%
	Well Completion Activities	48.2	61	109.2	150	73%
PM_{10} Annual Average	Well Pad and Road Construction	11.0	22	33.0	50	66%
	Well Drilling Activities	1.0	22	23.0	50	46%
	Well Completion Activities	6.0	22	28.0	50	56%

Proposed Action – Potential Nitrogen Dioxide and Carbon Monoxide Impacts

Nitrogen dioxide and carbon monoxide emissions would be generated primarily from the following emissions sources:

- New compressor stations;
- Expansion of existing compressor stations;
- Existing compressor stations;
- Separators heaters located at well pads;
- Drill rigs engines, and
- Other small sources including treatment equipment at compressor stations and vehicle emissions.

Maximum predicted NO_2, CO and SO_2 concentrations that could occur as a result of the implementation of the Proposed Action are summarized and compared with the most stringent Wyoming and National ambient air quality standards and the PSD Class II increments in Tables 4.4-7 and 4.4-8. As demonstrated below, potential increases in pollutant concentrations are predicted to occur at levels below the ambient standards and NO_2 concentrations would be less than the PSD Class II increment.

Table 4.4-7. Proposed Action - Near-Field NO_2, and CO Impact Comparison to Ambient Standards.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Maximum Impact Location (UTM)	Background Concentration ($\mu g/m^3$)	Background Plus Impact ($\mu g/m^3$)	WAAQS NAAQS Standard ($\mu g/m^3$)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	12.1	Sand Mesa Field 716,023 mE 4,798,063 mN	3.4	15.5	100	16%
CO	1-hour	1,553	Muddy Ridge Field 697,929 mE 4,795,013 mN	3,336	4,889	40,000	12%
	8-hour	497	Sand Mesa Field 716,040 mE 4,798,071 mN	1,381	1,878	10,000	19%

Table 4.4-8. Proposed Action – Near-Field NO_2 Impact Comparison to PSD Class II Increment.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	PSD Class II Increment	Impact Percentage of PSD Increment
NO_2	Annual	12.1	25	48%

__Proposed Action – Potential Sulfur Dioxide Impacts__

Sulfur dioxide emissions would be emitted primarily from drill rig engines as a result of the consumption of diesel fuel. Minor amounts of SO_2 would also be emitted from diesel vehicles traveling to and from the well site. Tables 4.4-9 and 4.4-10 summarize the potential SO_2 impacts and compare the results with the ambient air quality standards and PSD increments. As presented in the tables, potential SO_2 impacts are predicted to be less than the applicable ambient standards and PSD increments.

Table 4.4-9. Proposed Action - Near-Field SO_2 Impact Comparison to Ambient Standards.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Maximum Impact Location (meters)	Background Concentration ($\mu g/m^3$)	Background Plus Impact ($\mu g/m^3$)	WAAQS NAAQS Standard ($\mu g/m^3$)	Impact Percentage of WAAQS/ NAAQS
SO_2	3-hour	4.4	500 meters from drill rig	132	136	1,300	11%
	24-hour	1.8	400 meters from drill rig	43	45	260	17%
	Annual	0.2	350 meters from drill rig	9	9.2	60	15%

Table 4.4-10. Proposed Action – Near-Field SO_2 Impact Comparison to PSD Class II Increments.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m³)	PSD Class II Increment	Impact Percentage of PSD Increment
SO_2	3-hour	4.4	512	Less than 1%
	24-hour	1.8	91	2 %
	Annual	0.2	20	1 %

<u>Proposed Action – Potential Ozone Impacts</u>

Ground-level ozone is formed through the chemical reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. A simplified screening tool, the Reactive Plume Model (RPM II), which was developed by EPA (Scheffe, 1988) was applied to estimate potential ozone impacts. The Scheffe methodology uses predicted VOC and NO_X emissions to provide a conservative estimate of ozone impacts. Potential increases in ozone concentrations that may occur should the Proposed Action be implemented are estimated at 50 μg/m³. The predicted ozone concentrations are less than the ambient air quality standard as shown in Table 4.4-11.

Table 4.4-11. Proposed Action – Near-Field Predicted Ozone Impacts.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m³)	Background Concentration (μg/m³)	Background Plus Impact (μg/m³)	WAAQS NAAQS Standard (μg/m³)	Impact Percentage of WAAQS/ NAAQS
O_3	1-hour	50	169	219	235	93%

<u>Proposed Action – Potential Hazardous Air Pollutant Impacts</u>

The dominant sources of HAP emissions resulting from the implementation of the Proposed Action would be compressor engine exhaust (formaldehyde) and central dehydrator still vents (benzene, toluene, ethylbenzene, xylenes and n-hexane). Predicted maximum HAP concentrations that could occur if the Proposed Action were approved, are summarized in Table 4.4-12. All maximum HAP concentrations are predicted to occur at the fencelines of the central compression and treatment facilities. To assess acute health effects, maximum one-hour average concentrations are compared to the HAP-specific REL (reference exposure level). Chronic health effects are assessed by comparing the maximum predicted annual average concentrations to the HAP-specific RfC (reference concentration for continuous inhalation exposure). As summarized in Table 4.4-12, maximum acute and chronic HAP concentrations are not predicted to exceed the RELs or RfCs. Therefore, no adverse non-carcinogenic human health effects would be expected should the Proposed Action be implemented.

Table 4.4-12. Proposed Action – Near-Field Non-Carcinogenic RELs and RfCs Comparisons.

Hazardous Air Pollutant	Predicted Maximum 1-Hour Impact (μg/m³)	REL (μg/m³)	Impact Percentage of REL	Predicted Maximum Annual Impact (μg/m³)	RfC[3] (μg/m³)	Impact Percentage of RfC
Benzene	159	1,300[1]	12%	3.1	30	10%
Toluene	0.96	37,000[1]	Less Than 1%	0.03	400	Less Than 1%
Ethylbenzene	0.03	350,000[2]	Less Than 1%	0.001	1,000	Less Than 1%
Xylenes	0.34	22,000[1]	Less Than 1%	0.01	100	Less Than 1%
n-Hexane	7.6	390,000[2]	Less Than 1%	0.20	200	Less Than 1%
Formaldehyde	32	94[1]	34%	0.71	9.8	7%

[1] EPA Air Toxics Database, Table 2 (EPA, 2002)
[2] Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
[3] EPA Air Toxics Database, Table 1 (EPA, 2003)

Benzene and formaldehyde are classified as known carcinogens. The incremental cancer risk for these two carcinogens can be estimated by applying traditional risk assessment methodologies. Cancer risk was estimated for two exposure scenarios: the most likely exposure (MLE) corresponding to a resident that lives an average of 20 years at a particular location within the WRPA, and a maximally exposed individual (MEI) corresponding to an individual that may be exposed for the entire life of the project (assumed as 40 years). The calculated incremental cancer risks were based on the maximum annual concentrations predicted to occur one-quarter mile (400 meters) from a compressor station and 300 feet (100 meters) from a well pad. These construction offsets represent the minimum distance that would be allowed between Project facilities and occupied residences.

The potential incremental cancer risks that may occur should the Proposed Action be approved are summarized in Table 4.4-13. As indicated, predicted incremental cancer risks are near or equal to the one incident per million exposures threshold. However, actual incremental cancer risks resulting from Proposed Action would be less than calculated if individuals were not continuously exposed to the maximum predicted concentrations for the duration of the assumed exposure scenarios. Predicted HAP concentrations decrease rapidly with distance and can vary dramatically within several hundred feet. Therefore it is unlikely that individuals would be constantly exposed to maximum HAP concentrations for periods of 20 to 40 years. Thus actual incremental cancer risks resulting from the implementation of the Proposed Action would most probably be less than predicted.

Table 4.4-13. Proposed Action – Near-Field Incremental Cancer Risks.

Hazardous Air Pollutant	Maximum Predicted Annual Concentration (μg/m^3)	Exposure Scenario	Incremental Cancer Risk (Incidents per Million Exposures)
Benzene	0.3	Most Likely Exposure	0.7 per million or 7 per ten million
		Maximally Exposed Individual	1 per million
Formaldehyde	0.2	Most Likely Exposure	0.0003 per million or 3 per ten billion
		Maximally Exposed Individual	0.0006 per million or 6 per ten billion

4.4.2.2 Alternative A (485 wells) – Direct and Indirect Impacts

Alternative A – Potential Particulate Matter Impacts

The annual development rate of Alternative A and the Proposed Action are nearly identical at 39 and 38 wells per year respectively. Therefore, potential short-term PM_{10} emission rates and associated ambient air quality impacts resulting from the implementation of Alternative A would be similar to the impacts predicted for the Proposed Action. PM_{10} impacts resulting from the implementation of Alternative A are not predicted to exceed the ambient air quality standards.

Alternative A – Potential Nitrogen Dioxide and Carbon Monoxide Impacts

Maximum predicted NO_2 and CO concentrations that could occur as a result of the implementation of Alternative A are summarized and compared with the most stringent Wyoming and National ambient air quality standards and the PSD Class II increments in Tables 4.4-14 and 4.4-15. As shown, predicted impacts that would result from Alternative A would be slightly greater than the impacts predicted for the Proposed Action. However, increases in pollutant concentrations would still occur at levels below the ambient standards and PSD Class II increments.

Table 4.4-14. Alternative A – Near-Field NO_2 and CO Impact Comparison to Ambient Standards.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m^3)	Maximum Impact Location (UTM)	Background Concentration (µg/m^3)	Background Plus Impact (µg/m^3)	WAAQS NAAQS Standard (µg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	16.5	Sand Mesa Field 716,023 mE 4,798,063 mN	3.4	19.9	100	20%
CO	1-hour	2,174	Muddy Ridge Field 697,929 mE 4,795,013 mN	3,336	5,510	40,000	14%
	8-hour	695	Sand Mesa Field 716,040 mE 4,798,071 mN	1,381	2,076	10,000	20%

Table 4.4-15. Alternative A – Near-Field NO_2 Impact Comparison to PSD Class II Increment.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m^3)	PSD Class II Increment	Impact Percentage of PSD Increment
NO_2	Annual	16.5	25	66%

<u>Alternative A – Potential Sulfur Dioxide Impacts</u>

The annual development rate of Alternative A and the Proposed Action are nearly identical at 39 and 38 wells per year respectively. Therefore, potential SO_2 impacts resulting from the implementation of Alternative A would be approximately the same as the impacts that would occur with the Proposed Action. SO_2 impacts resulting from the implementation of Alternative A are not predicted to exceed the ambient air quality standards.

<u>Alternative A – Potential Ozone Impacts</u>

Potential increases in ozone concentrations that may occur should Alternative A be implemented are estimated at 58 µg/m^3. The predicted ozone concentrations would be less than the ambient air quality standard as shown in Table 4.4-16.

Table 4.4-16. Alternative A – Near-Field Predicted Ozone Impacts.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m^3)	Background Concentration (µg/m^3)	Background Plus Impact (µg/m^3)	WAAQS NAAQS Standard (µg/m^3)	Impact Percentage of WAAQS/ NAAQS
O_3	1-hour	58	169	227	235	97%

Alternative A – Potential Hazardous Air Pollutant Impacts

The HAP concentrations that could occur if Alternative A were approved are summarized in Table 4.4-17. All maximum HAP concentrations are predicted to occur at the fence line of the central compression and treatment facilities. To assess acute health effects, maximum one-hour average concentrations are compared to the HAP-specific REL (reference exposure level). Chronic health effects are assessed by comparing the maximum predicted annual average concentrations to the HAP-specific RfC (reference concentration for continuous inhalation exposure). As summarized in Table 4.4-17, maximum acute and chronic HAP concentrations are not predicted to exceed the RELs or RfCs. Therefore, no adverse non-carcinogenic human health effects would be expected should Alternative A be implemented.

Table 4.4-17. Alternative A – Near-Field Non-Carcinogenic Acute RELs and RfCs.

Hazardous Air Pollutant	Predicted Maximum 1-Hour Impact (μg/m^3)	REL (μg/m^3)	Impact Percentage of REL	Predicted Maximum Annual Impact (μg/m^3)	RfC[3] (μg/m^3)	Impact Percentage of RfC
Benzene	300	1,300[1]	23%	5.8	30	19.3%
Toluene	0.97	37,000[1]	Less Than 1%	0.03	400	Less Than 1%
Ethylbenzene	0.04	350,000[2]	Less Than 1%	0.002	1,000	Less Than 1%
Xylenes	0.36	22,000[1]	Less Than 1%	0.02	100	Less Than 1%
n-Hexane	7.67	390,000[2]	Less Than 1%	0.22	200	Less Than 1%
Formaldehyde	44.7	94[1]	34%	0.99	9.8	10.1%

[1] EPA Air Toxics Database, Table 2 (EPA, 2002)
[2] Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
[3] EPA Air Toxics Database, Table 1 (EPA, 2003)

The potential incremental cancer risks that may occur should Alternative A be approved are summarized in Table 4.4-18. As indicated, predicted formaldehyde incremental cancer risks are less than, or equal to, the one incident per million exposures threshold. However, predicted benzene incremental cancer risks range from 1 to 2 incidents per million exposures. Actual incremental cancer risks resulting from Alternative A would be less than predicted if the public were not continuously exposed to the maximum predicted concentrations for the duration of the assumed exposure scenarios. Predicted HAP concentrations decrease rapidly with distance and can vary dramatically within several hundred feet. Therefore it is unlikely that individuals would be constantly exposed to maximum HAP concentrations for periods of 20 to 40 years.

Table 4.4-18. Alternative A – Near-Field Incremental Cancer Risks.

Hazardous Air Pollutant	Maximum Predicted Annual Concentration (µg/m^3)	Exposure Scenario	Incremental Cancer Risk (Incidents per Million Exposures)
Benzene	0.5	Most Likely Exposure	1 per million
		Maximally Exposed Individual	2 per million
Formaldehyde	0.4	Most Likely Exposure	0.0006 per million or 6 per ten billion
		Maximally Exposed Individual	0.001 per million or 1 per billion

4.4.2.2 Alternative B (233 wells) – Direct and Indirect Impacts

Alternative B – Potential Particulate Matter Impacts

The annual development rate of Alternative B and the Proposed Action are identical at 38 wells per year. Therefore, potential short-term PM_{10} emission rates and associated ambient air quality impacts for the Proposed Action and Alternative B would also be identical. PM_{10} impacts resulting from the implementation of Alternative B are not predicted to exceed the ambient air quality standards

Alternative B – Potential Nitrogen Dioxide and Carbon Monoxide Impacts

Maximum predicted NO_2 and CO concentrations that could occur as a result of the implementation of Alternative B are summarized and compared with the most stringent Wyoming and National ambient air quality standards and the PSD Class II increments in Tables 4.4-19 and 4.4-20. As shown, predicted impacts for Alternative B would be slightly less than the impacts predicted for the Proposed Action. With the implementation of Alternative B, increases in pollutant concentrations are predicted to occur at levels below the ambient standards and PSD Class II increments.

Table 4.4-19. Alternative B – Near-Field NO_2 and CO Impact Comparison to Ambient Standards.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Maximum Impact Location (UTM)	Background Concentration ($\mu g/m^3$)	Background Plus Impact ($\mu g/m^3$)	WAAQS NAAQS Standard ($\mu g/m^3$)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	9.7	Muddy Ridge Field 695,590 mE 4,802,571 mN	3.4	13.1	100	13%
CO	1-hour	1,070	Muddy Ridge Field 697,929 mE 4,795,013 mN	3,336	4,406	40,000	11%
	8-hour	344	Pavillion Field 699,471 mE 4,792,137 mN	1,381	1,725	10,000	17%

Table 4.4-20. Alternative B – Near-Field NO_2 Impact Comparison to PSD Class II Increment.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	PSD Class II Increment	Impact Percentage of PSD Increment
NO_2	Annual	9.7	25	39%

Alternative B – Potential Sulfur Dioxide Impacts

The annual development rate of Alternative B and the Proposed Action are identical at 38 wells per year. Potential SO_2 impacts resulting from the implementation of Alternative A would be identical to the impacts that would result from the Proposed Action. SO_2 impacts resulting from the implementation of Alternative B are not predicted to exceed the ambient air quality standards.

Alternative B – Potential Ozone Impacts

Potential increases in ozone concentrations that may occur should Alternative B be implemented are estimated at 43 $\mu g/m^3$. The predicted ozone concentrations would be less than the ambient air quality standard as shown in Table 4.4-21.

Table 4.4-21. Alternative B – Near-Field Predicted Ozone Impacts.

Pollutant	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Background Plus Impact ($\mu g/m^3$)	WAAQS NAAQS Standard ($\mu g/m^3$)	Impact Percentage of WAAQS/ NAAQS
O_3	1-hour	43	169	212	235	90%

Alternative B – Potential Hazardous Air Pollutant Impacts

The HAP concentrations that could occur if Alternative B were approved are summarized in Table 4.4-22. All maximum HAP concentrations are predicted to occur at the fence line of the central compression and treatment facilities. As summarized in Table 4.4-22, maximum acute and chronic HAP concentrations are not predicted to exceed the RELs or RfCs. Therefore, no adverse non-carcinogenic human health effects would be expected should Alternative B be implemented.

Table 4.4-22. Alternative B – Near-Field Non-Carcinogenic Acute RELs and RfCs.

Hazardous Air Pollutant	Predicted Maximum 1-Hour Impact (µg/m³)	REL (µg/m³)	Impact Percentage of REL	Predicted Maximum Annual Impact (µg/m³)	RfC[3] (µg/m³)	Impact Percentage of RfC
Benzene	127	1,300[1]	9.7%	2.5	30	8.2%
Toluene	0.96	37,000[1]	Less Than1%	0.03	400	Less Than 1%
Ethylbenzene	0.04	350,000[2]	Less Than1%	0.001	1,000	Less Than 1%
Xylenes	0.36	22,000[1]	Less Than1%	0.01	100	Less Than 1%
n-Hexane	6.1	390,000[2]	Less Than1%	0.18	200	Less Than 1%
Formaldehyde	22	94[1]	24%	0.49	9.8	5.0%

[1] EPA Air Toxics Database, Table 2 (EPA, 2002)
[2] Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
[3] EPA Air Toxics Database, Table 1 (EPA, 2003)

The potential incremental cancer risks that may occur should Alternative B be approved are summarized in Table 4.4-23. As indicated, predicted incremental cancer risks are less than the one incident per million exposure threshold.

Table 4.4-23. Alternative B – Near-Field Incremental Cancer Risks.

Hazardous Air Pollutant	Maximum Predicted Annual Concentration (µg/m³)	Exposure Scenario	Incremental Cancer Risk (Incidents per Million Exposures)
Benzene	0.2	Most Likely Exposure	0.4 per million or 4 per ten million
		Maximally Exposed Individual	0.9 per million or 9 per ten million
Formaldehyde	0.2	Most Likely Exposure	0.0003 per million or 3 per ten billion
		Maximally Exposed Individual	0.006 per million or 6 per ten billion

4.4.2.4 Alternative C (No Action), 100 wells) – Direct and Indirect Impacts

Alternative C – Potential Particulate Matter Impacts

The annual development rate of Alternative C is estimated at 14 wells per year, significantly less than the 38 wells per year projected for the Proposed Action. Short term (24 hour average) PM_{10} emissions resulting from Alternative C would be similar to the impacts predicted for the Proposed Action. However, long term (annual average) PM_{10} impacts would be proportionally less than the Proposed Action. With the implementation of Alternative C, PM_{10} impacts would be localized near the construction activities occurring within the Pavillion area.

Alternative C – Potential Nitrogen Dioxide and Carbon Monoxide Impacts

Maximum predicted NO_2 and CO concentrations that could occur as a result of the implementation of Alternative C are summarized and compared with the most stringent Wyoming and National ambient air quality standards and the PSD Class II increments in Tables 4.4-24 and 4.4-25. With the implementation of Alternative C, potential NO_2 and CO impacts would be minimized. Increases in pollutant concentrations are predicted to occur at levels below the ambient standards and PSD Class II increments.

Table 4.4-24. Alternative C – Near-Field NO_2 and CO Impact Comparison to Ambient Standards.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location (UTM)	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	5.3	Pavillion Field 696,646 mE 4,790,590 mN	3.4	8.7	100	9%
CO	1-hour	312	Pavillion Field 696,646 mE 4,790,590 mN	3,336	3,648	40,000	9%
	8-hour	119	Pavillion Field 696,640 mE 4,790,512 mN	1,381	1,500	10,000	15%

Table 4.4-25. Alternative C – Near-Field NO_2 Impact Comparison to PSD Class II Increment.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m^3)	PSD Class II Increment	Impact Percentage of PSD Increment
NO_2	Annual	5.3	25	21%

Alternative C – Potential Sulfur Dioxide Impacts

The annual development rate of Alternative C is estimated at 14 wells per year, significantly less than the 38 wells per year projected for the Proposed Action. Short term (3-hr and 24-hr average) SO_2 impacts would be similar to the short term impacts that would occur with the implementation of the Proposed Action. However, long term (annual average) SO_2 impacts resulting from Alternative C would be proportionally less than the Proposed Action and would occur only within the Pavillion field.

Alternative C – Potential Ozone Impacts

Potential increases in ozone concentrations that may occur should Alternative C be implemented are estimated at 31 µg/m^3. The predicted ozone concentrations would be less than the ambient air quality standard as shown in Table 4.4-26.

Table 4.4-26. Alternative C – Near-Field Predicted Ozone Impacts.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m^3)	Background Concentration (µg/m^3)	Background Plus Impact (µg/m^3)	WAAQS NAAQS Standard (µg/m^3)	Impact Percentage of WAAQS/ NAAQS
O_3	1-hour	31	169	200	235	85%

Alternative C – Potential Hazardous Air Pollutant Impacts

The HAP concentrations that could occur if Alternative C were implemented are summarized in Table 4.4-27. All maximum HAP concentrations are predicted to occur at the fence line of the central compression and treatment facilities. As summarized, in Table 4.4-27, maximum acute and chronic HAP concentrations are not predicted to exceed the RELs or RfCs. Therefore, no adverse non-carcinogenic human health effects would be expected should Alternative C be implemented.

Table 4.4-27. Alternative C – Near-Field Non-Carcinogenic Acute RELs and RfCs.

Hazardous Air Pollutant	Predicted Maximum 1-Hour Impact (µg/m^3)	REL (µg/m^3)	Impact Percentage of REL	Predicted Maximum Annual Impact (µg/m^3)	RfC[3] (µg/m^3)	Impact Percentage of RfC
Benzene	0.64	1,300[1]	Less Than 1%	0.22	30	Less Than 1%
Toluene	0.96	37,000[1]	Less Than 1%	0.02	400	Less Than 1%
Ethylbenzene	0.03	350,000[2]	Less Than 1%	0.0009	1,000	Less Than 1%
Xylenes	0.36	22,000[1]	Less Than 1%	0.01	100	Less Than 1%
n-Hexane	3.6	390,000[2]	Less Than 1%	0.08	200	Less Than 1%
Formaldehyde	6.5	94[1]	6.9%	0.15	9.8	1.5%

[1] EPA Air Toxics Database, Table 2 (EPA, 2002)
[2] Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
[3] EPA Air Toxics Database, Table 1 (EPA, 2003)

The potential incremental cancer risks that may occur should Alternative C be approved are summarized in Table 4.4-28. As indicated, predicted incremental cancer risks are less than the one incident per million exposure threshold.

Table 4.4-28. Alternative C – Near-Field Incremental Cancer Risks.

Hazardous Air Pollutant	Maximum Predicted Annual Concentration (µg/m^3)	Exposure Scenario	Incremental Cancer Risk (Incidents per Million Exposures)
Benzene	0.02	Most Likely Exposure	0.04 per million or 4 per hundred million
		Maximally Exposed Individual	0.09 per million or 9 per hundred million
Formaldehyde	0.05	Most Likely Exposure	0.00008 per million or 8 per hundred billion
		Maximally Exposed Individual	0.0002 per million or 2 per ten billion

4.4.2.5 Summary of Near-Field Impacts

As a result of the implementation of the Proposed Action or Alternatives, increases in air pollutant concentrations would occur. For the majority of the emitted pollutants, the magnitude of the potential impacts would vary in proportion with the scale of the alternative. The greatest impacts would occur with the implementation of Alternative A. Proportionally lower impacts would occur with the implementation of the Proposed Action or Alternative B. Air quality impacts would be minimized with the implementation of Alternative C.

Potential Particulate Matter Impacts

The Proposed Action and Alternatives would cause minor increases in particulate matter concentrations. The impacts would be short term, occurring primarily during the development phase of the project as a result of construction activities and increased vehicle traffic on unpaved roads. Particulate matter impacts would be essentially equivalent for all project alternatives and are not predicted to exceed the ambient air quality standards. With the implementation of the Proposed Action, or Alternatives A and B, increases in PM_{10} concentrations would occur in all five development areas; Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South and Coastal Extension. However, with the implementation of Alternative C, PM_{10} impacts would occur primarily within the Pavillion development area only.

Potential Nitrogen Dioxide, Carbon Monoxide and Ozone Impacts

Project activities would result in minor increases in pollutant concentrations. The impacts would be long-term, lasting the duration of the project. Maximum NO_2, CO and O_3 impacts would occur with the implementation of Alternative A. Impacts resulting from the Proposed Action and Alternative B and C would be proportionally less. Resulting increases in NO_2, CO and O_3 concentrations would not exceed the applicable ambient air quality standards or PSD Class II increments. Table 4.4-29 summarizes the predicted NO_2, CO and O_3 impacts for each alternative.

Table 4.4-29. Summary of Predicted Near-Field NO_2 and CO Impacts.

Alternative	Maximum NO_2 Annual Average Impact (μg/m^3)	Maximum CO 1-hour Average Impact (μg/m^3)	Maximum CO 8-hour Average Impact (μg/m^3)	Maximum O_3 1-hour Average Impact (μg/m^3)
Proposed Action	12.1	1,553	497	50
Alternative A	16.5	2,174	695	58
Alternative B	9.7	1,070	344	43
Alternative C	5.3	312	119	31

Potential Sulfur Dioxide Impacts

The Proposed Action and Alternatives would cause minor increases in SO_2 concentrations. The impacts would be localized and short term, resulting primarily from drilling operation. Sulfur dioxide impacts would be essentially equivalent for all project alternatives and are not predicted to exceed the ambient air quality standards. With the implementation of the Proposed Action, or Alternatives A and B, increases in SO_2 concentrations would occur in all five development areas; Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South and Coastal Extension. However, with the implementation of Alternative C, SO_2 impacts would occur primarily within the Pavillion development area only.

Potential Hazardous Air Pollutant Impacts

Implementation of the Proposed Action or Alternatives would cause incremental increases in hazardous air pollutant concentrations. The increased concentration would be long term, lasting the life of the project. Maximum HAP impacts would occur with the implementation of Alternative A. Impacts resulting from the Proposed Action and Alternatives B and C would be proportionally less. For all Project alternatives, the acute and chronic non-cancerous health effects would be negligible, as predicted concentrations would be less than the REL and RfC thresholds. With the implementation of the Proposed Action or Alternative A, minor increases in cancer risk are predicted to occur. The predicted incremental cancer risks would range from 1 to 2 incidents per million exposures. However, the predicted incremental cancer risks would occur only within relatively small areas. Should Alternatives B or C be implemented, the incremental cancer risk would be negligible.

4.4.3 Far-Field Air Quality

The far-field air quality analysis focused upon project related and cumulative impacts that could occur within areas of special concern (i.e., Federal designated Class I areas and areas identified as important to the Tribes and the USFS). Figure 4.4-1 and Table 4.4-30 present the areas of special concern and the associated high elevation lakes evaluated for the Far-Field analysis. The Absaroka Beartooth Wilderness was omitted from the far-field analysis due to its great distance from the project area. However, at the request of the Forest Service, two lakes within the Absaroka Beartooth Wilderness were analyzed for impacts; Stepping Stone Lake and Twin Island Lake.

Table 4.4-30. Areas of Special Concern.

Area of Special Concern	PSD Classification	Analyzed Lakes of Special Concern	Land Management Agency
Bridger Wilderness	Class I	Black Joe Lake Deep Lake Hobbs Lake Upper Frozen Lake	Forest Service
Cloud Peak Wilderness	Class II	Emerald Lake Florence Lake	Forest Service
Fitzpatrick Wilderness	Class I	Ross Lake	Forest Service
Grand Teton National Park	Class I	None	National Park Service
North Absaroka Wilderness	Class I	None	Forest Service
Owl Creek Range	Class II	None	BIA / Tribes
Popo Agie Wilderness	Class II	Lower Saddlebag Lake	BIA / Tribes
Phlox Mountain	Class II	None	BIA / Tribes
Teton Wilderness	Class I	None	Forest Service
Washakie Wilderness	Class I	None	Forest Service
Wind River Canyon	Class II	None	BIA / Tribes
Wind River Roadless Area	Class II	None	BIA / Tribes
Yellowstone National Park	Class I	None	National Park Service

To assess potential far-field impacts, the CALPUFF set of dispersion models were applied. The CALPUFF set of models (CALMET, CALPUFF, CALPOST, and associated utilities) were designed specifically to assess ambient air quality impacts at significant distances from the source and therefore long pollutant travel times. The predicted pollutant concentrations were compared to the most stringent of the State of Wyoming and National Air Quality Standards (WAAQS, NAAQS) and (for informational purposes only) to the Prevention of Significant Deterioration (PSD) Class I and II increments). For simplicity, all far-field predicted impacts were compared to the more stringent Class I increments, regardless of the location of the impact and actual PSD Class designation. In addition, the predicted concentration and deposition results were processed to evaluate potential visibility and acid deposition impacts for comparison with the Federal Land Manager (FLM) Limits of Acceptable Change (LAC).

Throughout this analysis, all comparisons with PSD increments are intended only to evaluate a level of concern and do not represent a regulatory PSD increment consumption analysis. PSD Increment consumption analyses are applied to large industrial sources and are solely the responsibility of the State and the Environmental Protection Agency.

Figure 4.4-1.

4.4.3.1 Proposed Action (325 wells) - Direct and Indirect Impacts

If the Proposed Action were approved, incremental increases in pollutant concentrations would occur. Potential impacts resulting from the implementation of the Proposed Action are discussed below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of the implementation of the Proposed Action are summarized in Table 4.4-31 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, increases in pollutant concentrations are predicted to occur at levels below the ambient standards.

Table 4.4-31. Proposed Action – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	0.21	Wind River Canyon	3.4	3.61	100	3.6%
SO_2	3-hour	0.05	Wind River Canyon	132	132.05	1300	10.2%
	24-hour	0.02	Wind River Canyon	43	43.02	260	16.6%
	Annual	0.00	Wind River Canyon	9	9.00	60	15.0%
PM_{10}	24-hour	1.51	Wind River Canyon	61	62.51	150	41.7%
	Annual	0.13	Wind River Canyon	22	22.13	50	44.3%

PSD Increments

The maximum predicted pollutant concentrations are compared with the PSD Class I Increments in Table 4.4-32. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 4.4-32. Proposed Action – Far-Field PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact ($\mu g/m^3$)	Maximum Impact Location	PSD Class I Increment ($\mu g/m^3$)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	0.21	Wind River Canyon	2.5	8.4%
SO_2	3-hour	0.05	Wind River Canyon	25	0.2%
	24-hour	0.02	Wind River Canyon	5	0.4%
	Annual	0.00	Wind River Canyon	2	0.07%
PM_{10}	24-hour	1.51	Wind River Canyon	8	18.9%
	Annual	0.13	Wind River Canyon	4	3.3%

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in Tables 4.4-33 through 4.4-35. Incremental increases in nitrogen deposition are predicted to exceed the DAT in two areas of special concern; the Wind River Canyon and the Owl Creek Range. However, total nitrogen deposition rates are predicted to remain below both the "Red Line" and "Green Line" Levels of Concern (LOC), indicating that total deposition rates are acceptable. Incremental sulfur deposition is predicted to be below the DAT for all areas of concern. Cumulative sulfur deposition is predicted to be less than both the "Red Line" and "Green Line" LOC.

Table 4.4-33. Proposed Action – Far-Field Incremental Nitrogen and Sulfur Deposition DAT Comparison.

Area of Special Concern	Nitrogen (N) Deposition (kg/ha/yr)	Sulfur (S) Deposition (kg/ha/yr)	Deposition Analysis Threshold (DAT) (kg/ha/yr)	Nitrogen (N) Percent of DAT	Sulfur (S) Percent of DAT
Bridger Wilderness	0.00199	0.00001	0.005	39.7%	0.2%
Cloud Peak Wilderness	0.00256	0.00002	0.005	51.2%	0.3%
Fitzpatrick Wilderness	0.00095	0.00001	0.005	19.0%	0.1%
North Absaroka Wilderness	0.00026	0.00000	0.005	5.3%	0.0%
Owl Creek Range	0.00833	0.00009	0.005	166.5%	1.9%
Popo Agie Wilderness	0.00289	0.00002	0.005	57.8%	0.4%
Phlox Mountain	0.00165	0.00001	0.005	33.0%	0.2%
Grand Teton NP	0.00020	0.00000	0.005	4.0%	0.0%
Teton Wilderness	0.00028	0.00000	0.005	5.6%	0.0%
Washakie Wilderness	0.00076	0.00000	0.005	15.1%	0.1%
Wind River Canyon	0.03150	0.00039	0.005	630.0%	7.9%
Wind River Roadless Area	0.00240	0.00001	0.005	48.0%	0.3%
Yellowstone NP	0.00022	0.00000	0.005	4.3%	0.0%
Maximum	**0.03150**	**0.00039**	**0.005**	**630.0%**	**7.9%**

Table 4.4-34. Proposed Action – Far-Field Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.00199	1.3	1.3	3.0	10.0	43.4%	13.0%
Cloud Peak Wilderness	0.00256	1.3	1.3	3.0	10.0	43.4%	13.0%
Fitzpatrick Wilderness	0.00095	1.3	1.3	3.0	10.0	43.4%	13.0%
North Absaroka Wilderness	0.00026	1.1	1.1	3.0	10.0	36.7%	11.0%
Owl Creek Range	0.00833	1.3	1.3	3.0	10.0	43.6%	13.1%
Popo Agie Wilderness	0.00289	1.3	1.3	3.0	10.0	43.4%	13.0%
Phlox Mountain	0.00165	1.3	1.3	3.0	10.0	43.4%	13.0%
Grand Teton NP	0.00020	1.1	1.1	3.0	10.0	36.7%	11.0%
Teton Wilderness	0.00028	1.1	1.1	3.0	10.0	36.7%	11.0%
Washakie Wilderness	0.00076	1.1	1.1	3.0	10.0	36.7%	11.0%
Wind River Canyon	0.03150	1.3	1.3	3.0	10.0	44.4%	13.3%
Wind River Roadless Area	0.00240	1.3	1.3	3.0	10.0	43.4%	13.0%
Yellowstone NP	0.00022	1.1	1.1	3.0	10.0	36.7%	11.0%
Maximum	**0.03150**	**1.3**	**1.3**	**3.0**	**10.0**	**44.4%**	**13.3%**

Table 4.4-35. Proposed Action – Far-Field Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.00009	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Teton Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.00039	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.00039**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Implementation of the Proposed Action is not predicted to cause ANC impacts greater than the LACs. All predicted impacts, as summarized in Table 4.4-36, are less than 1 µeq/l or a10 percent change in ANC.

Table 4.4-36. Proposed Action – Far-Field Predicted ANC Impacts

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.02	0.03%
Deep Lake	59.9	10% or 6.0 µeq/l	0.02	0.03%
Emerald Lake	69.8	10% or 7.0 µeq/l	0.03	0.04%
Florence Lake	33.0	10% or 3.3 µeq/l	0.03	0.09%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.01	0.01%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.02	0.04%
Ross Lake	53.5	10% or 5.4 µeq/l	0.01	0.01%
Stepping Stone Lake	19.9	1 µeq/l	0.00	0.00%
Twin Island Lake	17.6	1 µeq/l	0.00	0.01%
Upper Frozen Lake	5.0	1 µeq/l	0.02	0.35%
Maximum			**0.03**	**0.35%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

The Proposed Action is predicted to cause a total of three days of visibility impairment greater than 1.0 deciviews. As presented in Table 4.4-37, one day of impairment is predicted to occur at the Owl Creek Range, and two days of impairment are predicted at Wind River Canyon.

Table 4.4-37. Proposed Action – Far-Field Predicted Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.18
Cloud Peak Wilderness	0	0.19
Fitzpatrick Wilderness	0	0.11
North Absaroka Wilderness	0	0.05
Owl Creek Range	1	1.07
Popo Agie Wilderness	0	0.22
Phlox Mountain	0	0.20
Grand Teton NP	0	0.02
Teton Wilderness	0	0.04
Washakie Wilderness	0	0.09
Wind River Canyon	2	1.96
Wind River Roadless Area	0	0.17
Yellowstone NP	0	0.05
Total Days / Max Δ dV	**3**	**1.96**

4.4.3.2 Proposed Action Post-Construction - Direct and Indirect Impacts

Following the construction phase of the Proposed Action, emissions to the atmosphere and related air quality impacts would be reduced to the levels predicted below for the remainder of the project.

Ambient Air Quality Standards

Post-Construction maximum pollutant concentrations that could occur as a result of the implementation of the Proposed Action are summarized in the following table and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated in Table 4.4-38, increases in pollutant concentrations are predicted to occur at levels below the ambient standards.

Table 4.4-38. Proposed Action Post-Construction – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	0.13	Wind River Canyon	3.4	3.53	100	3.5%
SO_2	3-hour	0.00	Wind River Canyon	132	132.00	1300	10.2%
	24-hour	0.00	Wind River Canyon	43	43.00	260	16.5%
	Annual	0.00	Wind River Canyon	9	9.00	60	15.0%
PM_{10}	24-hour	0.10	Wind River Canyon	61	61.10	150	40.7%
	Annual	0.01	Wind River Canyon	22	22.01	50	44.0%

PSD Increments

The following table compares the maximum predicted pollutant concentrations with the PSD Class I Increments. As demonstrated in Table 4.4-39, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 4.4-39. Proposed Action Post-Construction – Far-Field PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact ($\mu g/m^3$)	Maximum Impact Location	PSD Class I Increment ($\mu g/m^3$)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	0.13	Wind River Canyon	2.5	5.1%
SO_2	3-hour	0.00	Wind River Canyon	25	0.00%
	24-hour	0.00	Wind River Canyon	5	0.00%
	Annual	0.00	Wind River Canyon	2	0.00%
PM_{10}	24-hour	0.10	Wind River Canyon	8	1.3%
	Annual	0.01	Wind River Canyon	4	0.2%

Terrestrial Acid Deposition

Results of the atmospheric nitrogen and sulfur atmospheric deposition are summarized in Tables 4.4-40 through 4.4-42. Proposed Action incremental nitrogen deposition rates would be reduced following the completion of the construction phase of the project. However, impacts are still predicted to equal or exceed the DAT in two areas of special concern; the Wind River Canyon and the Owl Creek Range. Total nitrogen deposition rates would remain below both the "Red Line" and "Green Line" LOC, indicating that total deposition rates are acceptable. Incremental sulfur deposition is predicted to be below the DAT for all areas of concern. Cumulative sulfur deposition is predicted to be less than both the "Red Line" and "Green Line" LOC.

Table 4.4-40. Proposed Action Post-Construction – Far-Field Incremental Nitrogen and Sulfur Deposition DAT Comparison.

Area of Special Concern	Nitrogen (N) Deposition (kg/ha/yr)	Sulfur (S) Deposition (kg/ha/yr)	Deposition Analysis Threshold (DAT) (kg/ha/yr)	Nitrogen (N) Percent of DAT	Sulfur (S) Percent of DAT
Bridger Wilderness	0.00135	0.00000	0.005	27.1%	0.0%
Cloud Peak Wilderness	0.00175	0.00000	0.005	35.0%	0.0%
Fitzpatrick Wilderness	0.00061	0.00000	0.005	12.1%	0.0%
North Absaroka Wilderness	0.00018	0.00000	0.005	3.6%	0.0%
Owl Creek Range	0.00501	0.00000	0.005	100.2%	0.0%
Popo Agie Wilderness	0.00195	0.00000	0.005	39.0%	0.0%
Phlox Mountain	0.00108	0.00000	0.005	21.5%	0.0%
Grand Teton NP	0.00013	0.00000	0.005	2.6%	0.0%
Teton Wilderness	0.00019	0.00000	0.005	3.9%	0.0%
Washakie Wilderness	0.00051	0.00000	0.005	10.2%	0.0%
Wind River Canyon	0.02130	0.00000	0.005	426.0%	0.1%
Wind River Roadless Area	0.00158	0.00000	0.005	31.6%	0.0%
Yellowstone NP	0.00014	0.00000	0.005	2.9%	0.0%
Maximum	**0.02130**	**0.00000**	**0.005**	**426.0%**	**0.1%**

Table 4.4-41. Proposed Action Post-Construction – Far-Field Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.00135	1.3	1.3	3.0	10.0	43.4%	13.0%
Cloud Peak Wilderness	0.00175	1.3	1.3	3.0	10.0	43.4%	13.0%
Fitzpatrick Wilderness	0.00061	1.3	1.3	3.0	10.0	43.4%	13.0%
North Absaroka Wilderness	0.00018	1.1	1.1	3.0	10.0	36.7%	11.0%
Owl Creek Range	0.00501	1.3	1.3	3.0	10.0	43.5%	13.1%
Popo Agie Wilderness	0.00195	1.3	1.3	3.0	10.0	43.4%	13.0%
Phlox Mountain	0.00108	1.3	1.3	3.0	10.0	43.4%	13.0%
Grand Teton NP	0.00013	1.1	1.1	3.0	10.0	36.7%	11.0%
Teton Wilderness	0.00019	1.1	1.1	3.0	10.0	36.7%	11.0%
Washakie Wilderness	0.00051	1.1	1.1	3.0	10.0	36.7%	11.0%
Wind River Canyon	0.02130	1.3	1.3	3.0	10.0	44.0%	13.2%
Wind River Roadless Area	0.00158	1.3	1.3	3.0	10.0	43.4%	13.0%
Yellowstone NP	0.00014	1.1	1.1	3.0	10.0	36.7%	11.0%
Maximum	**0.02130**	**1.3**	**1.3**	**3.0**	**10.0**	**44.0%**	**13.2%**

Table 4.4-42. Proposed Action Post-Construction – Far-Field Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Teton Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.00000**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Following the completion of the construction phase of the Proposed Action, impacts to lakes would be reduced. Predicted impacts at all lakes are less than 1 μeq/l or a 10 percent change in ANC as summarized in Table 4.4-43.

Table 4.4-43. Proposed Action Post-Construction – Far-Field Predicted ANC Impacts

High Elevation Lake	Baseline 10%Lowest ANC (μeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (μeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 μeq/l	0.01	0.02%
Deep Lake	59.9	10% or 6.0 μeq/l	0.01	0.02%
Emerald Lake	69.8	10% or 7.0 μeq/l	0.02	0.02%
Florence Lake	33.0	10% or 3.3 μeq/l	0.02	0.06%
Hobbs Lake	69.9	10% or 7.0 μeq/l	0.00	0.01%
Lower Saddlebag	55.5	10% or 5.6 μeq/l	0.01	0.03%
Ross Lake	53.5	10% or 5.4 μeq/l	0.00	0.01%
Stepping Stone Lake	19.9	1 μeq/l	0.00	0.00%
Twin Island Lake	17.6	1 μeq/l	0.00	0.00%
Upper Frozen Lake	5.0	1 μeq/l	0.01	0.24%
Maximum			**0.02**	**0.24%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

The Proposed Action is predicted to cause a total of three days of visibility impairment greater than 1.0 deciviews. However, following the completion of construction activities, visibility impacts would be reduced and no days greater than the 1.0 change in deciviews threshold are predicted to occur. Table 4.4-44 summarizes visibility impacts that may occur following the development of the Proposed Action. The maximum visibility impacts are predicted to be reduced from 1.96 to 0.775 deciviews following the completion of construction activities.

Table 4.4-44. Proposed Action Post-Construction – Far-Field Predicted Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.11
Cloud Peak Wilderness	0	0.11
Fitzpatrick Wilderness	0	0.06
North Absaroka Wilderness	0	0.04
Owl Creek Range	0	0.76
Popo Agie Wilderness	0	0.12
Phlox Mountain	0	0.12
Grand Teton NP	0	0.01
Teton Wilderness	0	0.02
Washakie Wilderness	0	0.06
Wind River Canyon	0	0.78
Wind River Roadless Area	0	0.10
Yellowstone NP	0	0.03
Total Days / Max Δ dV	**0**	**0.78**

4.4.3.3 Alternative A (485 wells) - Direct and Indirect Impacts

If Alternative A were to be approved, the emission of pollutant to the atmosphere and related air quality impacts would be proportionally greater than the emissions and resulting impacts predicted for the Proposed Action. Potential impacts resulting from the implementation of Alternative A are discussed below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of the implementation of the Alternative A as summarized in table 4.4-45 and compared with the most stringent Wyoming and National Ambient Air Quality Standards. As demonstrated, increases in pollutant concentrations are predicted to occur at levels below the ambient standards.

Table 4.4-45. Alternative A – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	0.27	Wind River Canyon	3.4	3.67	100	3.7%
SO_2	3-hour	0.05	Wind River Canyon	132	132.05	1300	10.2%
	24-hour	0.02	Wind River Canyon	43	43.02	260	16.6%
	Annual	0.00	Wind River Canyon	9	9.00	60	15.0%
PM_{10}	24-hour	1.63	Wind River Canyon	61	62.63	150	41.8%
	Annual	0.14	Wind River Canyon	22	22.14	50	44.3%

PSD Increments

Table 4.4-46 compares the maximum predicted pollutant concentrations with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 4.4-46. Alternative A – Far-Field PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	0.27	Wind River Canyon	2.5	10.6%
SO_2	3-hour	0.05	Wind River Canyon	25	0.2%
	24-hour	0.02	Wind River Canyon	5	0.4%
	Annual	0.00	Wind River Canyon	2	0.07%
PM_{10}	24-hour	1.63	Wind River Canyon	8	20.4%
	Annual	0.14	Wind River Canyon	4	3.5%

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in tables 4.4-47 through 4.4-49. Incremental increases in nitrogen deposition are predicted to exceed the DAT in two areas of special concern; the Wind River Canyon and the Owl Creek Range. However, total nitrogen deposition rates are predicted to remain below both the "Red Line" and “Green Line” LOC, indicating that total deposition rates are acceptable. Incremental sulfur deposition is predicted to be below the DAT for all areas of concern. Cumulative sulfur deposition is predicted to be less than both the “Red Line” and “Green Line” LOC.

Table 4.4-47. Alternative A – Far-Field Incremental Nitrogen and Sulfur Deposition DAT Comparison.

Area of Special Concern	Nitrogen (N) Deposition (kg/ha/yr)	Sulfur (S) Deposition (kg/ha/yr)	Deposition Analysis Threshold (DAT) (kg/ha/yr)	Nitrogen (N) Percent of DAT	Sulfur (S) Percent of DAT
Bridger Wilderness	0.00256	0.00001	0.005	51.3%	0.2%
Cloud Peak Wilderness	0.00332	0.00002	0.005	66.4%	0.4%
Fitzpatrick Wilderness	0.00122	0.00001	0.005	24.4%	0.1%
North Absaroka Wilderness	0.00034	0.00000	0.005	6.9%	0.0%
Owl Creek Range	0.01059	0.00010	0.005	211.8%	2.0%
Popo Agie Wilderness	0.00372	0.00002	0.005	74.4%	0.4%
Phlox Mountain	0.00212	0.00001	0.005	42.4%	0.2%
Grand Teton NP	0.00026	0.00000	0.005	5.2%	0.0%
Teton Wilderness	0.00037	0.00000	0.005	7.3%	0.0%
Washakie Wilderness	0.00098	0.00000	0.005	19.6%	0.1%
Wind River Canyon	0.04063	0.00042	0.005	812.6%	8.3%
Wind River Roadless Area	0.00308	0.00001	0.005	61.7%	0.3%
Yellowstone NP	0.00028	0.00000	0.005	5.6%	0.0%
Maximum	**0.04063**	**0.00042**	**0.005**	**812.6%**	**8.3%**

Table 4.4-48. Alternative A – Far-Field Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.00256	1.3	1.3	3.0	10.0	43.4%	13.0%
Cloud Peak Wilderness	0.00332	1.3	1.3	3.0	10.0	43.4%	13.0%
Fitzpatrick Wilderness	0.00122	1.3	1.3	3.0	10.0	43.4%	13.0%
North Absaroka Wilderness	0.00034	1.1	1.1	3.0	10.0	36.7%	11.0%
Owl Creek Range	0.01059	1.3	1.3	3.0	10.0	43.7%	13.1%
Popo Agie Wilderness	0.00372	1.3	1.3	3.0	10.0	43.5%	13.0%
Phlox Mountain	0.00212	1.3	1.3	3.0	10.0	43.4%	13.0%
Grand Teton NP	0.00026	1.1	1.1	3.0	10.0	36.7%	11.0%
Teton Wilderness	0.00037	1.1	1.1	3.0	10.0	36.7%	11.0%
Washakie Wilderness	0.00098	1.1	1.1	3.0	10.0	36.7%	11.0%
Wind River Canyon	0.04063	1.3	1.3	3.0	10.0	44.7%	13.4%
Wind River Roadless Area	0.00308	1.3	1.3	3.0	10.0	43.4%	13.0%
Yellowstone NP	0.00028	1.1	1.1	3.0	10.0	36.7%	11.0%
Maximum	**0.04063**	**1.3**	**1.3**	**3.0**	**10.0**	**44.7%**	**13.4%**

Table 4.4-49. Alternative A – Far-Field Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.00010	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Teton Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.00042	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.00042**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Implementation Alternative A is not predicted to cause ANC impacts greater than the LACs. All predicted impacts as summarized in table 4.4-50 are less than 1 μeq/l or a 10 percent change in ANC.

Table 4.4-50. Alternative A – Far-Field Predicted ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (μeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (μeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 μeq/l	0.02	0.03%
Deep Lake	59.9	10% or 6.0 μeq/l	0.02	0.04%
Emerald Lake	69.8	10% or 7.0 μeq/l	0.03	0.05%
Florence Lake	33.0	10% or 3.3 μeq/l	0.04	0.11%
Hobbs Lake	69.9	10% or 7.0 μeq/l	0.01	0.01%
Lower Saddlebag	55.5	10% or 5.6 μeq/l	0.03	0.05%
Ross Lake	53.5	10% or 5.4 μeq/l	0.01	0.01%
Stepping Stone Lake	19.9	1 μeq/l	0.00	0.01%
Twin Island Lake	17.6	1 μeq/l	0.00	0.01%
Upper Frozen Lake	5.0	1 μeq/l	0.02	0.45%
Maximum			**0.04**	**0.45%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

The Proposed Action is predicted to cause a total of six days of visibility impairment greater than 1.0 deciviews. As presented in table 4.4-51, two days of impairment are predicted to occur at the Owl Creek Range, and four days of impairment are predicted at the Wind River Canyon.

Table 4.4-51. Alternative A – Far-Field Predicted Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.23
Cloud Peak Wilderness	0	0.24
Fitzpatrick Wilderness	0	0.13
North Absaroka Wilderness	0	0.07
Owl Creek Range	2	1.25
Popo Agie Wilderness	0	0.27
Phlox Mountain	0	0.25
Grand Teton NP	0	0.03
Teton Wilderness	0	0.05
Washakie Wilderness	0	0.12
Wind River Canyon	4	2.22
Wind River Roadless Area	0	0.22
Yellowstone NP	0	0.06
Total Days / Max Δ dV	**6**	**2.22**

4.4.3.4 Alternative B (233 wells) - Direct and Indirect Impacts

If Alternative B were to be approved, the emission of pollutants to the atmosphere and related air quality impacts would be proportionally less than the emissions and resulting impacts predicted for the Proposed Action and Alternative A. Potential impacts resulting from the implementation of Alternative B are discussed below.

<u>Ambient Air Quality Standards</u>

Predicted maximum pollutant concentrations that could occur as a result of the implementation of Alternative B are summarized in the following table and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated in table 4.4-52, increases in pollutant concentrations are predicted to occur at levels below the ambient standards.

Table 4.4-52. Alternative B – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	0.17	Wind River Canyon	3.4	3.57	100	3.6%
SO_2	3-hour	0.05	Wind River Canyon	132	132.05	1300	10.2%
	24-hour	0.02	Wind River Canyon	43	43.02	260	16.6%
	Annual	0.00	Wind River Canyon	9	9.00	60	15.0%
PM_{10}	24-hour	1.48	Wind River Canyon	61	62.48	150	41.7%
	Annual	0.13	Wind River Canyon	22	22.13	50	44.3%

PSD Increments

Table 4.4-53 compares the maximum predicted pollutant concentrations with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 4.4-53. Alternative B – Far-Field PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	0.17	Wind River Canyon	2.5	6.9%
SO_2	3-hour	0.05	Wind River Canyon	25	0.2%
	24-hour	0.02	Wind River Canyon	5	0.4%
	Annual	0.00	Wind River Canyon	2	0.07%
PM_{10}	24-hour	1.48	Wind River Canyon	8	18.5%
	Annual	0.13	Wind River Canyon	4	3.2%

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in Tables 4.4-54 through 4.4-46. Incremental increases in nitrogen deposition are predicted to exceed the DAT in two areas of special concern; the Wind River Canyon and the Owl Creek Range. However, total nitrogen deposition rates are predicted to remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates are acceptable. Incremental sulfur deposition is predicted to be below the DAT for all areas of concern. Cumulative sulfur deposition is predicted to be less than both the “Red Line” and “Green Line” LOC.

Table 4.4-54. Alternative B – Far-Field Incremental Nitrogen and Sulfur Deposition DAT Comparison.

Area of Special Concern	Nitrogen (N) Deposition (kg/ha/yr)	Sulfur (S) Deposition (kg/ha/yr)	Deposition Analysis Threshold (DAT) (kg/ha/yr)	Nitrogen (N) Percent of DAT	Sulfur (S) Percent of DAT
Bridger Wilderness	0.00157	0.00001	0.005	31.3%	0.2%
Cloud Peak Wilderness	0.00202	0.00002	0.005	40.4%	0.3%
Fitzpatrick Wilderness	0.00076	0.00001	0.005	15.2%	0.1%
North Absaroka Wilderness	0.00021	0.00000	0.005	4.1%	0.0%
Owl Creek Range	0.00678	0.00009	0.005	135.6%	1.9%
Popo Agie Wilderness	0.00228	0.00002	0.005	45.7%	0.4%
Phlox Mountain	0.00131	0.00001	0.005	26.3%	0.2%
Grand Teton NP	0.00016	0.00000	0.005	3.2%	0.0%
Teton Wilderness	0.00022	0.00000	0.005	4.4%	0.0%
Washakie Wilderness	0.00060	0.00000	0.005	11.9%	0.1%
Wind River Canyon	0.02511	0.00039	0.005	502.2%	7.9%
Wind River Roadless Area	0.00191	0.00001	0.005	38.2%	0.3%
Yellowstone NP	0.00017	0.00000	0.005	3.4%	0.0%
Maximum	**0.02511**	**0.00039**	**0.005**	**502.2%**	**7.9%**

Table 4.4-55. Alternative B – Far-Field Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.00157	1.3	1.3	3.0	10.0	43.4%	13.0%
Cloud Peak Wilderness	0.00202	1.3	1.3	3.0	10.0	43.4%	13.0%
Fitzpatrick Wilderness	0.00076	1.3	1.3	3.0	10.0	43.4%	13.0%
North Absaroka Wilderness	0.00021	1.1	1.1	3.0	10.0	36.7%	11.0%
Owl Creek Range	0.00678	1.3	1.3	3.0	10.0	43.6%	13.1%
Popo Agie Wilderness	0.00228	1.3	1.3	3.0	10.0	43.4%	13.0%
Phlox Mountain	0.00131	1.3	1.3	3.0	10.0	43.4%	13.0%
Grand Teton NP	0.00016	1.1	1.1	3.0	10.0	36.7%	11.0%
Teton Wilderness	0.00022	1.1	1.1	3.0	10.0	36.7%	11.0%
Washakie Wilderness	0.00060	1.1	1.1	3.0	10.0	36.7%	11.0%
Wind River Canyon	0.02511	1.3	1.3	3.0	10.0	44.2%	13.3%
Wind River Roadless Area	0.00191	1.3	1.3	3.0	10.0	43.4%	13.0%
Yellowstone NP	0.00017	1.1	1.1	3.0	10.0	36.7%	11.0%
Maximum	**0.02511**	**1.3**	**1.3**	**3.0**	**10.0**	**44.2%**	**13.3%**

Table 4.4-56. Alternative B – Far-Field Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.00009	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.00002	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Teton Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.00039	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.00039**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Implementation of Alternative B is not predicted to cause ANC impacts greater than the LACs. All predicted impacts as summarized in Table 4.4-57 are less than 1 μeq/l or a 10 percent change in ANC.

Table 4.4-57. Alternative B – Far-Field Predicted ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (μeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (μeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 μeq/l	0.01	0.02%
Deep Lake	59.9	10% or 6.0 μeq/l	0.01	0.02%
Emerald Lake	69.8	10% or 7.0 μeq/l	0.02	0.03%
Florence Lake	33.0	10% or 3.3 μeq/l	0.02	0.07%
Hobbs Lake	69.9	10% or 7.0 μeq/l	0.01	0.01%
Lower Saddlebag	55.5	10% or 5.6 μeq/l	0.02	0.03%
Ross Lake	53.5	10% or 5.4 μeq/l	0.00	0.01%
Stepping Stone Lake	19.9	1 μeq/l	0.00	0.00%
Twin Island Lake	17.6	1 μeq/l	0.00	0.00%
Upper Frozen Lake	5.0	1 μeq/l	0.01	0.28%
Maximum			**0.02**	**0.28%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Alternative B is predicted to cause one day of visibility impairment greater than 1.0 deciviews. As presented in Table 4.4-58, one day of impairment is predicted to occur at Wind River Canyon.

Table 4.4-58. Alternative B – Far-Field Predicted Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.14
Cloud Peak Wilderness	0	0.16
Fitzpatrick Wilderness	0	0.10
North Absaroka Wilderness	0	0.04
Owl Creek Range	0	0.92
Popo Agie Wilderness	0	0.19
Phlox Mountain	0	0.16
Grand Teton NP	0	0.02
Teton Wilderness	0	0.03
Washakie Wilderness	0	0.08
Wind River Canyon	1	1.78
Wind River Roadless Area	0	0.16
Yellowstone NP	0	0.04
Total Days / Max Δ dV	**1**	**1.78**

4.4.3.5 Alternative C (No Action – 100 wells) – Direct and Indirect Impacts

If Alternative C were to be implemented, the emission of pollutants to the atmosphere and related air quality impacts would be minimized. Potential impacts resulting from the implementation of Alternative C are discussed below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of the implementation of the No Action Alternative are summarized in Table 4.4-59 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, increases in pollutant concentrations are predicted to occur at levels below the ambient standards.

Table 4.4-59. Alternative C – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	0.01	Wind River Canyon	3.4	3.41	100	3.4%
SO_2	3-hour	0.00	Wind River Canyon	132	132.00	1300	10.2%
	24-hour	0.00	Wind River Canyon	43	43.00	260	16.5%
	Annual	0.00	Wind River Canyon	9	9.00	60	15.0%
PM_{10}	24-hour	0.22	Wind River Canyon	61	61.22	150	40.8%
	Annual	0.01	Wind River Canyon	22	22.01	50	44.0%

PSD Increments

Table 4.4-60 compares the maximum predicted pollutant concentrations with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 4.4-60. Alternative C – Far-Field PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	0.01	Wind River Canyon	2.5	0.3%
SO_2	3-hour	0.00	Wind River Canyon	25	0.02%
	24-hour	0.00	Wind River Canyon	5	0.01%
	Annual	0.00	Wind River Canyon	2	0.00%
PM_{10}	24-hour	0.22	Wind River Canyon	8	2.7%
	Annual	0.01	Wind River Canyon	4	0.3%

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in Tables 4.4-61 through 4.4-63. With implementation of the No Action Alternative, Incremental increases in nitrogen and sulfur deposition are predicted to occur. However, incremental increases in nitrogen and sulfur are not predicted to exceed the DATs. Total nitrogen and sulfur deposition rates are predicted to remain below both the respective "Red Line" and "Green Line" LOC, indicating that total deposition rates are acceptable.

Table 4.4-61. Alternative C – Far-Field Incremental Nitrogen and Sulfur Deposition DAT Comparison.

Area of Special Concern	Nitrogen (N) Deposition (kg/ha/yr)	Sulfur (S) Deposition (kg/ha/yr)	Deposition Analysis Threshold (DAT) (kg/ha/yr)	Nitrogen (N) Percent of DAT	Sulfur (S) Percent of DAT
Bridger Wilderness	0.00022	0.00000	0.005	4.3%	0.0%
Cloud Peak Wilderness	0.00021	0.00000	0.005	4.1%	0.0%
Fitzpatrick Wilderness	0.00009	0.00000	0.005	1.8%	0.0%
North Absaroka Wilderness	0.00002	0.00000	0.005	0.4%	0.0%
Owl Creek Range	0.00063	0.00000	0.005	12.6%	0.1%
Popo Agie Wilderness	0.00032	0.00000	0.005	6.5%	0.0%
Phlox Mountain	0.00015	0.00000	0.005	3.1%	0.0%
Grand Teton NP	0.00002	0.00000	0.005	0.3%	0.0%
Teton Wilderness	0.00002	0.00000	0.005	0.5%	0.0%
Washakie Wilderness	0.00006	0.00000	0.005	1.3%	0.0%
Wind River Canyon	0.00149	0.00001	0.005	29.8%	0.2%
Wind River Roadless Area	0.00025	0.00000	0.005	5.0%	0.0%
Yellowstone NP	0.00002	0.00000	0.005	0.3%	0.0%
Maximum	**0.00149**	**0.00001**	**0.005**	**29.8%**	**0.2%**

Table 4.4-62. Alternative C – Far-Field Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.00022	1.3	1.3	3.0	10.0	43.3%	13.0%
Cloud Peak Wilderness	0.00021	1.3	1.3	3.0	10.0	43.3%	13.0%
Fitzpatrick Wilderness	0.00009	1.3	1.3	3.0	10.0	43.3%	13.0%
North Absaroka Wilderness	0.00002	1.1	1.1	3.0	10.0	36.7%	11.0%
Owl Creek Range	0.00063	1.3	1.3	3.0	10.0	43.4%	13.0%
Popo Agie Wilderness	0.00032	1.3	1.3	3.0	10.0	43.3%	13.0%
Phlox Mountain	0.00015	1.3	1.3	3.0	10.0	43.3%	13.0%
Grand Teton NP	0.00002	1.1	1.1	3.0	10.0	36.7%	11.0%
Teton Wilderness	0.00002	1.1	1.1	3.0	10.0	36.7%	11.0%
Washakie Wilderness	0.00006	1.1	1.1	3.0	10.0	36.7%	11.0%
Wind River Canyon	0.00149	1.3	1.3	3.0	10.0	43.4%	13.0%
Wind River Roadless Area	0.00025	1.3	1.3	3.0	10.0	43.3%	13.0%
Yellowstone NP	0.00002	1.1	1.1	3.0	10.0	36.7%	11.0%
Maximum	**0.00149**	**1.3**	**1.3**	**3.0**	**10.0**	**43.4%**	**13.0%**

Table 4.4-63. Alternative C – Far-Field Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Teton Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.00001	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.00000	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.00000	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.00001**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Implementation of the Proposed Action is not predicted to cause ANC impacts greater than the LACs. All predicted impacts, as summarized in Table 4.4-64, are less than 1 μeq/l or a 10 percent change in ANC.

Table 4.4-64. Alternative C – Far-Field Predicted ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (μeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (μeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 μeq/l	0.002	0.00%
Deep Lake	59.9	10% or 6.0 μeq/l	0.002	0.00%
Emerald Lake	69.8	10% or 7.0 μeq/l	0.002	0.00%
Florence Lake	33.0	10% or 3.3 μeq/l	0.002	0.01%
Hobbs Lake	69.9	10% or 7.0 μeq/l	0.001	0.00%
Lower Saddlebag	55.5	10% or 5.6 μeq/l	0.002	0.00%
Ross Lake	53.5	10% or 5.4 μeq/l	0.000	0.00%
Stepping Stone Lake	19.9	1 μeq/l	0.000	0.00%
Twin Island Lake	17.6	1 μeq/l	0.000	0.00%
Upper Frozen Lake	5.0	1 μeq/l	0.002	0.04%
Maximum			**0.002**	**0.04%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Visibility impacts resulting form the implementation of the No Action Alternative are not predicted to exceed the 1.0 deciview threshold. As presented in Table 4.4-65, a maximum visibility impact of 0.14 decivews is predicted to occur at Wind River Canyon.

Table 4.4-65. Alternative C – Far-Field Predicted Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.03
Cloud Peak Wilderness	0	0.02
Fitzpatrick Wilderness	0	0.02
North Absaroka Wilderness	0	0.01
Owl Creek Range	0	0.07
Popo Agie Wilderness	0	0.04
Phlox Mountain	0	0.02
Grand Teton NP	0	0.00
Teton Wilderness	0	0.01
Washakie Wilderness	0	0.01
Wind River Canyon	0	0.14
Wind River Roadless Area	0	0.02
Yellowstone NP	0	0.01
Total Days / Max Δ dV	**0**	**0.14**

4.4.3.6 Far-Field Impacts Summary

As a result of the implementation of the Proposed Action or Alternatives, increases in air pollutant concentrations would occur. The magnitude of the potential impacts would vary in proportion with the scale of the alternative. The greatest impacts would occur with the implementation of Alternative A. Proportionally lower impacts would occur with the implementation of the Proposed Action or Alternative B. Air quality impacts would be minimized with the implementation of Alternative C.

Ambient Air Quality Standards and PSD Increments

Predicted maximum pollutant concentrations are summarized in Table 4.4-66 for each of the alternatives. As illustrated, minor increases in PM_{10} concentrations would occur upon implementation of the Proposed Action or Alternatives A or B. PM_{10} impacts would be short term, lasting the duration of the development activities. Negligible PM_{10} impacts would occur with the implementation of Alternative C. Predicted NO_2 and SO_2 impacts would be negligible for all Project Alternatives.

Table 4.4-66. Proposed Action – Far-Field Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Proposed Action Maximum Predicted Impact (μg/m^3)	Proposed Action Post-Construction Maximum Predicted Impact (μg/m^3)	Alternative A Maximum Predicted Impact (μg/m^3)	Alternative B Maximum Predicted Impact (μg/m^3)	Alternative C Maximum Predicted Impact (μg/m^3)
NO_2	Annual	0.21	0.13	0.27	0.17	0.01
SO_2	3-hour	0.05	0.00	0.05	0.05	0.00
	24-hour	0.02	0.00	0.02	0.02	0.00
	Annual	0.00	0.00	0.00	0.00	0.00
PM_{10}	24-hour	1.51	0.10	1.63	1.48	0.22
	Annual	0.13	0.01	0.14	0.13	0.01

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in Tables 4.4-67 and 4.4-68. With the implementation of the Proposed Action or Alternatives A or B, minor long-term increases in nitrogen deposition are predicted to occur. The nitrogen impacts would exceed the DAT in two areas of special concern; Wind River Canyon and the Owl Creek Range. However, total nitrogen deposition rates would remain between 43% and 45% of the "Green Line" LOC, indicating that nitrogen deposition would remain within acceptable ranges. Nitrogen deposition impacts that may occur upon implementation of Alternative C would be negligible, as predicted impacts are substantially less than the DAT.

No sulfur deposition impacts are predicted to occur as a result of the implementation of the Proposed Action or Alternatives. For all Project Alternatives, increases in sulfur deposition would be considerably less than the DAT. Similarly, cumulative sulfur deposition would not exceed 22% of the "Green Line" LOC, indicating that total sulfur deposition rates would remain within the acceptable range.

Table 4.4-67. Far-Field Incremental Nitrogen DAT Summary.

Area of Special Concern	Proposed Action Nitrogen (N) Percent of DAT	Proposed Action Post-Construction Nitrogen (N) Percent of DAT	Alternative A Nitrogen (N) Percent of DAT	Alternative B Nitrogen (N) Percent of DAT	Alternative C Nitrogen (N) Percent of DAT
Bridger Wilderness	39.7%	27.1%	51.3%	31.3%	4.3%
Cloud Peak Wilderness	51.2%	35.0%	66.4%	40.4%	4.1%
Fitzpatrick Wilderness	19.0%	12.1%	24.4%	15.2%	1.8%
North Absaroka Wilderness	5.3%	3.6%	6.9%	4.1%	0.4%
Owl Creek Range	166.5%	100.2%	211.8%	135.6%	12.6%
Popo Agie Wilderness	57.8%	39.0%	74.4%	45.7%	6.5%
Phlox Mountain	33.0%	21.5%	42.4%	26.3%	3.1%
Grand Teton NP	4.0%	2.6%	5.2%	3.2%	0.3%
Teton Wilderness	5.6%	3.9%	7.3%	4.4%	0.5%
Washakie Wilderness	15.1%	10.2%	19.6%	11.9%	1.3%
Wind River Canyon	630.0%	426.0%	812.6%	502.2%	29.8%
Wind River Roadless Area	48.0%	31.6%	61.7%	38.2%	5.0%
Yellowstone NP	4.3%	2.9%	5.6%	3.4%	0.3%
Maximum	**630.0%**	**426.0%**	**812.6%**	**502.2%**	**29.8%**

Table 4.4-68. Far-Field Total Nitrogen Deposition "Green Line" Summary.

Area of Special Concern	Proposed Action Total Nitrogen (N) Percent of "Green Line"	Proposed Action Post-Construction Total Nitrogen (N) Percent of "Green Line"	Alternative A Total Nitrogen (N) Percent of "Green Line"	Alternative B Total Nitrogen (N) Percent of "Green Line"	Alternative C Total Nitrogen (N) Percent of "Green Line"
Bridger Wilderness	43.4%	43.4%	43.4%	43.4%	43.3%
Cloud Peak Wilderness	43.4%	43.4%	43.4%	43.4%	43.3%
Fitzpatrick Wilderness	43.4%	43.4%	43.4%	43.4%	43.3%
North Absaroka Wilderness	36.7%	36.7%	36.7%	36.7%	36.7%
Owl Creek Range	43.6%	43.5%	43.7%	43.6%	43.4%
Popo Agie Wilderness	43.4%	43.4%	43.5%	43.4%	43.3%
Phlox Mountain	43.4%	43.4%	43.4%	43.4%	43.3%
Grand Teton NP	36.7%	36.7%	36.7%	36.7%	36.7%
Teton Wilderness	36.7%	36.7%	36.7%	36.7%	36.7%
Washakie Wilderness	36.7%	36.7%	36.7%	36.7%	36.7%
Wind River Canyon	44.4%	44.0%	44.7%	44.2%	43.4%
Wind River Roadless Area	43.4%	43.4%	43.4%	43.4%	43.3%
Yellowstone NP	36.7%	36.7%	36.7%	36.7%	36.7%
Maximum	**44.4%**	**44.0%**	**44.7%**	**44.2%**	**43.4%**

Aquatic Acid Deposition

Upon implementation of the Proposed Action or Alternatives, no impacts to lake ANC are predicted to occur. As summarized in Table 4.4-69, predicted ANC impacts are substantially less than the LACs.

Table 4.4-69. Summary of Predicted Far-Field ANC Impacts

High Elevation Lake	Level of Acceptable Change [1]	Proposed Action Predicted Change in ANC (µeq/l)	Proposed Action Post-Construction Predicted Change in ANC (µeq/l)	Alternative A Predicted Change in ANC (µeq/l)	Alternative B Predicted Change in ANC (µeq/l)	Alternative C Predicted Change in ANC (µeq/l)
Black Joe Lake	6.7 µeq/l	0.02	0.01	0.02	0.01	0.002
Deep Lake	6.0 µeq/l	0.02	0.01	0.02	0.01	0.002
Emerald Lake	7.0 µeq/l	0.03	0.02	0.03	0.02	0.002
Florence Lake	3.3 µeq/l	0.03	0.02	0.04	0.02	0.002
Hobbs Lake	7.0 µeq/l	0.01	0.00	0.01	0.01	0.001
Lower Saddlebag	5.6 µeq/l	0.02	0.01	0.03	0.02	0.002
Ross Lake	5.4 µeq/l	0.01	0.00	0.01	0.00	0.000
Stepping Stone Lake	1 µeq/l	0.00	0.00	0.00	0.00	0.000
Twin Island Lake	1 µeq/l	0.00	0.00	0.00	0.00	0.000
Upper Frozen Lake	1 µeq/l	0.02	0.01	0.02	0.01	0.002
Maximum		**0.03**	**0.02**	**0.04**	**0.02**	**0.002**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Predicted changes in visibility and number of days exceeding the 1.0 Δdv threshold are summarized in Tables 4.4-70 and 4.4-71. With the implementation of the Proposed Action or Alternative A, moderate visibility impacts are predicted to occur at the Wind River Canyon and the Owl Creek Range. These impacts would be short term, existing for the duration of the Project construction activities. Upon the completion of the development phase of the Project, visibility impacts at Wind River Canyon and Owl Creek Range would be reduced to minor levels. Minor short-term visibility impacts are predicted to occur at Wind River Canyon and the Owl Creek range upon implementation of Alternative B. No discernable visibility impacts would occur with the implementation of Alternative C.

Table 4.4-70. Summary of Predicted Far-Field Visibility Impairment.

Area of Special Concern	Proposed Action Greatest Predicted Δ dv	Proposed Action Post-Construction Greatest Predicted Δ dv	Alternative A Greatest Predicted Δ dv	Alternative B Greatest Predicted Δ dv	Alternative C Greatest Predicted Δ dv
Bridger Wilderness	0.177	0.108	0.225	0.144	0.027
Cloud Peak Wilderness	0.193	0.114	0.243	0.158	0.019
Fitzpatrick Wilderness	0.114	0.057	0.132	0.104	0.015
North Absaroka Wilderness	0.052	0.036	0.067	0.041	0.005
Owl Creek Range	1.071	0.758	1.252	0.923	0.074
Popo Agie Wilderness	0.219	0.116	0.270	0.185	0.037
Phlox Mountain	0.197	0.116	0.248	0.162	0.023
Grand Teton NP	0.021	0.014	0.027	0.016	0.002
Teton Wilderness	0.037	0.024	0.048	0.030	0.005
Washakie Wilderness	0.094	0.062	0.120	0.075	0.011
Wind River Canyon	1.960	0.775	2.218	1.780	0.137
Wind River Roadless Area	0.173	0.101	0.217	0.156	0.021
Yellowstone NP	0.046	0.032	0.059	0.036	0.005
Maximum Δ dv	**1.960**	**0.775**	**2.218**	**1.780**	**0.137**

Table 4.4-71. Summary of Predicted Far-Field Visibility Impairment Days.

Area of Special Concern	Proposed Action Number of Days with Δ dv Greater Than 1.0	Proposed Action Post-Construction Number of Days with Δ dv Greater Than 1.0	Alternative A Number of Days with Δ dv Greater Than 1.0	Alternative B Number of Days with Δ dv Greater Than 1.0	Alternative C Number of Days with Δ dv Greater Than 1.0
Bridger Wilderness	0	0	0	0	0
Cloud Peak Wilderness	0	0	0	0	0
Fitzpatrick Wilderness	0	0	0	0	0
North Absaroka Wilderness	0	0	0	0	0
Owl Creek Range	1	0	2	0	0
Popo Agie Wilderness	0	0	0	0	0
Phlox Mountain	0	0	0	0	0
Grand Teton NP	0	0	0	0	0
Teton Wilderness	0	0	0	0	0
Washakie Wilderness	0	0	0	0	0
Wind River Canyon	2	0	4	1	0
Wind River Roadless Area	0	0	0	0	0
Yellowstone NP	0	0	0	0	0
Total Days	**3**	**0**	**6**	**1**	**0**

4.4.3.7 Additional Mitigation Measures

Air quality related impacts would result primarily from NO_X emitted from compressor and drill rig engines in conjunction with particulate matter generated from construction activities and vehicle travel on unpaved roads. Table 4.4-72 summarizes mitigation measures that may reduce potential impacts.

Table 4.4-72. Air Quality Additional Mitigation Measures.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
NO_X and CO Mitigation Measures				
Utilize selective catalytic reduction on compressors.	Relatively expensive as compared to non-selective catalysts. Typical costs are $125/horsepower (EPA Cost Control Manual, January 2002).	Requires the use and storage of ammonia, which presents health and safety issues. Results in increased ammonia emissions which may contribute to the formation of ammonium sulfates and increased visibility degradation.	NO_X emission rate reduced to 0.1 g/hp-hr. Reduced ammonium nitrate formation and resulting visibility impacts.	Not applicable for 2-stroke engines.
Application of non-selective catalytic reduction.	$5,000 to $25,000 per unit.	Regeneration / disposal costs for catalysts.	As a result of the BACT process, average NO_X emission rates for Wyoming engines 100 hp or greater is 1.0 g/hp-hr. The application of non-selective catalysts may reduce the NO_X emission rate to 0.7 g/hp-hr for some types of engines.	Not applicable for Lean-burn or 2-stroke engines.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Utilize compressors driven by electrical motors.	Capital costs equal 40% of gas turbine costs. Operating cost dependent upon the location of high voltage power lines.	Displaced air emissions from compressor units to electrical power plant.	May potentially relocate emissions away from sensitive Class I areas.	Requires high voltage power lines.
Increased diameter of sales pipelines.	With larger diameter sales pipelines, capital costs increase while operating costs decrease.	Slightly more surface disturbance.	Lower pipeline pressures resulting in lower compression hp requirements.	
Utilize wind generated electricity to power compressors.	Capital costs are very large.	Visual impacts from generation equipment. Increased mortality of birds including raptors.	Reduced use of fossil fuels and associated emissions.	Location of wind generation facilities is critical. Requires consistent strong winds for economic operation. Also requires high voltage transmission lines between generation facility and compressor stations.
Increased Monitoring.	Unknown.	None.	Improved data for estimating impacts.	The monitoring of emission sources does not reduce the magnitude of the impacts.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Phased development.	Short term loss of State and Federal royalties.	Emissions generated at a lower rate over a longer period.	Peak emissions and associated impacts reduced.	Administration / jurisdiction limitations - The WDEQ-AQD and EPA are the regulatory authorities for air quality within the State of Wyoming. Therefore, the BIA cannot limit or otherwise restrict development based upon potential air quality impacts. Economic limitations - A minimum production rate is required to cost effectively develop the resource while maintaining the processing and transportation infrastructure.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Particulate Matter Mitigation Measures				
Increase water application rate to achieve greater than 50% fugitive dust control.	Varies with the source of the water and the trucking distance.	None	Can achieve fugitive dust control rates up to 95%.	Diminishing returns per gallon of water applied. Water must be applied at much greater rates to achieve control efficiencies greater than 75%.
Unpaved Road Dust Suppressant Treatments.	$2,400 to $50,000 per mile.	Treatment chemicals have the potential to negatively impact water quality.	Estimated 20% to 100% reduction in fugitive dust emissions.	Jurisdictional limitation – The County controls many of the main roads within the WRPA and retains responsibility for road maintenance and dust control.
Administrative control of speed limits	Relatively low costs for installation of signs and enforcement.	None	Slower speeds may provide 20% to 50% reduction in dust emissions.	Jurisdictional limitation – The County controls many of the main roads within the WRPA and retains authority for determining speed limits.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Installation of remote telemetry.	Approximately $13,000 per well.	None	Reduction in vehicle miles traveled and associated vehicle emissions during production operations. No benefit for construction operations which generate the greatest amount of PM.	Effective only for the production phase of the operations. Would have no impact upon construction activities which generate the greatest amount of particulate matter.
Gravel roads.	Approximately $9,000 per mile.	None	Estimated 30% reduction in fugitive road dust.	Jurisdictional limitation – The County controls many of the main roads within the WRPA and retains responsibility road maintenance.
Pave roads.	Approximately $11,000 to $60,000 per mile	None	Estimated 90% reduction in fugitive road dust.	Jurisdictional limitation – The County controls many of the main roads within the WRPA and retains responsibility for road construction and maintenance.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Phased development.	Short term loss of State and Federal royalties.	Emissions generated at a lower rate over a longer period.	Peak emissions and associated impacts reduced.	Administration / jurisdiction limitations - The WDEQ-AQD and EPA are the regulatory authorities for air quality within the State of Wyoming. Therefore, the BIA cannot limit or otherwise restrict development based upon potential air quality impacts. Economic limitations - A minimum production rate is required to cost effectively develop the resource while maintaining the processing and transportation infrastructure.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
VOC and HAP Mitigation Measures				
Use of condenser controls on dehydrator still vents.	$1,000 to $10,000 for capital equipment.	Larger units may require electrical power.	VOC/HAP emission reductions ranging from 1% to 50%.	The effectiveness of passive condensers is dependent upon ambient air temperatures. Control efficiency decreases with increasing temperatures.
Use of combination condenser / combustion controls on dehydrator still vents.	$5,000 to $25,000 for capital equipment plus increased maintenance costs.	Larger units may require electrical power. Increased NO_X and CO emissions.	VOC/HAP control rates ranging from 95% to better than 99%.	May require continuous electrical power source for larger units.
Minimize dehydrator glycol circulation rates.	Minimal costs associated with increased monitoring and maintenance.	None.	May reduce VOC and HAP emissions by 1% to 50%.	Glycol circulation rates may only be reduced to the point where gas quality still meets pipeline specifications.

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Use of oxidation catalysts on compressor engines.	$5,000 to $10,000 capital costs.	Disposal of spent catalysts.	Typically reduces formaldehyde emissions by 50%. Reductions of up to 90% may be achieved. Also reduces CO emissions by similar percentages.	Not applicable for 2-stroke engines.
Use of flares or smokeless combustion units to control vapors from condensate storage tanks	$5,000 to $20,000 per well.	Increased NO_X and CO emissions. May contribute to light pollution.	Reduction in tank emissions of 95% or better.	
Use of activated carbon filters on condensate tanks	$1,000 initial capital costs. High maintenance costs.	High energy costs for replacement / regeneration of carbon filters	Estimated 50% to 80% reduction in VOC and HAP emissions.	
Green completion / flowback unit.	Capital costs range from $1,000 to $10,000. Operating costs estimated at $1,000 per year.	Potential for reduced gas production.	Potentially reduces completion flaring/venting emissions by 70% to 90%.	

Type of Mitigation	Estimated Cost of Mitigation	Environmental Cost	Environmental Benefit	Potential Limitations
Phased development.	Short term loss of State and Federal royalties.	Emissions generated at a lower rate over a longer period.	Peak emissions and associated impacts reduced.	Administration / jurisdiction limitations - The WDEQ-AQD and EPA are the regulatory authorities for air quality within the State of Wyoming. Therefore, the BIA cannot limit or otherwise restrict development based upon potential air quality impacts. Economic limitations - A minimum production rate is required to cost effectively develop the resource while maintaining the processing and transportation infrastructure.

4.4.3.8 Residual Impacts

Implementation of the Proposed Action or Alternatives would cause increased levels of pollutants in the ambient air. With the implementation of one or more of the previously described additional mitigation measures, the emission of air pollutants and related impacts to air quality related values may potentially be reduced.

4.5 WATER RESOURCES

This section addresses the potential impacts on water resources from the proposed development of gas resources in the WRPA. It discusses the potential effects of the Proposed Action and other alternatives to water quality and quantity in the watersheds within and near the WRPA. Water Resources include Muddy Creek (with Upper and Middle depression Reservoirs, Lake Cameahwait, and Cottonwood Drain), Fivemile Creek, and Cottonwood Creek, as well as Ocean Lake, which lies just outside the WRPA. Potential Impacts identified for water resources include surface disturbance in their watersheds (such as runoff from roads and well pads), the potential for spills of produced fluids and hazardous materials that may contaminate surface water or groundwater, and loss of containment from pits and tanks. Other concerns include the source of water to be used for drilling operations and development of the well fields, and effects on local aquifers from gas well completion, formation fracturing with chemicals, well operations, and from injection of wastewater and other fluids into disposal wells.

Based on the review of existing data, the potential for significant impacts to water resources associated with drilling, facility construction, operation, and well abandonment for the Proposed Action and alternatives is relatively low and ranges from negligible to minor. However, concerns do exist in terms of increased erosion and sedimentation and the potential for groundwater contamination within the three main watersheds, including Fivemile Creek, Muddy Creek, and Cottonwood Creek. Each of these creeks flows into Boysen Reservoir.

4.5.1 Proposed Action (325 wells)- Direct and Indirect Impacts

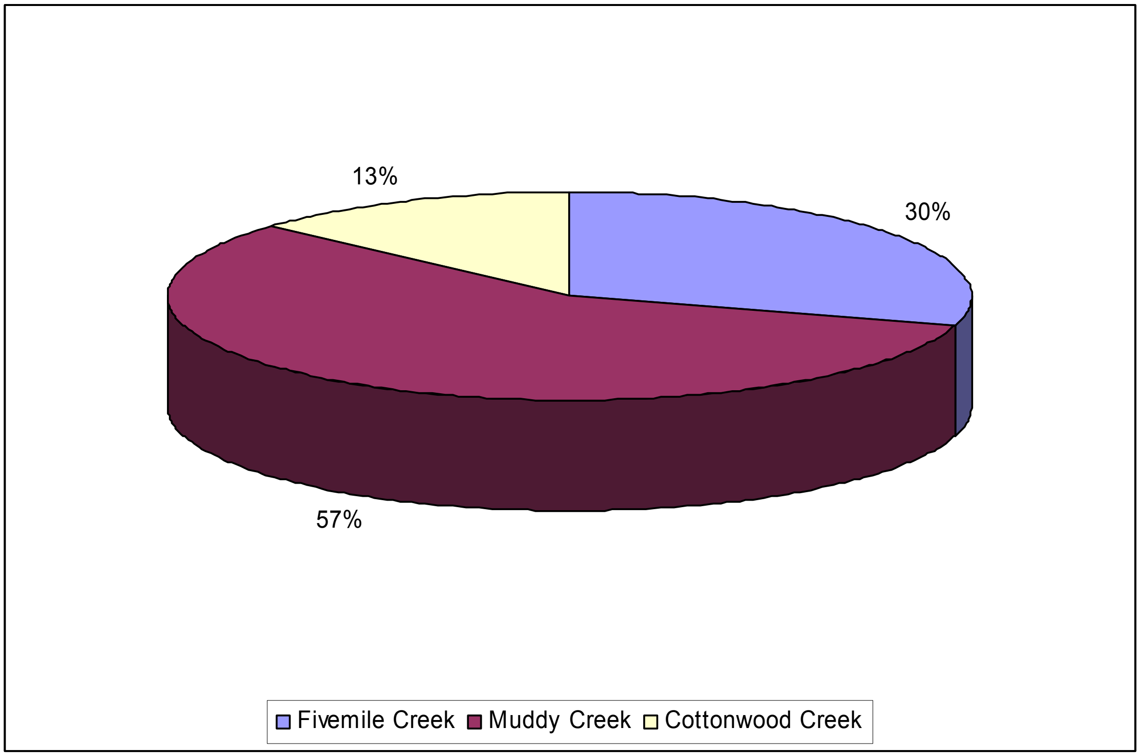
4.5.1.1 Surface Water

The extent of the three watersheds within the WRPA, Fivemile Creek, Muddy Creek, and Cottonwood Creek are shown in Figure 3.5-2. Table 4.5-1 shows the distribution of wells and initial surface disturbance from construction and drilling within these three watersheds. As shown on Figure 4.5-1, the highest level of activity would occur in the Muddy Creek watershed. The following discusses the potential impacts of the development of these well development areas to surface water quality and quantity.

Table 4.5-1: Initial Disturbance in WRPA Watersheds resulting from the Proposed Action

Field	No. of Wells	% in Watershed and Disturbed Acreage					
		Fivemile Creek		Muddy Creek		Cottonwood Creek	
		Wells in Watershed	Disturbed Acreage (ac)	Wells in Watershed	Disturbed Acreage (ac)	Wells in Watershed	Disturbed Acreage (ac)
Pavillion	155	155	472.1				
Muddy Ridge	50	18	148	32	263.2		
Sand Mesa	100			88	673.1	12	91.8
Sand Mesa South	12			12	173.0		
Coastal Extension	8			1	20.1	7	140.6
Total	**325**	**173**	**620.1**	**133**	**1,129.4**	**19**	**232.4**

Figure 4.5-1: Percentage Disturbed Acreage from the Proposed Action by Watershed.



Erosion and Sedimentation

Sediment from construction activities and drilling operations could potentially:

- Reduce water storage in Boysen Reservoir.
- Clog stream channels.
- Settle on productive land.
- Degrade aquatic habitat.
- Expose bare soil to erosion as well as the dissolution of salts and possibly other trace substances.
- Create turbidity that detracts from the recreational use of water.
- Degrade water for consumptive uses.
- Increase water treatment costs.
- Damage water distribution systems.
- Act as a carrier for other pollutants (trace metals, pesticides, plant nutrients, etc.).

Within the WRPA, the potential for erosion by wind and water is minor to moderate depending on the contents of sand, silt, and clay in the soil. In general, soils such as well-drained silty clays are only slightly susceptible to erosion, whereas deep sandy loams are moderately to highly susceptible to wind and water erosion.

The methodology and the results to estimate potential sediment yield from the WRPA over the Life of the Project are shown in Appendix N. Basic assumptions used to calculate sediment yield from well pads, roads, pipelines, and other facilities are presented. The Universal Soil Loss Equation was used to calculate annual erosion rates for site specific soils in each well development area based on soil characteristics described in Section 3.3, (soils). The erosion rates from reclaimed areas were calculated by assuming the use of control measures, such as mulch, water bars, water turnouts, and revegetation, and assuming a 60 percent success rate from reclamation. Estimated yearly erosion rates for each development area for disturbed areas, reclaimed areas, and undisturbed areas are presented in Table 4.5-2. Yearly sediment loss rates were based on the following proposed drilling schedule:

- Pavillion 155 wells in 11 years
- Muddy Ridge 50 wells in 5 years
- Sand Mesa 100 wells in 13 years
- Sand Mesa South 12 wells in 4 years
- Coastal Extension 8 wells in 8 years.

Sediment yield was calculated for each affected watershed. The area of disturbance, timing of operations, and distribution of wells used in the calculations were based on values presented in Chapter 2.

Figure 4.5-2 illustrates sediment yield (soil loss) rates by watershed for the Proposed Action over the life of the project. Table 4.5-3 presents basic statistics on soil loss over a 16-year period. This time period was selected because erosion rates stabilize about five years after construction, drilling, and completion. Over a 16-year period from the initiation of the Proposed Action, considerable soil loss could potentially occur. As presented in Table 4.5-3, project-related soil loss could be up to 66 percent higher than the natural soil loss rates that would occur without the Proposed Action (486 tons/year occurring naturally compared to 941 tons/year associated with the Proposed Action).

The direct impacts on water quality in Fivemile, Muddy and Cottonwood Creeks are dependent on the percent of sediment that actually reaches these steams. The sediment delivery ratio (SDR) is a function of drainage area. Boyce (1975) calculated that the SDR would be about five percent of the soil loss in watersheds with an area of 300 square miles, a size typical of the watersheds within the WRPA. Vegetative trapping effects, deposition of sediment on land and in the streams, and the degree of channelization (Haan and Barfield 1979) also influence the SDR. In addition, construction Best Management Practices (BMP) (i.e., containment berms, sediment control structures, and other engineered stormwater control structures) and the Operator’s commitment not to construct well pads within 500 feet of streams, would greatly reduce the amount of sediment reaching the streams.

Table 4.5-3 also shows the yearly estimates of sediment loading into streams in the WRPA. As illustrated in Figure 4.5-2, sediment loading into streams would gradually increase to year 11 then decrease as disturbed areas are reclaimed. Long-term sediment loading is highest for the Fivemile Creek watershed, with an average load of 23 tons per year. Sediment loading for Muddy and Cottonwood Creeks would be about 7 and 16 tons of sediment per year, respectively. Predicted sediment loadings would increase over naturally occurring rates by an average of 23 tons per year over the 16-year period.

Table 4.5-2: Soil Loss Parameters by Soil Type for WRPA

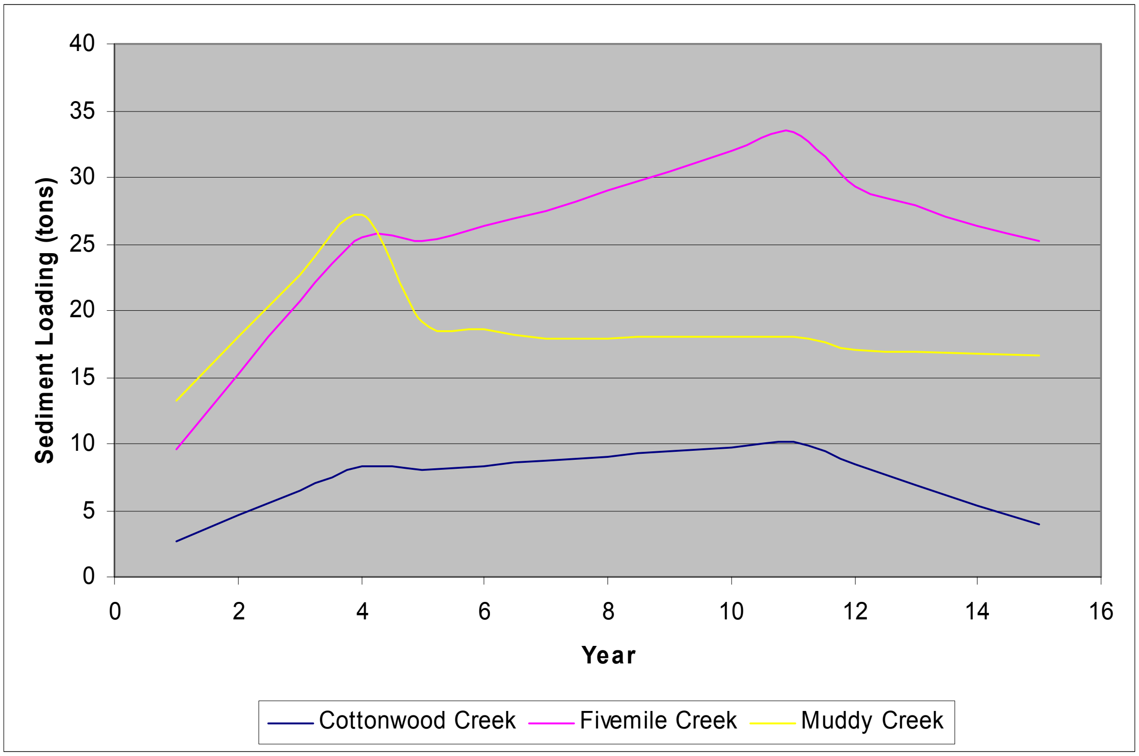
Development Area	Predominant Soil Types	Slope	Soil Loss (tons/acre/year)		
			Construction Disturbance[1]	Reclaimed	Undisturbed
Pavillion	Sandy-clay loam to sandy clay (est. 50% each)	0 – 5%	8.300	1.800	0.700
Muddy Ridge	Clayey loam to sandy clay (est. 50% each)	0 – 5%	7.250	1.550	0.650
Sand Mesa	Sandy loam	(nearly level)	6.600	0.033	0.014
Sand Mesa South	Sandy loam	(nearly level)	6.600	0.033	0.014
Coastal Extension	Sandy loam	0 – 5%	6.600	2.200	0.083

[1]Construction disturbance assumes a 20% slope of berms, topsoil stockpiles, and banks.

Table 4.5-3: Estimated Soil Loss and Sediment Loading by Watershed for the Proposed Action – 16 Years from Start of Project

Watershed	Soil Loss			
	(tons/yr)			16-Year Total (tons)
	Min	Max	Average	
Cottonwood Creek	53	193	136	2,176
Muddy Creek	264	534	337	5,392
Fivemile Creek	192	607	468	7,488
WRPA Total	**509**	**1191**	**941**	**15,056**
Natural Conditions			486	7,936
	Sediment Loading (tons/yr)			
Cottonwood Creek	3	10	7	112
Muddy Creek	13	27	16	256
Fivemile Creek	10	30	23	368
WRPA Total	**25**	**59**	**47**	**752**
Natural Conditions			24	397

Figure 4.5-2: Calculated Sediment Loading from the WRPA to Nearby Streams



To minimize erosion and to prevent sediment from reaching streams in the WRPA, a Stormwater Management Plan would be implemented for each site. These plans would meet state and federal requirements and include the following measures:

- Reduction of the exposure of materials, such as drilling fluids and other chemicals stored on-site, to rainfall and storm water runoff. This would also be accomplished by storing drums and other materials under cover (such as in a trailer, in a shed, or covering with tarp).
- Utilization of BMPs, such as diversion dikes, containment diking, and curbing to reduce exposure of stormwater runoff to drill cuttings and other waste storage areas.
- Proper design and utilization of sediment traps, swales, and mulching during construction activities (e.g., as during road construction or construction of facilities) to reduce loss of sediment and contamination of runoff.
- Keep adequate materials and equipment in the WRPA to contain and control spills in order to prevent contamination of runoff.

All disturbed areas that are not in use would be reclaimed by replacing topsoil, using a proper seed mix with seasonal planting, and retaining features such as scaring and mulch to reduce erosion. An example of a Storm Water Management Plan is presented in Appendix O, and describes measures that could be employed to control erosion and contain sediment on well pad sites and typical designs to reduce erosion from roads and pipelines.

In summary, with development of the well fields, the Fivemile Creek watershed would have the highest potential for increased sediment loading, followed by the Muddy Creek and

Cottonwood Creek watersheds. Each of these streams can support a fish population. According to the Wyoming Department of Environmental Quality (2001a), these streams would be classified as Class 2C, but because of high total dissolved solids (TDS) concentrations, they are not suitable as drinking water. Potential impacts from the Proposed Action would be increased sedimentation and associated turbidity from increases in erosion, due mainly to the construction of well pads, roads, and pipelines. The increase in erosion and turbidity from the Proposed Action would be moderate in the short term and minor in the long term. The impacts from increased sedimentation would be minor in the short term and negligible over the long term.

Stream Channel Disturbance

Road and pipeline construction across ephemeral, intermittent, and perennial stream channels could alter the hydraulics of the streams and result in increased erosion downstream. Streams within the WRPA are classified as "Waters of the U.S." and construction of stream crossings would require authorization by the U.S. Army Corps of Engineers through a Section 404 permit or through the more expedited General Permit 98-08.

BMPs, as defined by federal agencies, would be followed for stream crossings. These standards are stated as follows:

- Directional drilling would be considered for pipeline crossings of perennial streams. When directional drilling is utilized, drilling pits would be located far enough back from the channel that stream bank stability is not reduced.
- Where pipeline crossings of streams would be constructed by trenching, stream banks would be stabilized with large angular rock or wire-enclosed riprap. Substrate layers would be replaced in the same order that they are removed. Pipeline crossings of riparian areas and streams would be at right angles to minimize area of disturbance.
- The pipeline would be installed below the streambed to a depth that would prevent exposure of the pipeline to free-flowing water. In areas of high stream velocity, where scouring may occur, the pipe would be encased in concrete or covered with rock riprap to prevent the pipeline from becoming exposed.
- The pipeline joints would be welded, glued, cemented or fastened together in a manner to provide a durable water tight connection. Whenever possible, the stream would be spanned by a single unjointed section of pipe.
- Pipelines crossing flowing streams would have automatic shutoff valves.
- Construction methods would provide for eliminating or minimizing discharges of sediment, organic matter, or toxic chemicals. A settling basin or cofferdam may be required for this purpose.
- Special consideration would be given to pipeline crossings in the vicinity of public water supply intakes. The operation would be timed and designed so as not to interfere with the use of the water by the water supplier.
- No in-stream activities would take place if they affect fish spawning habitat.

- Upon completion, the streambed would be returned to its original elevation and configuration. All temporary fill material would be removed.

- Stream banks would be returned to a stable condition and revegetated with appropriate vegetation.

Because of the potential for flash floods in the WRPA and stream responses to high intensity, short duration runoff events, pipeline stream crossings would be designed to withstand a 25 to 50-year storm event, or as directed by the BIA.

Erosion of roadway and pipeline rights-of-way may increase sediment in local stock ponds, drainage features, canals and drains. Routine maintenance and structure replacement would be implemented to mitigate and lessen sediment loading, if necessary.

Overall, the Proposed Action could have a moderate short-term impact on stream networks and drainage systems and minor long-term impacts. In addition, there could be a minor, long-term reduction in peak flows.

Spills and Loss of Containment

Another potential impact to surface water resources is the accidental spill of potentially toxic substances, due to loss of containment of tanks containing glycol, wastewater, or petroleum products. An accidental spill of such substances would most likely be contained within the well pad. The Operator's commitment not to construct well pads within 500 feet of waterways, would likely eliminate the possibility that accidental spills would reach waterways within the WRPA.

Accidental spills could occur at anytime during the life of the project. The magnitude of the potential impacts from spills is largely dependent on the proximity of the spill location to drainageways, the nature the of soils in the area, the slope aspect and gradient of the site, the duration of construction and implementation of mitigation measures. Other factors, include rainfall intensity, freezing and thawing action, and burrowing of animals. In areas 1,000 feet farther from a stream on impermeable ground, the impact would be relatively small, if clean-up actions are taken quickly. On the other hand, an accidental spill of a tanker truck near a stream or where the land is relatively permeable could have a large impact to the water quality of streams and shallow groundwater. This could also negatively impact fish and their habitat.

A Spill Prevention, Control, and Countermeasure (SPCC) Plan would be implemented to prevent petroleum products and other chemicals from leaving the site and contaminating surface water. During drilling, a reserve pit would be constructed onsite to retain drill cuttings and drilling fluid. The reserve pit is intended only for temporary storage of drilling fluids before being moved offsite for treatment and disposal. However, it may be used as the final disposal site for solids. After drilling is completed, the liquid would be removed (by suction or by evaporation) and the solid remnants covered over with dirt. The liquids could account for up to 62 percent of drilling waste by volume.

To prevent infiltration of contaminated water, the reserve pit would be lined. The liner would consist of an impermeable synthetic liner that would be at least 12 mm thick, reinforced with a bursting strength of 174 x 175 pounds per inch (ASTM 75719). The liner must be resistant to decay from sunlight and hydrocarbons, and compatible with the drilling fluids to be retained. Because liners sometimes fail, an inspection program would be initiated, and repairs to the liner would be done quickly to prevent downward migration of contaminated water into shallow groundwater, if present.

Process water from wells and other liquid wastes would be pumped into a truck and transported to a permitted Underground Disposal Well (UDW) for disposal. Service trailers located on the well pad would be self-contained and would not require a septic system. Sewage would be hauled offsite to a government-approved disposal site.

Overall, the Proposed Action would have negligible to minor long-term effects on surface water resources. It is anticipated that the Proposed Action would:

- Not affect floodplains, thereby complying with Executive Order 11990 on the Protection of Floodplains.
- Have negligible, long-term impacts on surface water quality, so that applicable federal standards would be met.
- Not cause significant changes to nearby stream channels in (terms of their geometry, bank stabilization, or gradient), which could produce undesirable effects such as down-cutting, sedimentation, clogging, or side-cutting.
- Have negligible to minor long-term impacts on surface water flow regime and water quality characteristics, that established water users would not be affected.
- Result in minor long-term impacts to irrigation and drainage systems in terms of reduction in quantity and or quality.

4.5.1.2 Groundwater

In the WRPA, groundwater is used as water for domestic and livestock consumption. As described in Section 3.5 (Water Resources), the main aquifers of concern are the Quaternary alluvium and the upper portion of the Wind River Formation. The formations targeted for the project are 5,000 to 17,000 feet below these aquifers. Targeted formations in the WRPA include the Wind River, Ft. Union, Lance, Meeteetse, Mesaverde, Cody and Frontier Formations.

Well density would vary from development area to development area and would range from 16-32 wells/section. Some of these wells may be classified as exploration or delineation wells, because natural gas production potential has not been fully defined due to geologic uncertainties.

Groundwater Quality

Because state-of the-art drilling and well completion techniques would be used in the WRPA, it is anticipated that the probability of affecting these shallow aquifers would be negligible. Well completion would be performed in accordance with "Onshore Oil and Gas Order No.2" (43 CFR 3164.1; BLM 1989) which states the following:

> "Proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable

> deposits of minerals. Any isolating medium other than cement shall receive approval prior to use"

As a guideline, usable water is defined as water with total dissolved solids of less than 10,000 mg/L. To be in compliance, all wells would be completed so that such zones are isolated. Throughout the drilling program, a monitoring program would be in place to ensure that "usable" water zones are identified and effectively isolated.

As discussed in Section 3.5 (Water Resources), there are currently approximately 285 permitted water wells in the WRPA. The majority are used for domestic consumption and livestock watering purposes. Because of high dissolved solids (>1,000 mg/L), most wells are not used for drinking water.

The existing and future water wells within and adjacent to the WRPA are not expected to be impacted by construction and drilling operations because of adherence by the Operators to the procedures prescribed in Onshore Oil and Gas Order No.2. Experience in other well development areas indicates that fracturing a completion zone to increase yield using hydropressure or other methods may impact shallow aquifers. This impact is highly dependent on the nature of the bedrock and other factors. Should impacts occur, steps would be taken to evaluate the situation and replacement water sources would be found.

To prevent contaminated water from spills from reaching groundwater, Spill Prevention, Control and Countermeasure (SPCC) Plan would be implemented. In addition as mentioned earlier, all pits would be lined with suitable impermeable material limiting any impact.

Groundwater Quantity

Water for construction and drilling operations would be obtained from local water wells within the WRPA. It is anticipated that existing water wells would be the primary source of water. Water would be required for compaction of roads and well pads, dust suppression, well drilling, and pipeline testing. Table 4.5-4 presents estimates for water use for construction activities based on the following assumptions: 1000 gallons (0.003 ac-ft) per acre of surface disturbance; 42,000 gallons (0.13 ac-ft) for drilling shallow wells in the Pavillion field; and 252,000 gallons (0.77 ac-ft) for deeper wells in the other development areas. Total water requirements for drilling and construction would be 157.05 ac-ft. Assuming a one-time testing program for the 140 miles of pipeline, an additional 3.3 ac-ft of water could be required for a total of 160.35 ac-ft for the Proposed Action.

Table 4.5-4: Proposed Action - Estimated Water Requirements for Construction and Drilling Activities

Field Name	No. of Wells	Drilling Water Usage (ac-ft)	Total Disturbance (acres)	Construction Water Usage (ac-ft)
Pavillion	155	20.2	472.1	1.42
Muddy Ridge	50	38.5	411.2	1.23
Sand Mesa	100	77.0	764.9	2.30
South Sand Mesa	12	9.2	173.0	0.52
Coastal Extension	8	6.2	160.7	0.48
Total	**325**	**151.1**	**1,982**	**5.95**

Assuming recharge to the aquifers is 0.04 inches per year (see Section 3.5.3.2) and the area of the three affected watersheds within the WRPA is approximately 91,220 acres, the annual groundwater recharge to the system in WRPA is estimated to be 3,650 ac-ft. Since construction and testing activity would take place over eleven years under the Proposed Action, a water requirement of 160.35 ac-ft (approximately 14.6 ac-ft per year) would be less than 1 percent of the available yearly groundwater balance for the WRPA. Therefore, water usage for construction, drilling, and operations would have a negligible affect on water quantity or existing water rights.

Prior to drilling any water well, necessary water appropriation permits would be obtained from appropriate authorities. To minimize water impacts after pipeline testing operations are completed, the water would be pumped into water hauling trucks and transported to drilling locations within the WRPA to be used in for the drilling operations. If not needed for drilling operations, the test water would be disposed of in the TBI injection well.

4.5.2 Alternative A (485 wells) – Direct and Indirect Impacts

Under Alternative A, the number of wells would increase from 325 to 485 wells. The increase in activity would lead to increased sediment loading into each nearby creek. Using the same methodology previously described for the Proposed Action, Table 4.5-5 presents estimated sediment loadings over natural levels for Alternative A. Predicted sediment loadings under Alternative A would increase over natural rates by an average of 36 tons per year over the 16-year period. This is an annual average increase in sediment loading of 13 tons per year over the Proposed Action.

Table 4.5-5: Estimated Soil Loss and Sediment Loading by Watershed for Alternative A –16 years from Start of Project

Watershed	Soil Loss (tons/yr)			Total (tons)
	Min	Max	Average	
Cottonwood Creek	120	356	248	3,976
Fivemile Creek	321	671	473	7,562
Muddy Creek	264	928	704	11,256
Alternative A Total	**706**	**1,764**	**1,425**	**22,794**
Natural			698	11,168
	Sediment Loading			
Cottonwood Creek	6	18	12	199
Muddy Creek	16	34	24	378
Fivemile Creek	13	46	35	563
Alternative A Total	**35**	**88**	**71**	**1,140**
Natural			35	558

By increasing the number of wells from 325 to 485, water used for drilling, well development and other purposes would also increase. Table 4.5-6 summarizes estimated water usage requirements for drilling and construction activities. Estimated water requirements for drilling and construction for Alternative A would be 250.4 ac-ft. Assuming a one time testing program, an additional 5 ac-ft of water would be required for a total of 255.4 ac-ft, or a 60 percent increase over the Proposed Action. However, the impacts to ground water resources would remain negligible.

Table 4.5-6: Alternative A: Estimated Water Requirements for Drilling and Construction Activities

Field Name	No. of Wells	Drilling Water Usage (ac-ft)	Total Disturbance (acres)	Construction Water Usage (ac-ft)
Pavillion	206	26.8	619.8	1.86
Muddy Ridge	66	50.8	506.8	1.52
Sand Mesa	133	102.4	974.4	2.92
South Sand Mesa	48	37.0	402.6	1.21
Coastal Extension	32	24.6	315.0	0.95
Total	**485**	**241.6**	**2,818.7**	**8.46**

4.5.3 Alternative B (233 wells) – Direct and Indirect Impacts

Under Alternative B, 233 wells would be drilled. The decrease in disturbed acreage would lead to decreased sediment loading into each nearby creek. This loading would be less than the Proposed Action and Alternative A. Table 4.5-7 presents calculated increased loadings over natural levels for Alternative B. Predicted sediment loadings under Alternative B would increase over natural rates by an average of 12 tons per year over the 16-year period. This is an annual average increase in sediment loading comparable to the Proposed Action.

Table 4.5-7: Estimated Soil Loss and Sediment Loading by Watershed for Alternative B – 16 years from Start of Project

Watershed	Soil Loss (tons/yr)			Total (tons)
	Min	Max	Average	
Cottonwood Creek	31	138	97	1,545
Fivemile Creek	105	446	335	5,365
Muddy Creek	111	292	228	3,644
Alternative B Total	**246**	**824**	**660**	**10,554**
Natural			413	6,608
	Sediment Loading (tons/yr)			
Cottonwood Creek	2	7	5	77
Fivemile Creek	5	22	17	268
Muddy Creek	6	15	11	182
Alternative B Total	**12**	**41**	**33**	**528**
Natural			21	330

By decreasing the number of wells from 325 to 233, Alternative B would require less water for drilling, well development, and other purposes than under the Proposed Action and Alternative A. Table 4.5-8 summarizes estimated water usage requirements for drilling and construction activities for the well development areas based on based on 1,000 gallons per acre (0.003 ac-ft) of disturbance and well drilling assuming 42,000 gallons per acre (0.13 ac-ft) for shallow wells and 252,000 gallons per acre (0.77 ac-ft) for deeper wells on Muddy Ridge. Estimated water requirements for drilling and construction would be 122.3 ac-ft. Assuming a one-time testing program, an additional 2 ac-ft of water would be required for a total of 124 ac-ft, or a 22 percent decrease over the Proposed Action. Overall, the surface and groundwater impacts from alternative B would range from negligible to minor.

Table 4.5-8: Alternative B: Estimated Water Requirements for Drilling and Construction Activities

Field Name	No. of Wells	Drilling Water Usage (ac-ft)	Total Disturbance (acres)	Construction Water Usage (ac-ft)
Pavillion	96	12.5	307.2	0.92
Muddy Ridge	40	30.8	352.8	1.06
Sand Mesa	80	61.6	635.9	1.91
South Sand Mesa	10	7.7	159.4	0.48
Coastal Extension	7	5.4	154.4	0.46
Total	**233**	**117.5**	**1609.7**	**4.83**

4.5.4 Alternative C (No Action, 100 wells) – Direct and Indirect Impacts

The No Action Alternative would deny the proposed drilling and development proposal, as submitted but would allow consideration of individual APDs on private minerals on a case-by-case basis through individual project and site-specific NEPA compliance. Private minerals are administered by the Wyoming Oil and Gas Conservation Commission (WOGCC).

The technical requirements for the No Action Alternative are the same as described for the Proposed Action. Any additional infrastructure necessary to upgrade existing wells and wells approved through the APD process within the WRPA would be similar to the Proposed Action.

Road and pipeline construction disturbance per well site associated with the No Action Alternative would be similar to the Proposed Action. The No Action Alternative would have approximately 316.6 acres of total new short-term disturbance (2.17 acres/well) from well locations, new roads or upgrades of existing roads, and new pipelines. It is anticipated that the existing natural gas production infrastructure within the WRPA (e.g., compressors, water disposal wells, etc) would support the No Action Alternative during the life of the project. Total disturbances would be reduced to 79.3 acres following reclamation of the pipelines and portions of the well pads not needed for production operations.

Under the No Action Alternative, the impacts to water resources would be similar to the levels of the existing operation in the Pavillion Field. Wells would be drilled only in the Pavillion Well and the Fivemile Creek watershed. Table 4.5-9 estimates sediment loading into Fivemile Creek and Boysen Reservoir over natural levels for Alternative C over a 10 year development period.

Table 4.5-9: Estimated Soil Loss and Sediment Loading by Watershed for Alternative C (No Action) – 10 Years from Start of Project.

Watershed	Soil Loss (tons/yr)			
	Min	Max	Average	**Total**
Cottonwood Creek	0	0	0	0
Fivemile Creek	80	322	219	2,190
Muddy Creek	0	0	0	0
Total	**80**	**322**	**219**	**2,190**
Natural			152	1,520
	Sediment Loading (tons/yr)			
Cottonwood Creek	0	0	0	0
Fivemile Creek	4	16	11	110
Muddy Creek	0	0	0	0
Boysen Reservoir	**4**	**16**	**11**	**110**
Natural			8	76

4.5.5 Impact Summary

Surface Water

The Proposed Action and the alternatives have the potential to impact surface water and groundwater. Impacts to surface water resources could be judged in terms of each alternative's potential to:

- Disrupt surface water drainage systems,
- Increase runoff and erosion,
- Reduce peak flows,
- Change surface water drainage networks,
- Increase suspended solids, and
- Change surface water quality.

Based on the analyses presented above, and assuming that the Operators use BMPs during construction, drilling, operation, and abandonment, the Proposed Action is anticipated to have negligible to minor impacts on the surface water systems. The highest potential for impacts would come during construction activities when there is the greatest potential for increased runoff and erosion, thereby increasing suspended solids into streams. However, by using BMPs and maintaining a safe working distance from flowing streams, these impacts are expected to be minor. The construction of stream crossings for pipelines and roads may disrupt surface water drainage systems and increase suspended solids. Again, using BMPs, these impacts would be relatively short lived and are considered minor. With the implementation of a Spill Prevention, Control and Countermeasure Plan (SPCC) impacts to surface water quality in terms of increased salt and trace metal loading due to the Proposed Action would be negligible.

The impacts to surface water from each of the other alternatives are anticipated to be similar to that of Proposed Action. Increased construction activity for Alternative A may have a greater potential for increased runoff and erosion. However, this impact would be considered moderate as long as BMPs are implemented. Alternative C (No Action) would lead to less construction of pipelines and roads; therefore, potential to disrupt surface water drainage systems from this activity are anticipated to be negligible.

Finally, impacts to other bodies of water including Ocean Lake, Upper and Middle Depression Reservoirs, Lake Cameahwait, and Boysen Reservoir from increased sedimentation or changes in water quality from any of the alternatives are expected to be negligible. Ocean Lake lies outside the WRPA and potential impacts would be from fugitive dust precipitating on it. Upper and Middle Depression Reservoirs and Lake Cameahwait lie within the Cottonwood Drain subbasin which is considered part of the Muddy Creek watershed. With the development of the Sand Mesa field, increased sedimentation into these bodies of water may occur, but the impact is considered a fraction of the impacts anticipated for the Muddy Creek watershed and negligible. Boysen Reservoir, which receives surface water from the entire WRPA, may also be impacted. However, total anticipated increased sediment loading is considered to be only a very small fraction of the total loading of the entire Wind River basin and the impact to the reservoir would be negligible.

Groundwater

The Proposed Action and each of the alternatives are anticipated to have negligible to minor impacts to the groundwater system in the WRPA. The extraction wells would be completed between 5,000 and 17,000 feet below existing water supply wells. BMPs would be used in the drilling, completion, and abandonment of the extraction wells. Therefore, impacts to water levels and hydraulic properties of the shallow aquifers used for water supply would be negligible for each of the alternatives. Because of the potential for accidental spills and leakage from reserve pits, impacts to groundwater quality may occur. However, by implementing a SPCC Plan, as well as lining the reserve pit and using BMPs, and the fact that groundwater quality in the area is naturally poor, these impacts to groundwater quality would be negligible.

4.5.6 Additional Mitigation Measures

By using BMPs for construction, drilling, operation and abandonment, the Operators would limit any potential impacts to surface water and groundwater resources. In addition, by implementing a SPCC Plan, steps would be taken by the Operators to prevent accidental spills from contaminating water systems. To increase this level of mitigation, the following mitigation measures are suggested to minimize the overall impact to water resources which could result from gas development activities in the WRPA:

- To provide additional protection to water resources within the WRPA, drilling operations or other surface disturbances should be limited within 1,000 ft of flowing streams or surface water bodies including Fivemile Creek, Muddy Creek, Cottonwood Drain, and Boysen Reservoir. Exceptions to this limitation would include pipelines and roads and their stream crossings or other activities specifically approved in writing by the BIA.

- Stormwater Management Plans should be developed for all well pads compressor, stations, and auxiliary gas facilities within the WRPA. As part of this plan, sufficient detail should be given to controlling erosion and sediment on each site.

- Spill Prevention, Control, and Countermeasure (SPCC) Plans should be developed prior to any gas development activities within the WRPA including the construction of compressor stations, well pads, and auxiliary facilities.

- Upon completion of construction and well abandonment activities, efforts should be made to reclaim lands that were disturbed and no longer in use as quickly as possible to minimized erosion. Reclamation should be done using methods, such as planting appropriate seed mixtures to ensure rapid growth of vegetation, retaining moisture on disturbed lands by scaring or other methods, such as using mulch, for enhanced reclamation.

- Environmental audits should be conducted periodically to ensure that reserve pit lining systems are functional and not leaking, SPCC Plans are implemented, and BMPs are being followed for all gas development activities.

Finally, specific concerns regarding the potential impacts to water resources from a particular site would be best addressed at the time of specific activity proposals, which would be reviewed by the BIA.

4.5.7 Residual Impacts

Long-term residual impacts to water resources from gas development activities in the WRPA are expected to be negligible. With the completion of construction activities, well pads, roads, pipelines, compressor stations, and auxiliary facilities would be reclaimed using BMPs. If possible, no further disturbances would take place at stream crossings for roads and pipelines, further reducing potential impacts to water resources. By also using BMPs for well abandonment, impacts to groundwater resources used for domestic consumptions and livestock water would also be negligible.

4.6 VEGETATION AND WETLANDS

4.6.1 Introduction

Native mixed-grass prairie, greasewood fans and flats, saltbush fans and flats, and riparian shrub interspersed with larger expanses of sparsely populated big Wyoming sagebrush and desert-shrub vegetation are spread throughout the WRPA (see Figure 3.6-1 in Section 3.6). Fragmentation of this native vegetation cover has occurred through localized conversion to crops, roads, or some degree of degradation from overgrazing by domestic livestock. These past vegetative disturbances have encouraged the spread of invasive grasses and noxious weeds throughout the area (see Figure 3.6-4 in Section 3.6). Irrigation diversions, storage structures, and drains within the WRPA have also affected the riparian areas. The combined effects of agriculture, livestock grazing, fire, and oil/gas production, have altered the structure and composition of vegetation within the WRPA. Fragmented landscapes such as these contain fewer intact ecosystems (Noss 1987).

The following analysis addresses the effects of proposed oil/gas exploration and production activities on six native cover-types (which include riparian areas and wetlands) that are associated with ephemeral or inundated areas adjacent to wetlands, stream channels, or open water bodies.

Primary steps for assessing impacts include identifying:

- Vegetative communities found in areas likely to be affected by the proposed oil/gas development.
- Disturbance or loss of vegetation caused by the oil/gas development.
- The vegetative communities' potential to be affected by these disturbances and their ability to recover.

4.6.2 Geographic Area Evaluated for Direct and Indirect Impacts

The area analyzed for possible impacts on sagebrush, desert-shrub, mixed-grass prairie, greasewood fans and flats, and saltbush fans and flats consists of:

- Potential oil/gas exploration and development areas, access roads, and pipelines that may affect these cover-types within the boundaries of the WRPA (see Figure 1-2 in Chapter 1).
- Riparian-shrub and wetlands along the Muddy, Fivemile, and Cottonwood Creeks, and their associated tributaries, and those associated with Middle Depression Reservoir and state wildlife management ponds that lie within these boundaries (see Figure 3.6-1 in Section 3.6).
- Terrestrial semi-arid lands extending from the riparian stream channels and open water bodies that are considered the zone of direct interaction between terrestrial and aquatic ecosystems (Cox 1996) 4.6.3 Proposed Action (325 wells) – Direct and Indirect Impacts

4.6.3.1 Vegetation

The Proposed Action, in which 325 new wells would be drilled in the WRPA, would result in new disturbance of about 1,982 acres or 2.15 percent of vegetation in the WRPA (see Table 2-2, in Chapter 2). Out of this total, about 422.7 acres (approximately 0.46 percent of WRPA) of vegetation will be permanently removed (see Table 2-2). More cropland would be affected by proportionately more development in the Pavillion fields. In Muddy Ridge and Sand Mesa, more native vegetation would be affected. At any time, smaller amounts of desert-shrub, sagebrush, and mixed-grass prairie would be removed and others reclaimed in each of the remaining development areas in accordance with the phased development plan (see Chapter 2, Sections 2.3 & 2.9), thereby minimizing overall impacts to native vegetation.

The exploration and development activity in the WRPA involves vegetation removal to construct new well pads, new roads, new facilities and production pipelines, or to upgrade existing roads. This can result in temporary or long-term disturbance to native vegetation lasting up to 20-years or more. Well pads of dry holes and abandoned wells would be revegetated. Pipelines are backfilled, restored to grade, and revegetated after construction has been completed.

Preliminary Exploration Impacts

Preliminary exploration investigations often require off-road vehicle travel and construction of access roads resulting in removal of vegetation, nutrient rich topsoil, and soil crusts. Microbiotic soil crusts are a primary contributor of nitrogen for plant growth in arid and semiarid regions. Destruction of nitrogen-fixing bacteria and lichens could result in degradation of the plant community (Evans and Ebleringer 1993).

Exploration and Development Impacts

Exploratory drilling activities involve use of heavy equipment and vehicles. Soil displacement, resulting from heavy equipment and vehicle travel along the road and localized wind, would generate dust that interferes with plant growth and reproduction. This would result in direct, minor, short-term adverse effects to vegetation. On the other hand, heavy equipment and vehicle passage would distribute loose gravel and dirt along the road edge, and may encourage growth of plants. This would result in minor beneficial effects to vegetation within the road corridor.

Gas development, including removal of vegetation for the construction of roads, well pads and ancillary facilities or pipelines, removes portions of plant communities. New road construction may fragment habitats, indirectly affecting adjoining plant communities. Clearing of vegetation and topsoil reduces biomass, affecting nutrient cycling and plant productivity. Well drilling equipment would damage vegetation in some areas, due to trampling and compaction, and result in loss of nutrients indirectly caused by surface erosion, and sedimentation. Use of non-native soil for well pads may introduce non-native plant species that compete with the native plant species and reduce dispersal and propagation of the native species.

Non-native plants are sometimes used to control erosion. Some non-native species can spread aggressively, reducing habitat for native species. Although noxious weeds are already widespread and are controlled through management (see Figure 3.6-4 in Section 3.6), invasive annual grasses often overtake native perennial bunchgrass in sagebrush communities. When non-native grasses are predominant, they change the fire regime from a 50 to 100-year interval to a five to 10-year interval (Kenworthy 1999). The increased frequency of fire results in changes in species composition within the Wyoming and Big Basin sagebrush cover-types (West 1983). When fire intervals are short, perennial grasses and shrubs are eliminated and non-native annual grasses dominate. Short-lived resprouting shrubs, such as rabbit brush (*Chrysothamnus* spp.*)* or Nuttall's horsebrush (*Tetradymia* spp.), begin to dominate under these fire intervals (Reid et al. 2002).

Production Impacts

Production operations require long-term use and maintenance of access roads within the WRPA, exposing some vegetation within the road corridor to fugitive dust, and other portions to trampling or compaction. Eroded road surfaces and road banks along some sections of the existing access roads provide little to no soil rooting or nutrients to support plant growth. Surface disturbance for road upgrades and maintenance would be contained within the road right-of-way. Small amounts of shrubs and herbaceous plants would be removed when road banks are stabilized. Increased runoff from unstabilized, disturbed soils may result in reduced soil productivity and affect revegetation. Use of gravel for road fill would potentially increase non-native species and exotics along road corridors as non-native weed seeds are often mixed with the gravel. Exotic plant and weed growth would be minimized through revegetation efforts. Stabilizing road banks would reduce erosion and sedimentation; slow the loss of soil helping to stabilize the adjacent drainage channel; and encourage plant growth, resulting in localized, long-term negligible adverse effects.

There are no federally listed plant species within the WRPA. Therefore, no impacts to federally listed plant species are anticipated. Most of the native vegetation communities within the WRPA have been disturbed to some degree, and because many are fragmented, their species composition and distribution no longer represent a natural community.

Hydrocarbon Spills

Spills of oil, gas condensate or produced water may occur from rupture of pipelines or storage tanks. The effects of spills of these substances are discussed below. During exploration and development, produced water, which may have high dissolved salt content, metals, some minerals, and hydrocarbons, may accidentally be spilled on the soil surface. Salt can interfere with the ability of plants to absorb water and nutrients, and it disrupts the transport of air and water to the root system by altering the mechanical structure of the soil, causing salt-scaring. In sagebrush communities, salt-scaring from spilled produced water may expose bare soils and introduce microclimatic changes and competition from plant species adapted to open conditions. Plants adapted to open conditions include invasive non-native annual grasses such as cheatgrass (*Bromus tectorum)* or Japanese brome (*Bromus japonicus*), and weeds such as Russian knapweed (*Centaurea repens)* or diffuse knapweed (*Centaurea diffusa)*. Increasing annual grasses and weeds may increase fire frequency within these areas (Hironaka et al. 1983). Over the long term, these direct, minor adverse effects could reduce species diversity in the Wyoming big sagebrush community.

Fuel storage tank spills may be caused by accidental equipment failure or operator error and may discharge directly onto surrounding native vegetation or deposit onto plants in the form of airborne particulates. Uptake rates of polycyclic aromatic hydrocarbons (PAHs) are dependent on the amount of existing PAHs in the environment, the plant species, and the nature of the substrate (Edward 1983). Degree of toxicity of PAHs to natural and cultivated plants is not well known, but concentrations of PAHs in vegetation are generally much less than concentrations in the soil (Nagpal 1993). Cropland yields however may be reduced if subject to long-term exposure to PAHs (Wagner and Wagner-Hering 1971).

Oil contamination results in hydrophobic soils and reduces water availability to plant roots (McCown et. al. 1972). Hydrophobic organic residues coat soil particles and prevent water entry into the soil. Hydrocarbons and metals may persist longer in soils than salt, because salt migrates through soil more rapidly than oil (Canadian Petroleum Association 1987). When soil cannot store and supply water, plant growth is reduced or eliminated, resulting in an indirect, minor long-term moderate adverse effect on native vegetation.

4.6.3.2 Wetlands and Riparian Areas

The key characteristic of the riparian system is the availability of water throughout the year or during the growing season. During periods of extensive oil/gas drilling, pathways by which the surface waters reach the wetlands may be altered. A high level of upland oil/gas development changes the flow of surface water runoff and sometimes decreases groundwater recharge.

Palustrine wetlands are intermittently distributed along low-lying areas adjacent to streams and reservoirs in the WRPA, such as the Middle Depression Reservoir and other wildlife habitat management ponds. Few well pads or facilities are located in wetland or riparian areas. The adverse impact to riparian and wetland habitats would be minor and short term, since there would be a minimum of a 500 foot setback from streams for oil/gas activities.

4.6.3.3 Soil Impacts

Accidental discharge of produced water from rupture of storage tanks may desiccate palustrine wetlands and riparian vegetation. Soils at produced water spill sites often include high exchangeable sodium concentrations (after precipitation), suspended and dissolved hydrocarbons, and heavy metals (Reis 1992; Dunn et. al. 1994). High sodium concentrations impact soil permeability, increase water salinity, and are toxic to most freshwater riparian vegetation. However, direct effects would be minor, short-term, and localized.

Estimated soil loss and sediment loadings from oil/gas activities indicate that high levels of long-term sediment loading would occur within the Fivemile Creek watershed followed by much lower levels in Cottonwood and Muddy Creeks (see Table 4.5-6 in Section 4.5). Certain pollutants from oil/gas operations are transported primarily in association with fine-grained sediments. Removal of sediment and nutrients from cropland runoff by surrounding upland vegetation suggest that vegetated uplands are effective filters if surface flow is shallow, uniformly distributed, and the surface is free of sediment deposits (Dillaha 1989). Localized soil composition, topography, and upland vegetation control these nutrients and sediments, and moderate the effects of oil/gas activities on riparian areas (see Figure 4.6-1 in Section 4.6).

4.6.3.4 Impacts to Streams

Recontouring of drainage channels, installing drainage culverts, and placing riprap at the inlet and outlet at stream crossings would remove individual riparian vegetation growing on the streambank. Installation of new road culverts and placement of riprap at inlets and outlets at stream crossings would also remove minor amounts of upland native sagebrush or desert-shrub along the road. Construction on steep slopes would increase erosion and sedimentation in riparian areas. Removing a few riparian shrubs and plants and upland plants would be a direct, short-term, localized, negligible, adverse impact at the stream crossings.

Road maintenance along roads and road banks adjacent to drainage channels and riparian areas would remove individual shrubs and herbaceous plants. Graded road banks would typically revegetate, and some vegetation may grow in riprap. Therefore, adverse impacts to vegetation from placement of riprap would be short-term, localized, and negligible. Widening roads with backfill and site grading adjacent to wetlands and riparian areas would remove some individual shrubs growing along the drainage channels. Riparian vegetation would not naturally regenerate along newly widened roads. Therefore, there would be direct, long-term, localized, and negligible adverse impacts to riparian vegetation.

Permits for stream crossings would be authorized by the U.S. Army Corps of Engineers (COE) under the Nationwide Permit (NWP) program. Activities authorized using a NWP are defined by the COE as having minimal individual and cumulative effects on the environment. These streams and adjacent wetlands would continue to provide aquatic habitat and wetland functions.

4.6.3.5 Vegetation Restoration

Approximately 2.15 percent, or 1,982 acres of initial vegetation disturbance would take place during construction (see Table 2-2). After construction, soils would be graded and stabilized and 79 percent of all vegetation removed within these development areas would be restored. This would leave 422.7 acres (0.46 percent of WRPA) of residual vegetation disturbance (see Table 2-2).

Site restoration and revegetation would mitigate most adverse effects to native vegetation and cropland from oil/gas operations. Cut and fill slopes and stockpiling areas associated with each production well site would be reclaimed and revegetated. After reclamation, the average size of the remaining well pad would range from 1 – 1.7 ac in most development areas, except for the irrigated portion of the Pavillion field, in which case it would be 0.002 acre (see Table 2-6 or Section 2.7.2.2 for further details).

All pipeline rights-of-way would be reclaimed, representing an approximate revegetation of 1,559 acres of the total 1,982 acres initially disturbed. Approximately 80% percent of the vegetation restoration would occur in the Sand Mesa and Muddy Ridge fields where desert-shrub and Wyoming big sagebrush are predominant (see Appendix C, Table C-2).

Degraded sagebrush communities, where there has been a long history of disturbance, may experience difficulty regenerating after oil/gas construction is completed. Reclamation of these sites may require specialized soil treatments. Studies on Wyoming big sagebrush (*Artemisia tridentata* spp. *Wyomingensis*) and big basin sagebrush (*Artemisia tridentata* spp.) habitat indicate that the condition of the microbiotic soil crusts affect plant germination. Studies showed that three grasses, needle-and-thread (*Stipa comata),* Thurber needlegrass *(Stipa thurberiana)***,** and downy chess (*Bromus tectorum)* produced more seedlings in plots where the microbiotic crusts had been removed, crumbled, then reapplied, than in plots where the crusts were either left intact or the first 2 cm of the soil was removed (Kaltenecker and Wicklow-Howard 1994).

Where disturbance to wetlands and waters of the U.S. cannot be avoided, mitigation would be required. Depending on site conditions such as hydrology, substrate, and disturbance level, selection of appropriate species to enhance revegetation and restoration would mitigate impacts to wetlands and riparian areas.

4.6.4 Alternative A (485 wells) – Direct and Indirect Impacts

4.6.4.1 Vegetation

Alternative A, in which 485 new wells would be drilled, would result in the disturbance of approximately 3.06 percent or 2818.7 acres of vegetation within the WRPA (see Table 2-2). Of that acreage, 611.9 acres (0.67 percent of WRPA) will be permanently removed (see Table 2-2). This is an increase of 189.2 acres of residual vegetation disturbance over the Proposed Action (increasing the residual disturbance percentage 0.21 percent).

As compared to the Proposed Action, the phased development plan, Alternative A, would remove slightly more vegetation at any one time in each of the five development areas. More cropland would be affected by proportionately more development in the Pavillion fields. At any time, smaller amounts of desert-shrub, sagebrush, and mixed-grass prairie would be removed and others reclaimed in each of the remaining development areas in accordance with the annual development plan. There would be a moderate, short-term increase in erosion due to the loss of vegetation.

Many of the new well pads would occur in the Pavillion and Sand Mesa fields, where large expanses of Wyoming big sagebrush and mixed-grass prairie vegetation occur (see Figure 3.6-1 in Section 3.6). Compared to the Proposed Action, 52.4 more acres of vegetation would be permanently removed to construct new access roads (see Table 2-2). Shrubs and perennial grasses would be removed when new roads are constructed and during placement of riprap protection on road banks. Riprap would provide opportunity for some native and non-native vegetation to re-establish resulting in direct, localized, and long-term negligible adverse effects. Overall, impacts to vegetation under Alternative A would be similar to those in the Proposed Action, except there would be a long-term, moderate reduction in vegetation species diversity, an increase in bare ground and noxious weeds and nuisance species, and a short-term loss of vegetation.

4.6.4.2 Wetlands and Riparian Areas

Under Alternative A, impacts to wetlands/riparian areas are expected to be similar to the Proposed Action. There would be direct, short-term localized hydrological effects on wetland functions as a result of potential increase in contaminants. Although increased well development will influence the potential levels of pollutants, the minor changes to infiltration would not cause any direct perceptible long-term loss or change of wetland or riparian communities.

Grading drainage crossings and road banks to construct culverts for new roads would remove a somewhat higher amount of vegetation than the Proposed Action. Installation of culverts modifies the stream channel often increasing flow and changing peak flows during storm events. Erosion could undermine and displace vegetation.

Overall, there would be direct short-term moderate adverse effects to riparian vegetation and wetlands. All other effects to vegetation would be similar to the Proposed Action.

4.6.4.3 Vegetation Restoration

Approximately 2818.7 acres, representing 3.06 percent of the WRPA would be restored following construction. Access roads, well pads, and production facilities would be partially reclaimed resulting in residual disturbance of 611.9 acres (0.67 percent of WRPA).

4.6.5 Alternative B – Direct and Indirect Impacts

4.6.5.1 Vegetation

Alternative B, in which 233 new wells would be drilled, would result in initial disturbance of 1609.6 acres or about 1.75 percent of the vegetation within the WRPA (see Table 2-2). Following construction and reclamation, residual disturbance will be 325.1 acres (0.35 percent of WRPA). As compared to the Proposed Action, Alternative B would permanently remove 97.6 acres less vegetation over the life of the project. Proportionately smaller amounts of the native vegetation would be removed and other sites reclaimed in the Sand Mesa South, Coastal Extension and Muddy Ridge fields during each development phase of Alternative B, as compared to the Proposed Action or Alternative A.

Impacts to vegetation in the Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South and Coastal Extension fields would be less than the Proposed Action. Efforts would be made to maintain natural contours and upgrade existing roads to minimize surface disturbances. Over the long-term the direct impacts to vegetation would be minor. All other effects to vegetation would be similar to the Proposed Action.

4.6.5.2 Wetlands and Riparian Areas

The potential impacts to riparian and wetland vegetation as a result of the reduced number of wells developed would be minor and long term since there would be a minimum 500-foot setback for oil/gas drilling activities. A predicted decrease in sediment loading (485 tons/yr, see Table 4.5-9 in Section 4.5) would improve wetland absorption and filtration, which would reduce pollutant loads compared to the Proposed Action. Maintaining infiltration capacity throughout adjacent uplands would minimize impacts to wetland vegetation over the long-term. All other effects to riparian vegetation and wetlands would be similar to the Proposed Action.

4.6.5.3 Vegetation Restoration

Of the 1609.6 acres initial disturbance a total of 1284.5 acres would be restored following construction. This equates to 325.1 acres of residual disturbance (0.35 percent of WRPA) (see Table 2-2). As new wells are drilled, other areas would be reclaimed thereby increasing vegetation within oil/gas development areas throughout the life of the project.

4.6.6 Alternative C (No Action-100 wells) – Direct and Indirect Impacts

4.6.6.1 Vegetation

The No Action Alternative, in which up to 100 new wells may be drilled, would permanently remove a total of 79.3 acres (0.09 percent of the WRPA) (see Table 2-2). Approximately 318.6 acres of vegetation (0.34 percent of the WRPA) would be initially removed to construct roads, well pads, one compressor station, and production facilities within Pavillion field (see Table 2-2). Vegetation would not be removed or disturbed in the Muddy Ridge, Sand Mesa, Sand Mesa South, or Coastal Extension fields, since there would be no drilling in these development areas.

Under Alternative C, wells would be developed on private minerals, and on Tribal and/or federal minerals to offset drainage. Without a consolidated development plan there would be higher potential for fragmenting the natural landscape and increasing fragmentation of the remaining native vegetation within the Pavillion field.

The vegetation within Pavillion field is predominated by irrigated cropland. Native vegetation is sparse or absent where existing well pads, oil/gas facilities, cattle grazing areas, and cultivated development areas are located. Soil compaction by heavy drilling equipment may limit revegetation in localized areas of the five development areas resulting in long-term adverse impacts to vegetation.

Non-vegetated naturally eroded and exposed rock, sandstone, and clay exist along several access roads throughout the Pavillion field. Periodic road maintenance, conducted to remove the washboards and surface irregularities caused by normal weathering and vehicle passage, would not disturb vegetation adjacent to the road, but material brought in to resurface the road may introduce exotic plants into the area. Vehicle travel and wind along access roads could generate dust that in severe cases would interfere with plant growth and reproduction by clogging pores in the leaves. Occasional buildup of loose dirt along the drainages adjacent to the roads would encourage growth of vegetation. Road and pipeline construction disturbance per well site associated with the No Action Alternative would be similar to the Proposed Action. Overall, loss of upland vegetation would result in minor, short-term impacts.

4.6.6.2 Wetlands and Riparian Areas

Severe rainstorms and wind would erode road banks and increase the undercutting of stream banks. Sloughing or eroding road banks would expose and dry out plant roots, and would eventually dislodge or kill vegetation. Hydrographs for ephemeral streams in areas similar to the WRPA show that peak flows correlate with high intensity, short duration thunderstorms during the summer (see Section 3.5.2.2). Severe rainstorms would scour the streambeds and remove newly established plants, particularly near where rocky substrate is present. Vegetation on the drainages and road banks would continue to prevent erosion of the roads during normal rainstorms. The No Action Alternative would not interfere with the natural growth and distribution of vegetation along the stream channels. Therefore, impacts to wetlands would be short-term, localized and negligible.

The eroding surfaces and road banks adjacent to drainages and at some road drainage crossings would continue to require regular maintenance to repair or replace washed out culverts. During intense rainstorms, high stream flows would erode the stream banks, undercut portions of the roadbed, and dislodge some culverts thereby widening the drainage channels and dislodging some riparian shrubs and vegetation. Under the No Action Alternative, the effects from construction of new wells to riparian vegetation would be less than effects in the Pavillion Field from the Proposed Action. Overall, the effects to wetland and riparian vegetation would be negligible to minor and long term.

4.6.6.3 Vegetation Restoration

As new wells are drilled, well pads for dry holes and pipeline rights-of-way would be reclaimed. Vegetation restoration may require soil preparation, weed and pest controls, surface preparation, and limited irrigation. Transplanting more mature plants may be needed to support restoration efforts.

4.6.7 Impacts Summary

4.6.7.1 Proposed Action

Implementation of the Proposed Action would produce direct, minor, adverse effects on the sagebrush, desert-shrub and riparian vegetation within the WRPA. These effects would be relatively short-term, and efforts would be made to minimize surface disturbances and maintain the natural contours of the well pads and ancillary facilities, pipelines, and roads. Long-term loss of native vegetation would result from construction of permanent well pads and culvert crossings at streams, but non-productive well sites would be rehabilitated and would be able to support native vegetation in the future.

Total residual disturbance to vegetation is 422.7 acres (0.46 percent of WRPA). This includes short-and long-term disturbances to the native sagebrush and desert-shrub community adjacent to existing roadways. Each road upgrade would affect some plants. This would produce direct, negligible, adverse effects on the plant communities of the WRPA. Overall, effects to vegetation from the Proposed Action would result in localized, short-term, and minor disturbance.

4.6.7.2 Alternative A

Implementation of Alternative A would produce direct, moderate, adverse effects on the native sagebrush, desert-shrub and riparian-shrub vegetation within the WRPA. These effects would be relatively short term, and efforts would be made to minimize surface disturbances and maintain the natural contours of the land when constructing new well pads, ancillary facilities, pipelines, and access roads. Cut and fill sites and riprap stabilization would result in long-term loss of some vegetation. Short-term disturbance from site grading for road culverts would also remove vegetation. Total residual disturbance to vegetation is 611.9 acres (0.67 percent of WRPA) (see Table 2-2). Overall, Alternative A would result in minor to moderate, adverse effects on the plant communities within the WRPA.

4.6.7.3 Alternative B

The implementation of Alternative B would produce direct, minor, adverse effects on the sagebrush, desert-shrub and riparian vegetation within the WRPA. Total initial disturbance to vegetation is 1609.6 acres (1.75 percent of WRPA), but estimated acres of residual vegetation disturbance following construction total 325.1 acres (0.35 percent of WRPA) (see Table 2-2). These effects would be relatively short-term, and efforts would be made to minimize surface disturbances and maintain the natural contours of the well pads and ancillary facilities, pipelines, and roads.

4.6.7.4 Alternative C

The No Action Alternative would produce long-term negligible to minor, adverse effects on vegetation resources of the WRPA. Under Alternative C, initial disturbance is 316.6 acres in the Pavillion Field and residual disturbance would be 79.3 acres (0.09 percent of WRPA) (see Table 2-2). However, minimal disturbance would occur from routine repair and maintenance of the roads, well pads, and facilities.

4.6.8 Additional Mitigation Measures

If the mitigation measures described in Chapter 2 are implemented, no additional mitigation measures would be necessary.

4.6.9 Residual Impacts

Vegetation would be completely restored along pipeline right-of-ways. However, vegetation removed to construct well pads, facilities and access roads would not be restored until the end of the life of the field.

4.7 LAND USE

4.7.1 Introduction

Impacts to land use would occur as a result of the Proposed Action and three alternatives. Impacts to land use would be caused by the development of natural gas extraction wells and associated facilities, and the day-to-day operational activities that would occur in support of the resource extraction. Facilities may include wellheads, capped wells, storage tanks, production units, meters, pipelines, evaporation ponds, well pads, access roads, storage areas, and compressor stations.

Descriptions of land use impacts in the following sections are organized based upon their life-span. Impacts are described as short-term or long-term, in addition to being either direct or indirect. Definitions of these terms are provided in section 4.1. Additional information on the use of direct and indirect impacts is provided below

Factors that change or affect current land use are described as direct impacts. Direct impacts to land use may result from the placement of facilities on the land and the operational activities associated with resource extraction. Direct impacts may affect land uses within and/or adjacent to the WRPA. These impacts may be short-term, or long-term.

Indirect impacts caused by changes in the land use of the area may include a change in visitation to adjacent recreation areas and changes in residential development within and near the WRPA.

4.7.2 Proposed Action (325 wells) – Direct and Indirect Impacts=

The Proposed Action would include the development of 325 new gas wells within the WRPA, creating a total land disturbance of 1,982 acres (Table 4.7-1). This disturbance would not occur concurrently, but rather would take place over the life-of-project (LOP), estimated to be between 20-40 years. The construction phase of the project is anticipated to occur over a 20 year period. (See Appendix C for disturbance calculations by field.)

Table 4.7-1. Proposed Action: Proposed Number of Wells and Disturbance in the WRPA.

Field	# of Proposed Wells	% of Total Development	Total Disturbance Acres	% of Total Disturbance
Pavillion	155	48%	472.1	23.8%
Muddy Ridge	50	15%	411.2	20.8%
Sand Mesa	100	31%	764.9	38.6%
Sand Mesa South	12	4%	173.0	8.7%
Coastal Extension	8	2%	160.7	8.1%
Total:	**325**	**100%**	**1,982**	**100%**

4.7.2.1 Agricultural Resources

Agricultural land use and practices would be moderately impacted by the Proposed Action. Drilling activities would occur in agricultural lands in Pavillion, Muddy Ridge, Coastal Extension, and Sand Mesa. The Sand Mesa South field has no existing agricultural lands, therefore this resource would not be impacted here. Development and construction of wells in agricultural areas is expected to take place during the winter months, to reduce impacts to agricultural production. Short-term impacts to land use in these areas would include temporary surface disturbance and access limitations due to drilling and construction activities. In the long-term, the development of new wells within existing agricultural areas would result in a direct loss of productive land, and a shift in agricultural practices to accommodate new facilities located within productive fields. Existing irrigation systems may require modification in order to accommodate new gas well facility development and configuration.

Under the Proposed Action, agricultural resources would be impacted most in the Pavillion Field, where 48 percent of new development would occur (Table 4.7-1). Of the 155 wells proposed in the Pavillion Field, 72 would be within irrigated agricultural land. These wells would cause a long-term disturbance to 16 acres of existing irrigated agricultural land, resulting in a conversion of this land use from agricultural production to resource extraction.

4.7.2.2 Range Resources

Impacts to range resources and grazing land would be minor under the Proposed Action. The majority of the existing rangelands within the WRPA are located in the Sand Mesa and Sand Mesa South fields. A total of 112 new wells would be drilled in these areas under the Proposed Action, with an estimated success rate of 50 percent in Sand Mesa and 20 percent in Sand Mesa South (See Table 2-1, Ch. 2). The short-term disturbance to these two fields would total 937.9 acres. Short-term disturbance including well pads, roads, pipelines, and compressor stations would average 7.6 acres per well in Sand Mesa, and 14.4 acres per well in Sand Mesa South. Long-term disturbance would create a reduction in the total amount of productive grazing land by approximately 1.2 acres per well in Sand Mesa, and 1.4 acres per well in Sand Mesa South, totaling 136.8 acres over the LOP (See Appendix C, Table C-2).

The construction and drilling operations on rangelands would occur year-round if approved by land owners. If construction or drilling operations were to occur during the grazing season, it could potentially impact grazing practices by reducing the amount of available range for livestock. Other impacts to rangeland may include unintentional damage to improvements such as fences, gates, and cattle guards. Depending upon final location of proposed facilities, certain improvement devices may need to be relocated, or new improvements added to maintain the integrity of livestock grazing operations.

Short-term impacts to productive grazing lands may last as long as several years, depending upon the reclamation strategies utilized to reclaim pipeline, pad, and road disturbance. The severity of the climate and lack of water on these rangelands could limit reclamation success and prevent some areas from returning to a productive grazing condition for several years.

4.7.2.3 Residential Areas

Residential land would be moderately impacted by the Proposed Action. The majority of residential areas within the WRPA lie in the western portion. Within this area, the most concentrated area of residential development is in the Pavillion field and adjacent areas. Under the Proposed Action, the Pavillion field would have 155 new wells drilled, accounting for 48 percent of the new development (See Table 4.7-1). Other residential areas within the WRPA include the Sand Mesa and Muddy Ridge areas. In Sand Mesa, 100 new wells would be drilled, accounting for 31 percent of the new development. In Muddy Ridge, 50 new wells would be drilled, accounting for 15 percent of the new development.

Short-term impacts to residential land use would include noise and disruption associated with construction, drilling, and completion activities. Most construction activities associated with new well development are anticipated to take anywhere from one to six days (TBI 2003). Drilling operations would follow construction and take anywhere from seven to 60 days, depending upon the formation being drilled (See Table 2-9). It is anticipated that well completion operations would take five to six days for Pavillion wells, and 30-60 days for all other wells (TBI). Total development time for new wells could take anywhere from eight to 96 days (TBI 2003, Table 2-9) for construction, drilling, and completion. Generally, development of wells in the Pavillion field would take less time than wells in other fields due to the shallower depth of the resource in this area. Noise and dust associated with development activities would likely be the most prominent impacts to residents. Other short-term impacts may include limited access to portions of landowners' properties while development is taking place.

Long-term impacts to residential land uses would include limited or altered access to portions of landowners' properties. Much of this potential impact would be influenced by operator-surface owner agreements. Long-term impacts to residential areas may include altered residential development patterns in response to new wells and facilities.

4.7.2.4 Recreational Resources/ WHMA's

Impacts to recreational land uses within and adjacent to the WRPA under the Proposed Action would be minor and long term. Most recreational resources in the area are located adjacent to the WRPA, with the exception of the Sand Mesa WHMA, which is within the WRPA, in part. The adjacent recreation areas include Boysen State Park and Ocean Lake WHMA. Boysen State Park is located on the east edge of the WRPA, near the Sand Mesa development fields. Ocean Lake WHMA is located adjacent to the south edge of the WRPA, one mile south of the Pavillion field.

Recreational areas within the WRPA include the Sand Mesa Wildlife Habitat Management Areas, which traverse much of the WRPA, primarily along the drainages of Fivemile and Muddy Creeks. Impacts to land use of this WHMA are expected to be minor, and long term since drilling operations are required to be at least 500 feet away from water bodies, and visitation to this WHMA is typically low. Section 4.10 provides a detailed discussion of recreation impacts that would occur as a result of the Proposed Action.

4.7.2.5 Resource Extraction

Impacts to resource extraction land uses are expected to be negligible and long term under the Proposed Action. Within the WRPA, two distinct forms of resource extraction exist. Resource extraction will increase both road material and natural gas. There are 178 existing producing natural gas wells contained in the Pavillion, Muddy Ridge, and Sand Mesa fields, and also within the WRPA are several gravel pits. Both of these resource extraction land use activities are expected to continue, and not be impacted by the Proposed Action.

4.7.2.6 Land Use Plans

There are two land use plans in place for areas within and adjacent to the WRPA and two draft plans. Impacts to these plans as a result of the Proposed Action would be minor and long term. These plans have been drawn by the following parties: Eastern Shoshone Tribe; Fremont County; and Bureau of Indian Affairs (BIA).

The BIA's Environmental Assessment of Land Management Activities (BIA 1984) was released in 1984 and addresses specific land management activities on the WRIR.

The Draft Wind River Land Use Development Plan has been developed thus far to identify goals and objectives as a foundation for further development of the plan. The goals and objectives identify land uses including residential, agriculture, commercial, industrial, public use, and economic development. Impacts to the Development Plan are expected to be negligible as a result of the Proposed Action since no land use guidelines have been set forth yet, as the plan is currently being developed.

The existing Fremont County Land Use Plan (Fremont County 1978) includes goals for public land coordination and management, economic development, growth management, environmental quality, and natural resources.

Fremont County's Draft Fremont County Land Use Plan 2001 (LUP) (Fremont County 2001) has not yet been formally adopted by the Fremont County government, but is being used in the interim. Assuming the LUP will be adopted in the future, the Proposed Action is generally consistent with this plan.

4.7.3 Alternative A (485 wells) – Direct and Indirect Impacts

Alternative A would include the development of 485 new gas wells within the WRPA, creating a total land disturbance of 2,818.6 acres (Table 4.7-2). This disturbance would not occur concurrently, but rather would take place over the life-of-project (LOP), which would be greater than 40 years. The construction phase of the project is anticipated to occur over a 20 year period. (See Appendix C for disturbance calculations by field.)

Table 4.7-2. Alternative A: Proposed Number of Wells and Disturbance in the WRPA.

Field	# of Proposed Wells	% of Total Development	Total Disturbance Acres	% of Total Disturbance
Pavillion	206	42%	619.8	21.9
Muddy Ridge	66	14%	506.8	18.0
Sand Mesa	133	27%	974.4	34.6
Sand Mesa South	48	10%	402.6	14.3
Coastal Extension	32	7%	315.0	11.2
Total:	**485**	**100%**	**2818.6**	**100%**

4.7.3.1 Agricultural Resources

Agricultural land use and practices would be moderately impacted by Alternative A. The types of impacts to agricultural land use would be similar, but greater than the Proposed Action. Drilling activities would occur in agricultural lands in Pavillion, Muddy Ridge, Coastal Extension, and Sand Mesa. The Sand Mesa South field has no existing agricultural lands, therefore this resource would not be impacted here. Development and construction of wells in agricultural areas is expected to take place during the winter months, to reduce impacts to agricultural production. In the Pavillion field, where most agricultural land is located, 96 new wells would be developed as opposed to 72 under the Proposed Action. Alternative A would create 27.5 acres of long term disturbance in the agricultural lands of Pavillion. This accounts for a 25 percent increase in wells and long term disturbance over the Proposed Action.

4.7.3.2 Range Resources

The impact to range resources from Alternative A would be minor and short term. The majority of the existing rangelands within the WRPA are located in the Sand Mesa and Sand Mesa South fields. A total of 181 new wells would be drilled in these areas under Alternative A. Impacts to this land use would similar, but greater than those outlined under the Proposed Action. The initial disturbance to these two fields would total 1,377 acres, a 32% increase over the Proposed Action. Initial disturbance including well pads, roads, pipelines, and compressor stations would average 7.3 acres per well in Sand Mesa, and 8.47 acres per well in Sand Mesa South. Residual disturbance would create a reduction in the total amount of productive grazing ground by approximately 1.21 acres per well in Sand Mesa and Sand Mesa South, totaling 219 acres over the LOP. Depending upon the use of directional drilling, the land disturbance amounts could be reduced. Directional drilling in the Sand Mesa areas would allow the placement of two wells on the same pad.

4.7.3.3 Residential Areas

Under Alternative A the impacts to residential areas would be moderate and long term. The majority of residential areas within the WRPA lie in the western portion. Within this area, the most heavily concentrated area of residential development is in the Pavillion field and adjacent areas. Under Alternative A, the Pavillion field would have 206 new wells drilled with a 100 percent success rate, accounting for 42 percent of the new development (See Table 4.7-2). Other residential areas within the WRPA include the Sand Mesa and Muddy Ridge areas. In Sand Mesa, 133 new wells would be drilled, accounting for 27 percent of the new development. In Muddy Ridge, 66 new wells would be drilled, accounting for 14 percent of the new development. The development of new wells in these three areas accounts for a 25 percent overall increase of wells in residential areas when compared to the Proposed Action.

The types of short-term and long-term impacts to residential land use would be similar, but greater than and more widespread than those outlined under the Proposed Action. As an indirect impact, residential land use patterns and property values may be more susceptible to change under Alternative A.

4.7.3.4 Recreational Resources/ WHMA's

The impacts to recreational land use from Alternative A would be minor and long term. Most recreational resources of the area are located adjacent to the WRPA. These include the areas of Boysen State Park and Ocean Lake WHMA. Ocean Lake WHMA is located adjacent to the southern edge of the WRPA, near the Pavilion field. Of the five development areas, the Pavillion field would have the highest amount of development under Alternative A. Boysen State Park is located on the east edge of the WRPA, near the Sand Mesa development fields. The Sand Mesa fields have the second-highest amount of development under Alternative A. The Pavillion, Sand Mesa, and Sand Mesa South fields account for 80 percent of the new development under Alternative A, with 387 proposed wells, a 31 percent increase over the Proposed Action. Recreational areas within the WRPA include the Sand Mesa Wildlife Habitat Management Areas, which traverse much of the WRPA, primarily along the drainages of Fivemile and Muddy Creeks. Impacts to land use of this WHMA are expected to be minor due to the increased number of wells that would be drilled in close proximity to the WHMA. However, no wells would be placed within 500 feet of the creeks. Section 4.10 provides a detailed discussion of recreation impacts that would occur as a result of Alternative A.

Impacts to recreational land use would be similar in type to those outlined under the Proposed Action, however they would be greater. Under Alternative A, 181 new wells would be developed in the Sand Mesa and Sand Mesa South fields, a 38 percent increase compared to the Proposed Action. In the Pavillion area, 206 new wells would be developed, a 25 percent increase over the Proposed Action.

4.7.3.5 Resource Extraction

Alternative A is expected to result in negligible impacts to resource extraction (e.g., gravel mining). Resource extraction land uses are not expected to be impacted by Alternative A. Natural gas extraction and gravel mining land use activities are expected to continue, and increase and will not be impacted by Alternative A.

4.7.3.6 Land Use Plans

The impacts from Alternative A to the draft and existing land use plans are expected to be negligible.

4.7.4 Alternative B (233 wells) – Direct and Indirect Impacts

Alternative B would include the development of 233 new gas wells within the WRPA, creating a total land disturbance of 1,609.6 acres (See Table 4.7-3). This disturbance would not occur concurrently, but rather would take place over the life-of-project (LOP), estimated to be between 20-40 years. The construction phase of the project is anticipated to occur over a 20-year period. (See Appendix C for disturbance calculations by field.)

Table 4.7-3. Alternative B: Proposed Number of Wells and Disturbance in the WRPA.

Field	# of Proposed Wells	% of Total Development	Total Disturbance Acres	% of Total Disturbance
Pavillion	96	41%	307.2	19.1
Muddy Ridge	40	17%	352.8	21.9
Sand Mesa	80	35%	635.9	39.5
Sand Mesa South	10	4%	159.4	9.9
Coastal Extension	7	3%	154.4	9.6
Total:	**233**	**100%**	**1609.7**	**100%**

4.7.4.1 Agricultural Resources

Impacts to agricultural land use would be minor and long term under Alternative B. Drilling activities would occur in agricultural lands in Pavillion, Muddy Ridge, Coastal Extension, and Sand Mesa. The Sand Mesa South field has no existing agricultural lands, therefore this resource would not be impacted here. The types of impacts to agricultural land use would be similar, but lower in intensity than the Proposed Action. Development and construction of wells in agricultural areas is expected to take place during the winter months, to reduce impacts to agricultural production. In the Pavillion field, where most agricultural land is located, 34 new wells would be developed in agricultural areas as opposed to 72 under the Proposed Action. Alternative B would create 9.8 acres of long-term disturbance in the agricultural lands of Pavillion resulting in a conversion of this land use from agricultural production to resource extraction. This accounts for a 53 percent decrease in wells and long term disturbance compared to the Proposed Action.

4.7.4.2 Range Resources

Impacts to range resources and grazing land would be minor under Alternative B. The majority of the existing rangelands within the WRPA are located in the Sand Mesa and Sand Mesa South fields. A total of 90 new wells would be drilled in these areas under Alternative B. The types of impacts to this land use would be similar, but lower than those outlined under the Proposed Action. The short-term disturbance to these two fields would total 795.3 acres, a 15 percent decrease compared to the Proposed Action. Short-term disturbance, including well pads, roads, pipelines, and compressor stations would average 7.9 acres per well in Sand Mesa, and 15.9 acres per well in Sand Mesa South. Long-term disturbance would create a reduction in the total amount of productive grazing ground by approximately 1.2 acres per well in Sand Mesa, and 1.35 acres per well in Sand Mesa South, totaling 109.8 acres over the LOP.

Depending upon the use of directional drilling, the land disturbance amounts could be further reduced. Directional drilling in the Sand Mesa areas would allow the placement of two wells on the same pad.

4.7.4.3 Residential Areas

Impacts to residential land uses would be minor and long term under Alternative B. The majority of residential areas within the WRPA lie in the western portion. Within this area, the most concentrated area of residential development is in the Pavillion field and adjacent areas. Under Alternative B, the Pavillion field would have 96 new wells drilled with a 100 percent success rate, accounting for 41 percent of the new development (See Table 4.7-3). Other residential areas within the WRPA include the Sand Mesa and Muddy Ridge areas. In Sand Mesa, 80 new wells would be drilled, accounting for 34 percent of the new development. In Muddy Ridge, 40 new wells would be drilled, accounting for 17 percent of the new development. The development of new wells in these three areas accounts for a 29 percent overall decrease of wells in residential areas when compared to the Proposed Action.

The types of short-term and long-term impacts to residential land use would be similar, but lower than those outlined under the Proposed Action.

4.7.4.4 Recreational Resources/ WHMA's

Impacts to recreational land uses within and adjacent to the WRPA would be minor and long term under Alternative B. Most recreational resources of the area are located adjacent to the WRPA. These include the areas of Boysen State Park and Ocean Lake WHMA. Ocean Lake WHMA is located adjacent to the southern edge of the WRPA, near the Pavilion field. Of the five development fields, the Pavillion field would have the highest amount of development under Alternative B. Boysen State Park is located on the east edge of the WRPA, near the Sand Mesa development fields. The Sand Mesa fields have the second-highest amount of development under Alternative B. The Pavillion, Sand Mesa, and Sand Mesa South fields account for 80 percent of the new development under Alternative B, with 186 proposed wells, a 30 percent decrease compared to the Proposed Action. Recreational areas within the WRPA include the Sand Mesa Wildlife Habitat Management Areas, which traverse much of the WRPA, primarily along the drainages of Fivemile and Muddy Creeks. Impacts to land use of this WHMA are expected to be minor. (Section 4.10 provides a detailed discussion of recreation impacts that would occur as a result of Alternative B.)

Impacts to recreational land use would be similar in type to those outlined under the Proposed Action, however they would be lower.

4.7.4.5 Resource Extraction

Impacts to resource extraction land uses are expected to be negligible under Alternative B. Natural gas extraction and gravel mining land use activities are expected to continue, and increase, and will not be impacted by Alternative B.

4.7.4.6 Land Use Plans

The impacts from Alternative B to the draft and existing land use plans are expected to be negligible.

4.7.5 Alternative C (No Action 100 wells) – Direct and Indirect Impacts

Alternative C would include the development of 100 new gas wells within the WRPA, creating a total land disturbance of 316.6 acres (See Table 4.7-4). This disturbance would not occur concurrently, but rather would take place over the life-of-project (LOP). See Appendix C for disturbance calculations by field. These wells would be approved on a case-by-case basis, and developed in the Pavillion field.

Table 4.7-4. Alternative C: Proposed Number of Wells and Disturbance in the WRPA.

Field	# of Proposed Wells	% of Total Development	Total Disturbance Acres	% of Total Disturbance
Pavillion	100	100%	316.6	100%
Muddy Ridge	0	0%	0	0%
Sand Mesa	0	0%	0	0%
Sand Mesa South	0	0%	0	0%
Coastal Extension	0	0%	0	0%
Total:	**100**	**100%**	**316.6**	**100%**

4.7.5.1 Agricultural Resources

Impacts to agricultural land use would be minor and short term under Alternative C, since all drilling activities would occur in the Pavillion field. Impacts to agricultural land use would be similar, but lower than the Proposed Action. Of the 100 wells proposed in the Pavillion field, 64 would be within irrigated agricultural land. These wells would cause a long-term disturbance to 18.5 acres of existing irrigated agricultural land, resulting in a conversion of this land use from agricultural production to resource extraction. This represents a 11 percent decrease in residual disturbance compared to the Proposed Action.

4.7.5.2 Range Resources

Impacts to range resources and grazing land would be negligible under Alternative C. Existing rangeland comprises a very small portion of the Pavillion field, usually in discontinuous parcels. The majority of the existing rangelands within the WRPA are located away from the Pavillion field, and would not be developed under Alternative C.

4.7.5.3 Residential Areas

Impacts to residential land uses would be minor and long term under Alternative C. The majority of residential areas within the WRPA lie in the western portion. Within this area, the most heavily concentrated area of residential development is in the Pavillion field and adjacent areas. Under Alternative C, the Pavillion field would have 100 new wells drilled, accounting for 100 percent of the new development (See Table 4.7-4). The development of new wells in the Pavillion field accounts for a 33 percent overall decrease compared to the Proposed Action. The types of short-term and long-term impacts to residential land use would be similar, but less than the Proposed Action.

4.7.5.4 Recreational Resources/ WHMA's

Impacts to recreational land uses within and adjacent to the WRPA would be negligible under Alternative C. The Ocean Lake WHMA is located adjacent to the south edge of the WRPA, near the Pavilion field. Recreational areas within the WRPA that would be impacted include the Sand Mesa Wildlife Habitat Management Areas, which traverse the Pavillion field, primarily along the drainage of Fivemile Creek, and also including part of a reservoir in the northern portion of Pavillion. Impacts to recreational land use of the Sand Mesa WHMA within the WRPA would be similar in type, but less than those outlined under the Proposed Action.

4.7.5.5 Resource Extraction

Impacts to resource extraction land uses are expected to be negligible under Alternative C. Natural gas extraction and gravel mining land use activities are expected to continue, and increase, and will not be impacted by Alternative C.

4.7.5.6 Land Use Plans

The impacts under Alternative C to the draft and existing land use plan would be negligible.

4.7.6 Impacts Summary

The Proposed Action and Alternatives A, B and C (No Action), would affect most land-use types within the WRPA to a varying degree. The impacts include the direct loss of rangelands and agricultural lands, the possible reduction in recreational activity both within and adjacent to the WRPA, the encroachment on wildlife habitat, and the encroachment on residential areas. These impacts are summarized below.

4.7.6.1 Agricultural Resources

The Proposed Action and Alternatives A, B and C (No Action) would impact agricultural land use and practices. Development and construction of wells on irrigated agricultural land is expected to take place during the winter months, to reduce impacts to agricultural production. Short-term impacts to land use in agricultural areas would include temporary surface disturbance and access limitations due to drilling and construction activities. In the long-term, the development of new wells within existing agricultural areas would result in a direct loss of productive land, and a shift in agricultural practices to accommodate new facilities located within productive fields. Existing irrigation systems may require modification in order to accommodate new gas well facility development and configuration.

4.7.6.2 Range Resources

The majority of the existing rangelands within the WRPA are located in the Sand Mesa and Sand Mesa South fields. The development and drilling operations in these fields would occur year-round. If construction or drilling operations were to occur during the grazing season, it could potentially impact grazing practices by reducing the amount of available range for livestock. Other impacts to range land use may include unintentional damage to stock ponds and structures such as fences, gates, and cattle guards. Depending upon final location of proposed facilities, certain ponds may need to be relocated, or new ponds constructed to maintain the integrity of livestock grazing operations.

Short-term disturbance impacts to productive grazing lands may last as long as several years, depending upon the reclamation strategies utilized to reclaim pipelines, well pads, and roads. The severity of the climate in the area and lack of water on these rangelands could limit the reclamation success and prevent some areas from returning to a productive grazing status for several years.

4.7.6.3 Residential Areas

The majority of residential areas within the WRPA lie in the western portion of the project area. Within this area, the most heavily concentrated area of residential development is in the Pavillion field and adjacent area. Short-term impacts to residential land use would include noise and disruption associated with construction, drilling, and completion activities. Depending upon the formation being drilled, the total development time for new wells could take anywhere from eight to 96 days. Generally, development of wells in the Pavillion field would take less time than wells in other fields, due to the shallower depth of the resource. Noise and dust associated with development activities would likely be the most prominent impacts to residents. Other short-term impacts may include limited access to portions of landowners' properties while development activities are taking place.

Long-term impacts to residential land uses would include limited or altered access to portions of landowners' properties. Much of this potential impact would be influenced by operator-surface owner agreements. Some portions of residential properties may become unusable due to the placement of new facilities. Other long-term impacts to residential areas may include altered residential development patterns in response to new well facilities.

4.7.6.4 Recreational Resources/ WHMA's

Most recreational resources in the area are located adjacent to the WRPA, with the exception of the Sand Mesa WHMA. The adjacent recreation areas include Boysen State Park and Ocean Lake WHMA. Boysen State Park is located on the east edge of the WRPA, near the Sand Mesa development fields. Ocean Lake WHMA is located adjacent to the south edge of the WRPA, one mile south of the Pavillion field.

Recreational areas within the WRPA include the Sand Mesa Wildlife Habitat Management Area, which traverse much of the WRPA, primarily along the drainages of Fivemile and Muddy Creeks. Impacts to land use of this WHMA are expected to be minor, since drilling operations are required to be at least 500 feet away from water bodies, and visitation to this WHMA is typically low. Section 4.10 provides a detailed discussion of recreation impacts.

4.7.6.5 Resource Extraction

Resource extraction operations within the WRPA would increase. Impacts to operations would be negligible under the Proposed Action and Alternatives A, B and C.

4.7.6.6 Land Use Plans

Impacts to land use plans covering the WRPA would be minor under the Proposed Action and Alternatives A and B, and negligible under Alternative C.

Table 4.7-5. Impacts Summary.

Alternative	Total # of Proposed Wells	Total Disturbance Acres	Total Long-term Disturbance Acres
Proposed Action (325 wells)	325	1,982.0	422.7
Alternative A (485 wells)	485	2,818.7	611.9
Alternative B (233 wells)	233	1609.6	325.1
Alternative C (No Action)	100	316.6	79.3

4.7.7 Additional Mitigation Measures

In addition to the mitigation measures identified in Chapter 2, there are several mitigation measures that can be implemented to reduce impacts to land use within the WRPA. Throughout the WRPA, one of the greatest impacts to land use caused by gas well development is the direct loss of existing land uses by construction of production facilities, access roads and well pads. Directional drilling and off-site wellheads, in conjunction with the consolidation of production facility equipment to a common pad area, may be used to reduce the direct loss of existing land uses in the Muddy Ridge, Sand Mesa, Sand Mesa South, and Coastal Extension fields. However, directional drilling is not feasible in the Pavillion field.

In addition to the mitigation measures listed above, the direct impacts to productive cropland would be further reduced by locating production facilities, so that existing county or farm roads may be used for access, rather than constructing new access roads. Short-term surface disturbance should be reclaimed promptly upon the completion of construction in order to reduce the total time of disruption to landowners and operators.

In the rangeland areas of the WRPA access roads, wells and production facilities should be located to minimize impacts to rangeland operations and land use. Temporary fencing of construction areas during the development of wells and associated facilities may be necessary where wells are to be located in areas of livestock concentration. In order to reduce the fragmentation of rangelands, production facilities should be located where they can be accessed via existing county or access roads.

4.8 WILDLIFE

4.8.1 Introduction

The focus of wildlife and wildlife habitat impact analysis is on wildlife species and habitats that are considered most likely to be exposed to potential effects from oil/gas exploration and development activities in the analysis area. Using technical reports from the published literature that describe the most susceptible aspects of species life cycle and/or habitat requirements as a guide, quantitative and qualitative information was gathered regarding the presence and status of wildlife resources within the WRPA. Ecologists from the U.S. Fish and Wildlife Service, Wyoming Game and Fish Department, and Wyoming Natural Diversity Database staff were contacted for professional judgments regarding the status of wildlife species and habitats, and potential oil/gas development effects on these species and habitats. Concerns over wildlife resources identified during public scoping (not including federally listed species) include big game habitat (mule deer, whitetail deer, elk, and pronghorn) and raptors.

Wildlife habitats directly affected by the proposed project include areas which would be affected by the construction of wells, roads, pipelines, and production facilities. Indirect impacts include species avoidance of habitats adjacent to directly impacted habitats, and disturbance during construction and production activity, which would produce noise sufficient to displace or preclude wildlife use of these areas.

Potential direct and indirect wildlife impacts likely to be associated with the Proposed Action or alternatives include:

- Direct loss of certain wildlife habitat;
- Temporary displacement of some wildlife species;
- Potential for collisions between wildlife and motor vehicles;
- Accessibility contributing to the potential death or harassment of wildlife;
- Increased habitat fragmentation and edge effects;
- Exposure to contaminants; and
- Changes in wildlife behavior such as, avoidance or predation patterns, or decreased reproduction.

This analysis was made in an effort to determine potential wildlife impacts within the WRPA, so that the Operators could take these potential impacts into account when planning and selecting well locations. Mitigation measures that correspond to the various types of wildlife impacts are also discussed.

4.8.2 Geographic Area Evaluated For Direct and Indirect Impacts

The area analyzed for possible impacts on wildlife and wildlife habitats consists of all potential oil/gas exploration and development fields, access roads, and pipelines that may affect these wildlife and wildlife habitat types within the boundaries of the WRPA (see Figures 3.8-1 through 3.8-6 in Section 3.8) and adjacent to the WRPA. All surface waters including, but not limited to, the Muddy, Fivemile, and Cottonwood Creeks, as well as Middle Depression Reservoir and State Wildlife Habitat Management Areas (WHMA) within the boundaries of the WRPA are also evaluated for direct or indirect impacts to wildlife.

4.8.3 Proposed Action (325 wells) – Direct and Indirect Impacts

Under the Proposed Action, oil/gas developments within the WRPA would mostly be concentrated within or near existing fields rather that in outlying areas where development currently does not exist. Because specific well placement within the WRPA is not known at this time, it was assumed that any part of the Pavillion, Muddy Ridge, Coastal Extension, Sand Mesa, and Sand Mesa South fields might be potentially developed.

Several potential impacts on wildlife and wildlife habitats have been associated with oil/gas development. These include habitat disturbance; human disturbances (i.e. noise, construction activity, access roads and traffic); and accidental spills of petroleum hydrocarbon constituents accidentally released during operations. The impacts that may result from the Proposed Action are described below.

Habitat disturbance from oil/gas development would include direct loss of vegetation through surface disturbance of approximately 1,982 acres of wildlife habitat, habitat fragmentation, and increased edge habitat resulting from construction of new well pads, access roads, ancillary facilities and pipelines.

Human disturbances and noise from construction, oil/gas exploration, and production, and motorized vehicles are associated with operations. Noise intensities, durations and frequencies change dramatically throughout the WRPA as a function of several variables, including number of engines, engine mixes, distance between the wildlife receptor and the source of noise, topographic features that may shield potential receptors from noise sources, and the level of noise habituation of the wildlife receptor. Motorized equipment exposes wildlife receptors to a wide range of noise conditions. Noise intensity and duration tend to be higher and most persistent near the well pads and compressor stations.

The accidental spill of petroleum hydrocarbons during operations releases contaminants into the soil and water. Aquatic and terrestrial wildlife species may inadvertently ingest or absorb some of these contaminants during feeding or other activities.

The severity of both short and long-term impacts would depend on factors such as the sensitivity of the species, seasonal use patterns, type and timing of project activity, and physical parameters of the surrounding environment such as topography, vegetation cover, food type, and season.

Primary wildlife resources known to be present within the WRPA include big game (elk, mule deer, whitetail deer, pronghorn antelope) ranges; sage grouse leks and nesting habitat; raptor nests; mountain plover habitat; and white-tailed prairie dog colonies. An evaluation of the distribution and overlap of key species of interest shows an overlap of up to five of these species within the WRPA (Figure 4.8-1). Muddy Ridge and Coastal Extension contain proportionately more key species (3 to 5 species) than other fields. The southwestern and south central portion of the WRPA and all of Sand Mesa South tend to have fewer species. The more wildlife that is present within a field of the WRPA the greater the potential for impacts from disturbance. Therefore, when 4-5 wildlife resource species are present within an area, more consideration should be given to mitigation measures that would avoid impacting wildlife resources in these areas.

Figure 4.8-1. Distribution and Overlap of Wildlife Habitats.

4.8.3.1 Mammals

Habitats

Removal of sagebrush, mixed-grass prairie, and desert-shrub habitat due to construction of well pads, ancillary facilities, new access roads and pipelines within the WRPA represents a direct loss of forage and shelter habitat, resulting in a minor local, adverse effect on large and small mammals and their habitats. The excavation, grading and recontouring associated with well pad construction, road construction, bank stabilization, and stream crossing modifications would be such that only localized areas would be affected at any one time. Habitat impacts to big game species would tend to be greater in the Sand Mesa, Coastal Extension and Sand Mesa South fields, where only a few access roads and existing production facilities are present and human activity is relatively low. Pronghorn antelope, mule deer, white-tailed deer, and elk occur within the WRPA. Moose have been documented within the WRPA, although resident populations are not present. No crucial winter ranges exist in the WRPA for pronghorn antelope, mule deer, white-tailed deer, elk, or moose. Displacement of big game species from the WRPA is likely to decrease over time as the animals become adapted to construction, drilling, and road building, and as wells are completed. Because of the limited seasonal use of this habitat, and usage of relatively large ranges, impacts from the Proposed Action to these big game species are expected to be minor and short term.

Generally, the area affected by construction of the roads and pipelines, which species tend to avoid, would range from 100 feet or less for small mammals (e.g., cottontails, jackrabbits, skunks, rodents) to 1,000 feet or more for larger, more mobile species (e.g., coyote, deer, pronghorn antelope, elk). Utilization of habitats adjacent to access roads and pipelines would be lowest during the construction phase of operations; many animals would likely become accustomed to equipment and facilities and once again resume using habitats immediately adjacent to these areas.

Human Disturbances

Noise

Mule deer and pronghorn antelope are adaptable and may adjust to non-threatening, predictable human activity (Irby et al. 1988, Gusey 1986). During a three-year study of the responses of pronghorn antelope and mule deer to petroleum development on crucial winter ranges in central Wyoming, Easterly et al. (1991) found that mule deer “did not avoid oil fields” and that “deer did not move significant distances from the well site after the start of drilling activity.” Pronghorn antelope were found to habituate to repetitive heavy machinery traffic and inhabit surface mining sites in Wyoming (Segerstrom 1982, Deblinger 1988, Reeve 1984). Similarly, in an assessment of the effects of winter 3-D seismic operations on mule deer in western Wyoming, Hayden-Wing Associates (1994) found that, although the deer avoided areas of major seismic activities, they quickly moved back into such areas following completion of work. Furthermore, the deer were not displaced long distances and remained immediately adjacent to active seismic operations. Most deer responses consisted of temporary avoidance of areas near to the operations. They were observed to carry out normal activities of feeding and resting within one-eighth to one-half of a mile from most active seismic operations (Hayden-Wing Associates 1994).

Well development operations or deviation from normal oil/gas activities may cause limited antelope displacement of up to one-half of a mile (Segerstrom 1982). This displacement would decrease as the animals habituated to gas field development.

Elk are sensitive to noise, and they may be displaced from well construction areas approximately 0.75 – 2 miles (Brekke 1988, Gusey 1986, Hiatt and Baker 1981). Displacement would be reduced in areas with topographic barriers (Edge and Marcum 1991). Elk would likely habituate to the physical presence of gas wells and predictable, non-threatening traffic movement associated with well maintenance (Ward et al 1973, Ward 1976, Hiatt and Baker 1981, Perry and Overly 1976). Only localized and short-term displacement of elk during the development phase of the Proposed Action is expected to occur in those areas that are identified as elk seasonal ranges (see Figure 3.8-5 in Section 3.8). Disturbances from human activity and traffic may lower the utilization of habitat immediately adjacent to these areas (Efroymson et.al 2003). The highly mobile game mammals found within the WRPA spend relatively limited time near the oil/gas production sites where exposure to noise and human activity would be most intense. Therefore, noise from the Proposed Action would produce minor, short-term, adverse impacts on larger mammals (i.e., elk, pronghorn antelope, and mule deer).

Krausman et al (1996) studied the effects of simulated, low-flying aircraft noise (92 to 112 decibels) on mule deer and desert bighorn sheep, and concluded that animals habituated rapidly to noise and probably did not view the stimuli as a threat. Noise levels produced by oil/gas equipment would be substantially lower than those of aircraft, ranging from 65-78 decibels and decreasing with increasing distance from the point source. Similar minor impacts from noise would be expected on mammals in the vicinity of the well development or production sites under the Proposed Action.

Road Traffic

The effects of access roads on wildlife, include mortality from collisions with vehicles; restricted movement; and introduction of exotic plants, which could affect wildlife habitat; habitat fragmentation, and increased human access to wildlife habitats (Findlay and Bourdages 2000, Forman 2000, Forman and Alexander 1998). Construction of new access roads would have a minor, local, adverse effect on wildlife and their habitats because of habitat disturbance from stream crossings, bank stabilization, and road widening. Construction of new roads may lead to an increased potential for poaching of big game animals. The mere presence of the road may inhibit some rodent species from crossing the road, even though it is relatively narrow and unpaved (Trombulak and Frissell 2000). Studies have reported that roads generally reduce the overall habitat value for mule deer for distances from 0.06 mile to 0.5 mile from the road, depending on the types of traffic and adjacent habitat types (Rost and Bailey 1979). Vehicles passing along the road would cause short-term, local disturbance or displacement of wildlife directly in the road corridor, and this would represent a negligible adverse effect from the Proposed Action.

The disturbance and potential displacement of small areas of habitat that result from excavation, grading and recontouring or maintenance conducted adjacent to roads, along road embankments, or at stream crossings, would be short-lived and generally would not adversely affect wildlife species. For example, there is evidence that wildlife would use culverts as a passageway under roadways. Yanes (et al. 1995) found that the intensity of animal movement was influenced by various factors, such as the culvert dimensions, road width, height of boundary fence, the diversity of the vegetation along the route, and the presence of detritus pits at the entrance of culverts. The author concluded that adequately designed culverts could aid in the conservation of wildlife populations. Since the Proposed Action would not substantially change the volume of traffic on the roads, it would be unlikely that mortality from vehicle collisions would increase. As a result, the impact of maintenance and upgrades to existing access roads would be short-term and negligible, but generally would not adversely affect wildlife species.

Accidental Spills

Large-scale accidental spills of oil condensate or produced water may affect wildlife populations (Efroymson et al. 2003). During their study of the effects of simulated oil or produced water spills on the prairie vole (*Microtus ochrogaster*) and the American badger (*Taxidea taxus*), the authors suggested that the potential for exposure to contaminants is determined by contaminant bioavailability and animal behavior. Small amounts of spilled oil throughout the landscape may affect animal movement, food and shelter availability, or the availability of refuge from predators (Efroymson et al 2003).

Potential impacts on mammals from ingesting surface water contaminated with petroleum hydrocarbons would be negligible and short-term, because contaminant concentrations would be very low (EPA 2001). The surface water would rapidly dilute the spilled oil or condensate spills the total concentration. The residual concentrations would, therefore, be below concentrations that would cause any acute or chronic effects to wildlife.

4.8.3.2 Birds

Habitats

Potential direct and indirect effects of oil/gas-related activities on birds include habitat loss; changes in use of habitats altered during construction and drilling operations, behavioral changes from human activities; and injury, mortality, and reduced reproductive success.

Several years of drought, ongoing oil and gas production, recreation, and livestock grazing in sagebrush and grassland habitats in the region have resulted in reduced forage and degraded habitat quality (USGS 1998, WGFD 2003c). Increased inter- and intra-specific competition could result when displaced birds move into adjacent habitats, which may be less suitable, possibly resulting in mortality of some individuals.

The mixed-grass prairie within the Pavillion and Sand Mesa fields contains more plant species than any other prairie type. Ecotonal mixing of short to intermediate warm-season grass species and the taller cool season grasses found in mixed-grass prairies exceeds that in other prairie habitats (Bragg and Steuter 1996). The species composition of these bird habitats is influenced by localized drought (Wiens 1974), with grazing (Hobbs and Huenneke 1992) and wildfire (Zimmerman 1992) playing secondary roles (USGS 1998). Drought in the area has reduced forage quality and quantity, which may increase the impacts associated with displacement. Over time degradation of bird habitat may increase, thereby contributing to bird population declines.

The key to maintaining adequate breeding area for waterfowl species such as the mallard, blue-winged teal, and northern pintail, is maintaining the proportion of native mixed-grasslands, wetlands, and riparian areas. These areas are essential for slowing declines in duck numbers, including the mallard, American widgeon, and northern pintail (USFWS 1994a). Increasing sharp edge habitat, such as between wetlands and sagebrush or dessert-shrub vegetation, creates wildlife corridors and openings for predators. Predation on waterfowl eggs and hatchlings by foxes, striped skunks, raccoons, and other species substantially reduces the abundances of ducks (Ball et al. 1995). Impacts from the Proposed Action on birds, including raptors, migratory bird species, and upland game birds would be a minor, short-term adverse effect.

Human Disturbances

Impacts to migratory birds in the WRPA would be dependent upon the timing of drilling activity. The disturbance from drilling would be short term at any particular location. Surface disturbance associated with the Proposed Action has little potential to cause direct mortality to migratory or upland game birds. Migratory birds concentrate in the mixed-grass prairie, sagebrush, desert-shrub lands, and wetland and riparian areas (Cerovski et al. 2001). High-density bird concentration areas, such as nesting, roosting, or feeding areas, are generally limited to riparian areas, where there will be 500-foot setbacks in which drilling would not occur.

Construction activity during the breeding and nesting season would result in some nest abandonment, direct mortality, reproductive failure, displacement of birds, and destruction of nests. Ground nesting birds would be particularly susceptible to nest destruction. Shrub nesting birds may also be affected due to destruction of some vegetation along well sites. Most birds would avoid construction equipment and most construction would not occur within or near riparian habitats. However, nests placed in locations subject to disturbance (such as tall grass near wetlands) could be lost. This effect would be relatively minor because of the low potential for direct mortality, the short breeding season for upland game birds, and the small percentage of the WRPA that would be directly affected during the breeding season. Compared to their aerial extent across the landscape, overall habitat disturbance from the Proposed Action would be minimal. Direct loss of habitat would, therefore, have a minor adverse effect on migratory birds or upland game birds.

Disturbance effects from vehicle traffic or noise would be a negligible adverse, short-term impact because effects on populations and habitats would be well within the range of natural variability and no detectable changes in habitats would result from such activities. Indirect effects of noise from oil/gas operations may displace these birds. Such disturbances are usually temporary events that are restricted to limited areas and affect a small number of individuals. Thus, the impacts from noise are short-term, negligible adverse effects to bird species.

Construction of new access roads would increase access to tribal and federal lands within the WRPA and increase the potential for avian mortality by vehicle collision, illegal shooting, and disturbance to nests and foraging areas. Most birds killed by vehicle collisions are passerines; although raptors, particularly owls, are also killed (Erickson et al 2001). The potential for collisions with vehicles is correlated with the volume of traffic. Project-related traffic is expected to be greatest during the construction phase and to diminish during the production and reclamation/abandonment phases. The impact to birds from increased traffic would be direct, short-term and minor, as a result of the Proposed Action because of the low incidence of vehicle collisions.

Accidental Spills

Oil/gas spills can injure or kill birds from exposure to toxic substances or by destroying the insulating capacity of feathers (USGAO 2003). Small amounts of oil applied externally to aquatic bird eggs have been shown to affect bird embryos (Leepen 1976, Szaro 1979). Female aquatic birds returning to their nests with oil on their feathers may transfer the oil to their eggs and cause embryo mortality (King and LeFever 1979).

Large spills cause petroleum hydrocarbons to accumulate in soil or sediment immediately downstream of the spill. Water birds, such as herons, gulls, and ducks, feed on aquatic and benthic invertebrates and ingest sediments in the process. This may result in bioaccumulation of the hydrocarbons by the waterbirds. Polycyclic aromatic hydrocarbons (PAHs), trace metals, and radionuclides accumulate in the sediments and food chain and, thus, present a source of exposure to aquatic birds (Ramirez 1993, Rattner et al. 1995). Aquatic birds ingesting sublethal doses of theses substances may experience impaired reproduction (Grau et al. 1977).

In semi-arid areas, such as Wyoming, birds may mistake oil field waste pits for wetlands. The birds land in the waste pit and become oiled. The oil constituents coating their feathers causes a loss of insulation and loss of buoyancy, which can result in drowning. Between 1997 and 2000, USFWS personnel found waterfowl, herons, raptors, songbirds, and other animals in uncovered oil pits and tanks in Wyoming (Ramirez 2002, Esmoil and Anderson 1995). Table 4.8-1 documents the number of dead birds found in oil pits located in four counties in Wyoming during the fall migration over a three-year period.

Table 4.8-1 Migratory Waterfowl Mortality In Wyoming During Fall Migration.

Location	Date	Number of Birds
Washakie County	1995	62
Johnson County	1996	46
Crook County	1998	17
Fremont County	1998	81

Source: Ramirez 2002

Water used in drilling operations and other field watering systems contains biocides to control bacteria. Certain biocides are moderately toxic to avian species if directly ingested, but are categorized as practically nontoxic if taken in through dietary means (EPA 2001). Therefore the effects from spills of hydrocarbons would be indirect, negligible to minor adverse impacts to bird species resulting from the Proposed Action.

4.8.3.3 Reptiles and Amphibians

Habitats

Reptiles and amphibians may be indirectly affected by oil/gas development through loss of habitat, habitat degradation, and diminished food sources. Indirect effects are caused by reductions in available sources of food or having to utilize less productive habitats. Increased sedimentation can degrade reptile and amphibian habitat particularly within riparian areas.

Studies of food habits, movements, and habitat selection show that reptiles and amphibians spend longer time feeding, or travel longer distances as a result of degradation of foraging habitat (USGS 1998). Therefore, oil/gas activities may affect the percent time spent foraging and resting, the distances traveled to foraging areas, and home range size. Longer-term indirect, negligible to minor adverse effects for amphibians, attributed to oil/gas operations would include disturbance of wintering and breeding habitats that contribute to population decline.

Accidental Spills

Accidental spills of gas condensate, produced water, or oil from the rupture of storage tanks may occur within close proximity to the wetlands or riparian areas within the WRPA and could adversely affect reptiles and amphibians. Oily residues and cleanup activities could degrade important habitats for reptiles and amphibians, particularly in wetlands. Habitat degradation occurs from the oil constituents that eventually sink, contaminating soil and sediments, and benthic habitats, resulting in direct mortality to preferred food items. Little data on the effects of hydrocarbons on reptiles and amphibians exists. Hall and Henry (1992) found that it was not possible to extrapolate study results from other vertebrate classes (mostly fish) for reaching conclusions on the relative toxicity of chemicals to reptiles and amphibians.

Embryonic development is affected by the amount and time of exposure of reptiles to petroleum hydrocarbons. Studies conducted on the effects of oil on turtle eggs and hatchlings indicate that there are higher numbers of unhatched eggs when fresh crude oil was on ground surfaces during the last quarter of incubation (Fritts and McGehee 1982; Vargo et al. 1986). When oil coats the surface of the nest during the peak oxygen consumption of the embryos, lighter oil fractions displace oxygen, affecting hatchling survival. However, no drilling operations would be conducted within 500 feet of streams or other water bodies so that accidental spills would not be likely to affect wetlands or riparian areas. Therefore, effects of hydrocarbon spills under the Proposed Action on reptiles and amphibians would be short-term and negligible.

Reptiles and amphibians may be directly affected by condensate absorbed through skin of adults and eggs, and ingestion of oil and oiled food. The long-term effects of petroleum hydrocarbons on these species are unknown and would be difficult to distinguish from other widely used agricultural chemicals (Pence 1979). Studies have indicated that degradation products of certain herbicides persist in the environment and are concentrated in certain vertebrate species, such as turtles (Harris 1978). Agricultural pesticides may also negatively affect toads, but conclusive evidence is lacking (USGS 1998). These indirect effects of petroleum hydrocarbons in combination with agricultural chemicals and environmental factors would potentially contribute to short-term fluctuations in reptile and amphibian population levels. However, these fluctuations would not be expected to exceed other natural environmental variables influencing populations of these species.

4.8.3.4 Fish and Aquatic Invertebrates

Fish

Habitats

Direct impacts on fish would be associated with disturbance of their habitat, including spawning habitat. Road culverts and drainage ditches that are poorly designed can block fish movement to tributaries or upstream reaches. They also affect streams by reducing, and then accelerating water flow, which results in the erosion of downstream banks and scouring of the streambed. Roadside drainage ditches may change surface water runoff, influencing stream flows and sediment entering the streams. Roadways constructed parallel to waterways for long distances are sources of sediment. Shrub removal or thinning can both improve and damage fish habitat. In some cases removal may increase rearing habitat for some fish species. However, shrub root systems hold stream banks together and reduce erosion. When riparian vegetation is removed, large woody debris, which holds sediment in place, controls flow, and provides fish cover, is adversely affected (Mayhood 1998).

Many fish species rely on gravel for spawning, egg incubation and rearing habitat. Fishes are sensitive to damage from sediment particles smaller than 4-6 mm in diameter (such as clay) (Platts et al. 1983, Shepard et al. 1984). Other species rely on crevices between large cobbles and boulders for shelter or over-wintering habitat. Displacement of coarser bedloads attributed to stream crossings, particularly during the winter, can directly affect the amount of over-wintering habitat. Coarse particle sediment may fill in these cobble beds within deep pools and reduce the quality and quantity of habitat for fishes.

Human Disturbance

New road construction makes the streams and reservoirs more accessible to humans and increases fishing pressure. As the number of access roads increase, insufficient manpower resources limit the capability of enforcing fishing restrictions throughout the area.

Effects of noise on fish would include disturbance from heavy equipment passing on roads adjacent to streams or water reservoirs. The direct adverse impact on the fish would be short-term and negligible, because the noise would cease as soon as the vehicles moved out of the area. In a localized shallow-water area these effects would generally be within the range of natural aquatic system variability.

Accidental Spills

Research, conducted by the National Oceanic and Atmospheric Administration (NOAA) in pink salmon spawning areas indicate that eggs incubated in oiled gravel showed a higher rate of mortality, and, for certain exposure levels, a 40 percent reduction in survival to adults (USGAO 2003). Increased deformities, including extra fins, delayed growth, irregular metabolism, less effective feeding, increased predation, and a lower percentage of returning adults, were also observed (Rice 2002).

Biocides used in drilling operations could be released to the environment if spills occurred. Certain biocides are categorized as highly toxic to freshwater fish and aquatic invertebrates (EPA 2001). Overall, accidental oil/gas spills would result in short-term adverse negligible impacts on fish under the Proposed Action.

Aquatic Invertebrates

Aquatic invertebrates are a food source for numerous species of birds and fish. Decreases in aquatic invertebrate populations from the effects of drilling operations, such as increased turbidity and scouring of the stream bed, could result in decreased fish populations. Most aquatic invertebrates (mussels, clams, insects, zooplankton) are found in and on sediment, which provides protection for these species. Placement of road culverts at stream crossings would remove sediment and could increase downstream scouring.

Direct toxic effects of PAHs or gas condensate to aquatic invertebrates include increased oxygen consumption, reduced ingestion rates, immobilization, and mortality. Unless high concentrations of contaminants and repetitive spills occurred, aquatic invertebrates that are found in and on bottom substrates would not be at high risk for contamination. When exposed to high concentrations of oil or condensate (such as in an accidental spill), benthic invertebrate ecosystems would be adversely affected. Large amounts of oil constituents entering aquatic environments sink and settle in the sand and mud. Preliminary toxicity data for bioassays conducted for one, seven, or 31 days after oiling, suggest that toxicity of oil to sediment-dwelling species, such as chironomids, is much higher than for water column species (i.e., water fleas) (Klerks and Nyman 1999).

Gas condensate, produced water, oil, biocides, and other constituents associated with accidental spills during oil/gas operations are known to be acutely toxic to crayfish, fish, and mussels (Indiana Geological Survey 2001). For example, salt concentrations exceeding 3,500 mg/l may kill caddisfly and midges, while lower levels reduced productivity of these species (Williams and Feltmate 1992). Certain biocides are categorized as highly toxic to aquatic invertebrates (EPA 2001). Overall, petroleum hydrocarbon spills resulting from the Proposed Action, would result in minor, short-term, adverse impacts.

4.8.3.5 Wildlife Habitat Reclamation

Reclamation of disturbed habitats would commence immediately after the completion of construction, drilling and completion activities, and continue throughout the 13-year drilling period, resulting in a total residual disturbance of 422.7 acres (0.46 percent of WRPA) (see Table 2-2). Reclamation of disturbed areas along pipelines, rights-of-way, and unused portions of well pads would result in re-establishment wildlife habitat within the WRPA in a relatively short time period. Under the Proposed Action, wildlife habitat reclamation would reduce initial impacts from 1,982 acres, or 2.15 percent of WRPA, by 1,559.3 acres to 422.7 acres of residual disturbances (see Table 2-2).

Ancillary facilities and infrastructure resulting from the Proposed Action could be utilized by raptors as feeding perches. These perching opportunities may not be utilized in the initial phases of project development. However, after drilling has been completed these structures would likely be utilized by raptors.

Numbers of prey species would be expected to rebound to pre-disturbance levels following reclamation of disturbed areas. Once reclaimed, these areas would likely promote an increased density and biomass of small mammals that would be comparable to those of undisturbed areas (Hingtgen and Clark 1984). Therefore, implementation of the Proposed Action is expected to result in negligible short-term changes to the raptor prey base within the WRPA.

4.8.4 Alternative A (485 wells) – Direct and Indirect Impacts

Development under Alternative A would initially impact approximately 2,818.7 acres (3.06 percent of WRPA) of wildlife habitat over the next twenty years. Of these 2,818.7 acres, a total of 611.9 acres (0.67 percent of WRPA) of disturbance would remain for an indefinite period of time. Since location of wells within the WRPA is not known at this time, it is assumed that any area within the Pavillion, Muddy Ridge, Coastal Extension, Sand Mesa, and Sand Mesa South fields may potentially be developed.

The potential for adverse effects to wildlife and wildlife habitats is greater under Alternative A relative to the Proposed Action. The increased number of wells (485 vs 325), with an increase of 836.7 acres initial disturbance and residual disturbance of 611.9 vs 422.7 acres, or 189.2 acres more residual disturbance (See Table 2-2), would be a substantial change. Impacts to wildlife populations due to direct mortality, habitat loss, and displacement would be similar to the Proposed Action, except for the additional 189.2 acres of wildlife habitat that would be permanently removed.

Other effects on wildlife habitats would be similar to the Proposed Action, except there may be more habitat fragmentation resulting from the increased disturbance. Fragmentation of large areas of native vegetation into small parcels typically degrade wildlife habitat. Proportionately higher oil/gas development within the Sand Mesa, Sand Mesa South, and Coastal Extension fields under this alternative would reduce habitat for pronghorn antelope, mule deer, other big game, and other wildlife species. Impacts on wildlife and wildlife habitats due to Alternative A would be minor and short-term.

Specific effects of habitat fragmentation and disturbance for mammals, birds, reptiles and amphibians, and fish and aquatic invertebrates are described in further detail below.

4.8.4.1 Mammals

Larger areas of pronghorn antelope and mule deer yearlong habitat, and other wildlife habitat would be lost under Alternative A. The increased disturbance would fragment and disturb more wildlife habitats within the Coastal Extension, Sand Mesa, and Sand Mesa South fields than the Proposed Action. Changes in the habitat mosaic throughout the WRPA (Figure 4.8-1) may ultimately support fewer species and limit populations to smaller, more isolated patches of habitat.

Oil/gas production within the Sand Mesa, Sand Mesa South, and Coastal Extension fields under this alternative would reduce pronghorn antelope, mule deer, and other habitat available to both large and small mammals. However, impacts on large and small mammals and habitats due to Alternative A would be moderate.

4.8.4.2. Birds

There would be direct, minor adverse effects to birds resulting from Alternative A as increasingly more bird habitat is lost within the Sand Mesa and Pavillion fields. Endemic prairie grassland bird species have shown more consistent, widespread, and steeper declines in population than any other guild of North American bird species (Knopf 1992, 1996). Populations of certain sparrows and the mountain plover are declining throughout their breeding ranges. It is thought that this decline is directly attributed to the decline in native grassland habitat throughout the prairie region. Estimated loss of native mixed-grass prairie exceeds 30 percent (USGS 1998). Increased disturbance to native mixed-grass prairie and sagebrush habitat would fragment and disturb more bird habitat within Coastal Extension, Sand Mesa, and Sand Mesa South fields than under the Proposed Action.

4.8.4.3 Reptiles and Amphibians

Minor amounts of riparian areas and wetlands would be disturbed by road and pipeline crossings. A sufficient mix of small ponds, wetlands and riparian areas would remain for use by reptiles and amphibians within the WRPA. Many reptiles and amphibians rely on temporary ponds rather than streams (USGS 1998). A good mixture of available habitats, and sandy or loose soils needed for concealment by some species is also present throughout the WRPA. Therefore, there would be negligible, adverse effects on reptiles and amphibians.

4.8.4.4 Fish and Aquatic Invertebrates

Impacts on fish and aquatic invertebrates from the physical disturbance by of oil/gas development would primarily be associated with damage to stream habitats and spawning areas. Changes in fish and benthic populations resulting from oil/gas operations would be noticeable, but temporary and localized. Implementation of an emergency response plan would reduce impacts in the areas that would be affected by exposure to oil, gas, or other contaminants. These direct adverse effects would be short-term and negligible.

4.8.4.5 Wildlife Habitat Reclamation

Following wildlife habitat reclamation, disturbance would be reduced to 611.9 acres under Alternative A (see Table 2-2). The majority of the reclaimed habitat would be within the Sand Mesa, Sand Mesa South, and Coastal Extension fields (see Appendix C, Table C-3).

4.8.5 Alternative B (233 wells) – Direct and Indirect Impacts

Alternative B would involve less disturbance to wildlife and wildlife habitats than the Proposed Action. The fewer well locations (233 vs 325) and reduced residual habitat disturbance of 325.1 vs 422.7 acres would reduce the effects on wildlife (see Table 2-2). The impacts to wildlife populations from direct mortality, habitat loss, and displacement would be less than the Proposed Action. Effects of disturbance on fish and wildlife species and their supporting habitats from oil/gas development under Alternative B would be reduced. These effects would be short-term, minor, direct and indirect adverse impacts, except for the long-term negligible impacts caused by habitat fragmentation.

Alternative B wildlife habitat reclamation would reduce residual impacts by 97.6 acres, when compared to the Proposed Action. The majority of the reclaimed habitat would be within the Muddy Ridge and Sand Mesa fields (see Appendix C, Table C-4).

4.8.6 Alternative C (100 wells) – Direct and Indirect Impacts

Under the No Action Alternative, further drilling would only be allowed on private minerals and on tribal or federal minerals to offset drainage of tribal or federal minerals in the WRPA through individual APD's that would be approved on a case-by-case basis.

Alternative C would involve substantially less direct disturbance to wildlife and wildlife habitats than the Proposed Action. The reduced number of wells (100 vs 325) with a decrease of 1,665.4 acres of initial disturbance and a decrease of residual disturbance to (79.3 acres vs. 422.7 acres), would substantially reduce the effects on wildlife (see Table 2-2). The impacts to wildlife populations from direct mortality, habitat loss, and displacement would be less than the Proposed Action.

Noise, human disturbance, and possible alteration of wildlife habitats resulting from oil/gas production under Alternative C would occur at or close to current levels from the existing development discussed in Chapter 3, Section 3.8.

Wildlife impacts would be similar to those described under Alternative B. In terms of magnitude, such impacts would cause less wildlife displacement and mortality than the Proposed Action. However, there would be a slightly increased probability of additional adverse impacts from the No Action Alternative, since the overall field development would not occur in a well-planned manner. The overall adverse effects that Alternative C would have on wildlife and wildlife habitats are negligible, short-term, localized effects.

Under Alternative C, reclamation would reduce disturbance in the Pavillion field to 79.3 acres, when compared to the Proposed Action (see Appendix C, Table C-5). No disturbance would occur within the other four fields within the WRPA.

4.8.7 Impacts Summary

The implementation of the Proposed Action, Alternative A, Alternative B, and Alternative C would result in the direct loss of wildlife habitat and possible mortality from surface disturbances associated with the construction of well sites, access roads, and pipelines. Additional roads would increase potential for poaching, collisions with motor vehicles, and overall traffic in the WRPA. In addition, some wildlife species would be indirectly impacted by temporary displacement from habitats in the vicinity of human activity associated with the construction and operation of wells. The severity of these impacts would be expected to decrease with the completion of construction and the initiation of reclamation efforts in many of the disturbed areas. Comparison of the initial and residual wildlife habitat disturbance under each of the four alternatives is provided in Table 4.8-2.

Table 4.8-2 Comparisons of Wildlife Habitat Disturbance under the Proposed Action and Alternatives A, B, and C.

Alternative	Initial (ac)	Residual (ac)
Proposed Action	1,982.0	422.7
Alternative A	2,818.7	611.9
Alternative B	1,609.6	325.1
Alternative C	316.6	79.3

[1]From Table 2-2

Impacts to wildlife species resulting from the Proposed Action or Alternatives would be expected to be negligible to minor following implementation of the mitigation because:

- Impacts would not cause a substantial increase in direct mortality of wildlife.
- Habitat of game species would not be permanently reduced in size or rendered unsuitable.
- Long-term declines in recruitment and/or survival of wildlife populations are not expected.
- Reproductive success would not be threatened.
- A Wildlife Monitoring Plan (Appendix P) would be implemented.

4.8.8 Additional Mitigation Measures

The BIA may require implementation of the following mitigation measures, in addition to the mitigation measures identified in Chapter 2, to minimize impacts to wildlife species within the WRPA. Additional mitigation measures may include the following:

- Retain all live trees and snags within the WRPA as roosting or foraging perches for raptors, to the extent possible.
- Avoid land use practices that fragment large areas of wildlife habitat into small parcels.
- Where disturbance of a raptor nest is unavoidable, the BIA may require the construction of artificial nesting structures.
- In areas where four wildlife resources of concern overlap, the BIA may consider avoidance of these areas in order to reduce impacts.

4.8.9 Residual Impacts

These additional mitigation measures would reduce potential impacts in the following ways:

- Retaining live trees and snags would increase hunting perches for raptors as well as increase habitat suitable for small and medium sized mammals.
- Construction of artificial nesting structures would provide raptors with alternative nesting sites, and the potential impact on raptor nesting habitat would be reduced.

4.9 THREATENED, ENDANGERED, AND SENSITIVE SPECIES

4.9.1 Introduction

The same oil/gas exploration and development issues described for wildlife and wildlife habitats pertain to species designated as endangered, threatened, or state sensitive species. Key differences are that endangered or threatened species generally are much less abundant, have more limited range distributions, may have less tolerance to habitat alterations, and are regulated by laws and regulations. Endangered, threatened, and state-sensitive species issues involve noise, human disturbance, toxicity from oil/gas compounds, and habitat loss from degradation and fragmentation. In addition, endangered or threatened species require consideration in accordance with the Endangered Species Act, which requires that the effects of oil/gas development not jeopardize the continued existence of a designated species or its critical habitat.

Five species of threatened or endangered species have been identified by the USFWS as potentially occurring within the WRPA. They include the bald eagle (*Haliaeetus leucocephalus*), black-footed ferret (*Mustela nigripes*), Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), and grizzly bear (*Ursus arctos horribilis*). In addition, two species present within the WRPA have been identified as species of concern by both the USFWS and WGFD. These seven species will be discussed in this section.

In accordance with Section 7 of the Endangered Species Act, the impact to threatened and endangered species will be characterized as “may affect, likely to adversely affect;” “may affect, not likely to adversely affect;” or “no effect.”

4.9.2 Geographic Area Evaluated for Direct and Indirect Impacts

The area being analyzed for possible impacts on threatened, and endangered species, and species of special concern consists of all potential oil/gas exploration and development areas, access roads, and pipelines within the WRPA that may affect these species, and a 2-mile buffer zone surrounding the outer boundary of the WRPA. Surface waters evaluated for impacts include Muddy, Fivemile, and Cottonwood Creeks, and their associated tributaries, as well as Middle Depression Reservoir and Sand Mesa Wildlife Habitat Management Area (WHMA) within the boundaries of the WRPA.

4.9.3 Proposed Action (325 wells) – Direct and Indirect Impacts

Under the Proposed Action, a total of 325 new wells would be drilled within the WRPA. The potential impacts of the Proposed Action to these threatened, endangered and sensitive species are discussed below.

4.9.3.1 Bald Eagle

Bald eagles have been reported to winter in the vicinity of the WRPA. No bald eagle nests are known within the WRPA, and communications with USFWS biologists (Hnilicka, P., USFWS, personal communication, June 2003) indicate that the area may occasionally used by this species during winter months (November through March). Bald eagles have been observed to roost within the Ocean Lake WHMA, one mile south of the WRPA (Hnilicka, P., USFWS, personal communication June 2003a) and a golden eagle was observed on a rocky ledge in the Muddy Ridge Field in April 2003 (B&A 2003a).

Habitats

Direct impacts, resulting from displacement away from winter roosting habitat in the WRPA, would occur as heavy equipment and vehicles move throughout the area. The extent of the displacement would depend on the duration and intensity of the activity and on the sensitivity and habituation to disturbance of individual eagles. Construction may result in displacement from affected habitats during the entire construction phase, while production may result in displacement only during well visits.

The Proposed Action is not expected to produce any appreciable long-term negative changes to the prey base of the bald eagle within the WRPA. Once reclaimed, sagebrush and mixed-grass prairies would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas (Hingtgen and Clark 1984). Eagles concentrate in areas that have abundant food resources, but even under normal environmental conditions these riparian habitats change annually and affect the quantity and quality of riparian and wetland habitat upon which wintering eagles rely. Creek morphology and flow conditions vary and influence the availability of fish. Provided adequate hydrology is maintained, the small changes to riparian habitats and wetlands at road and pipeline crossings would not require a substantial amount of reclamation. Wells and facilities will create multiple, open sited perching structures throughout the WRPA, and these facilities will provide optimal viewing locations for the bald eagle.

Human Disturbances

During winter there would be some potential for mortality from vehicular collisions. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed big game carcasses on and adjacent to the access roads is an attractant. Eagle feeding on these carcasses are in danger of being struck by motor vehicles. Because there would potentially be exposure of bald eagles to humans, eagle mortality may occur over existing, pre-project levels. However, direct interaction between oil/gas equipment and vehicles and bald eagles would be rare.

The operation of oil/gas equipment may indirectly affect bald eagles that forage in the vicinity of the reservoirs, wildlife management ponds, or riparian areas. Motorized equipment and other motor vehicles currently use the highways and roads providing access to the WRPA. The noise may cause localized avoidance of these locations by eagles during the wintering period, which would be a short-term, minor adverse effect to this species.

Accidental Spills

Accidental oil or produced water spills in the vicinity of the reservoirs, wildlife management ponds, or riparian areas would temporarily reduce the number of prey species. Indirect effects to the eagle would involve potential ingestion of PAHs and other potentially toxic constituents from prey. Under normal oil/gas operations, high concentrations of oil byproducts would not be encountered within the WRPA, and the likelihood of an accidental spill is low. Indirect, short-term, negligible adverse effects may result from eagles ingesting hydrocarbon derivatives through dietary sources associated with an accidental spill (EPA 2001).

Water used in drilling operations and other field watering systems often use biocides to control bacteria. Certain biocides are moderately toxic to avian species if directly ingested, but are categorized as practically nontoxic if taken in through dietary means (EPA 2001).

Effects Determination

Because of the potential presence of the bald eagle during the winter in the WRPA, there would be direct and indirect, but negligible effects from oil/gas development to bald eagles. Therefore, the Proposed Action "may affect, but is not likely to adversely affect" the threatened bald eagle.

4.9.3.2 Black-footed Ferret

The WRPA (and a 2-mile buffer) supports 1,243 acres of white-tailed prairie dog colonies that meet the requirements for providing potential black-footed ferret habitat. Under the Proposed Action, potential black-footed ferret habitat may be disturbed, if wells and associated facilities are constructed within white-tailed prairie dog colonies (Biggins et al. 1989, USFWS 1989).

Habitats

Conversion of prairie dog habitat to oil/gas production sites, cropland, and other development has substantially reduced available ferret habitat throughout the region. Recent GIS data for black-tailed prairie dog colonies in Montana found that 33 percent of the colonies were less than 10 acres in size and 84 percent were less than 100 acres (Sidle 1999). However, some colonies may be close enough to other colonies to provide adequate habitat for the ferret (USFWS 2000b).

Ferret reintroduction programs have had limited success because of the decline in prairie dog populations, and lack of adequate (quality and/or size) habitat. Researchers have not yet determined what makes good ferret habitat *(*Aschwanden 2001). Studies of recent reintroduction sites indicate that a sustainable population requires a minimum of 10,000 acres of contiguous prairie dog habitat of which there are fewer than ten suitable sites left in North America (Aschwanden 2001). Therefore, in a highly fragmented landscape, ferret recolonization within an area where prairie dog habitat has been modified may not be possible.

Burrow deterioration may also limit recolonization by prairie dogs particularly in areas where there is livestock grazing or unfavorable soil conditions. Once underground burrows collapse due to the effects of weathering and age, prairie dogs are less likely to reoccupy them and reestablish themselves. Prairie dogs re-establish slowly and with much less success where burrows have deteriorated (USFWS 2000b). Without an adequate population of prairie dogs, it would be unlikely that ferrets would inhabit the prairie dog colonies.

Human Disturbances

Direct interaction of heavy equipment and vehicles with individual ferrets would be unlikely. However, loss of soil structure or soil compaction from ORV or heavy equipment operations could contribute to the destruction of prairie dog habitat and reduce the prey and habitat available for the ferret.

Indirect adverse effects may result from heavy equipment and other motorized vehicles that generate noise and ground vibrations near prairie dog colonies in which ferrets could be present. Depending on the intensity and duration of the noise or ground vibrations and the distance between the motorized equipment and the physical barriers that may exist between the source of the disturbance and ferrets, temporary exposure to high noise or vibration levels may influence ferret behavior.

Accidental Spills

Accidental oil, condensate, or produced water spills in the vicinity of prairie dog colonies, could temporarily reduce the number of prey species. Indirect affects to the black-footed ferret would involve potential ingestion of PAHs and other potentially toxic constituents. Under normal oil/gas operations, high concentrations of oil byproducts would not be encountered within the WRPA, and the likelihood of an accidental spill is low.

Effects Determination

Through implementation of mitigation measures by the operations, the Proposed Action “may affect, but is not likely to adversely affect” the black-footed ferret within the WRPA.

Overall the limited distribution of prairie dog colonies and the marginal ferret habitat within the WRPA, would result in direct, negligible, long-term impacts from oil/gas development to black-footed ferret.

4.9.3.3 Canada Lynx

There would be no adverse or beneficial effects of the proposed action on the threatened Canada lynx. This conclusion is based on the:

- Lack of snowshoe hare habitat (primary prey for lynx) within the WRPA.
- Lack of suitable habitat (boreal forest) for this species within the WRPA.

Although lynx have been found along the edges of boreal forests, such habitats are not present within the WRPA. Therefore, there would be “no effect” from the Wind River gas development project on this species.

4.9.3.4 Gray Wolf

Under the ESA, the gray wolf is considered an experimental population. This designation increases the flexibility of the USFWS in managing this reintroduced endangered species, because such experimental animals may be treated as a threatened rather than endangered species (USFWS 1994). The regulations of the gray wolf experimental populations require that experimental populations be separated geographically from non-experimental populations of the same species.

Habitats

Gray wolves are social animals, normally living in packs of 2-12 wolves. These packs typically occupy and defend territories from 32,000 to 665,000 acres. Wolves are considered opportunistic and do not require a specific habitat type for survival. They move within and between islands of occupied wolf habitats, including some habitats assumed to be unsuitable for long-term occupancy because of the potential for human conflict (WGFD 2003b). Wolf habitat is based largely on the density of prey species found in a given habitat. Resident wolf packs do not exist within the WRPA and habitat usage in the area is rare.

The WRPA is located outside of the Wolf Management Area and the proposed Northwest Wyoming Wolf Data Analysis Units (DAU). To minimize wildlife or livestock conflicts on public, tribal, and private lands, the WGFD excluded the lower end of the Wind River Range from the Wyoming Grey Wolf Management Plans. Several individual and pairs of wolves have attempted to use the lower portion of this range in the last few years, and almost all of them have been removed from the wolf population due to livestock predation (WGFD 2003b). If the grey wolf population remains at current levels or increases in number and distribution, and the USFWS accepts the Wyoming Wolf Management Plan, the USFWS may propose delisting as soon as 2004 (WGFD 2003b). Should the gray wolf be delisted in the future, wolves that occupy areas outside the DAUs will be classified as predatory animals and would not be subject to USFWS regulations (WFGD 2003b). Therefore, due to the limited distribution of gray wolves, there would be negligible short-term effects to potential gray wolf habitat from the Proposed Action.

Human Disturbances

Activities associated with the Proposed Action would increase both the amount of roads within the WRPA as well as the amount of human activity. It is known that highways with low traffic volume are not barriers or significant mortality factors for carnivores such as the gray wolf, but traffic volume over 4,000 vehicles per day creates habitat fragmentation and wildlife mortality (Reudiger et al. no date). However, road improvements produce both positive and negative impacts to wolf habitat usage in the area.

Negative impacts include mortality caused by vehicle collisions and/or poaching, and harassment and/or displacement away from human activity. Positive impacts include increased carrion resulting from big game vehicle collisions, and snow compacted winter travel corridors (Ruediger et al, no date).

Accidental Spills

A temporary reduction in the number of prey species could result from accidental oil, condensate, or produced water spills in the WRPA. Indirect affects to the gray wolf would involve potential ingestion of PAHs and other potentially toxic constituents from prey. Under normal oil/gas operations, high concentrations of oil byproducts would not be encountered within the WRPA, and the likelihood of an accidental spill is low. Indirect, negligible, short-term impacts may occur from wolves ingesting hydrocarbons from prey contaminated by oil or condensate.

Effects Determination

Given the low likelihood of the presence of the gray wolf at the present time within the WRPA, negligible, short-term adverse effects to gray wolf populations would occur as a result of the Proposed Action. Therefore, the Proposed Action “may affect, but is not likely to adversely affect” the gray wolf.

4.9.3.5 Grizzly Bear

The current extent of the grizzly bear’s range in Wyoming is not known precisely, but monitoring radio-collared bears from 1975 to 1999 has documented their general range. This area includes all of Yellowstone and Grand Teton National Parks, portions of adjacent National Forests, private lands to the south and east of Yellowstone, and south in the Wind River Range to the Green River Lakes. Most currently occupied grizzly bear habitat in Wyoming is on U. S. Forest Service land. However, grizzly bears use other federal, state and private lands (WGFD 2002) and show a wide range of habitat tolerance.

Habitats

Grizzly bears are solitary animals, typically occupying a home range of one bear per 15-23 square miles (USFWS 1993). The size each bear’s home range varies in relation to food availability, weather conditions, and interactions with other bears.

Large tracts of land needed by grizzly bears remain available in only a few areas throughout Wyoming. Management efforts include maintaining movement corridors in the northern Rockies for grizzly bears. The major emphasis for management is to create areas of safe passage for the bears across highways, railroad tracks, and other developed areas (WGFD 2002b).

Much of the land outside of the grizzly bears’ Primary Conservation Area (PCA) which is the area within the Wyoming portion of the Greater Yellowstone Ecosystem, is managed for multiple uses. Outside of the outer boundary of the grizzly bear PCA, the WGFD established an additional ecosystem transition zone (ETZ) (WGFD 2002e). This ETZ includes the southern and southwestern portions of the Wind River Indian Reservation.

Human Disturbances

Activities associated with the Proposed Action would increase both the amount of roads within the WRPA as well as the amount of human activity. Radio telemetry studies have identified roads as contributing to brown and grizzly bear habitat deterioration and increased mortality (WGFD 2002e). Impacts to grizzly bears from roads has been attributed to the percentage of habitat loss associated with increased road density (Mattson, et al. 1987).

Accidental Spills

A temporary reduction in the number of prey species could result from accidental oil or produced water spills in the WRPA. Indirect effects to the grizzly bear would involve potential ingestion of PAHs and other potentially toxic constituents from prey. Under normal oil/gas operations, high concentrations of oil byproducts would not be encountered within the WRPA, and the likelihood of an accidental spill is low. Indirect, short-term, negligible effects may occur from grizzly bears ingesting hydrocarbon derivatives through dietary sources associated with an accidental spill.

Effects Determination

It is unlikely that oil/gas operations would directly conflict with this species. Therefore, there would be negligible short-term effects on grizzly bear habitat. This conclusion is based on the fact that no resident grizzly bears exist in the WRPA, and observations of grizzly bears in WRPA are rare. Given the minimal acreage of disturbance relative to grizzly bear home ranges, the Proposed Action "may affect, but is not likely to adversely affect" the grizzly bear.

4.9.3.6 Greater Sage-grouse

Although the greater sage-grouse is not federally listed as threatened or endangered at this time, it is a species of high interest among federal and state agencies. The sage-grouse is categorized as a Wyoming State-sensitive species.

Habitats

Oil/gas developments are generally localized and are unlikely to have widespread impacts on sage-grouse. However, removal of vegetation can fragment and reduce the availability of suitable habitat, and mechanical and human disturbances may disrupt breeding activities (Aldridge 1998).

Sage-grouse rely heavily on sagebrush habitat for leks, nesting sites, feeding sites, rearing sites, shelter and wintering grounds. Approximately 20,437 acres of sagebrush habitat comprising 22 percent, are present within the WRPA. Although sagebrush is the most important component of the sage-grouse diet, forbs and grasses are also a significant food source.

The most suitable sage-grouse habitat was found immediately south of the WRPA boundary, north of Fivemile Creek and south of Muddy Ridge. These areas consist of approximately 50-60 percent sagebrush (*Artemisia* spp.), 10-15 percent short grasses, with the remaining area bare ground. However, no sage-grouse leks have been observed within the WRPA (Buys & Associates 2003a).

Although sage-grouse have not been reported within the WRPA, they have been observed south and west of the WRPA. Construction activities could affect potential sage-grouse habitat. Direct habitat loss and degradation have been implicated in the decline in lek attendance and abandonment of sites where oil and gas development has occurred within 0.25 miles of leks or nesting areas (Braun et al. in press). Most nests are close to leks (Braun et al. 1977) and hens show strong site fidelity, which may be in response to the presence of important vegetative nesting habitat characteristics such as sagebrush, forbs and grass cover, and height of the sagebrush (Lyon 2000). Hens from disturbed leks adapt in part by selecting higher canopy cover and shrub heights in sagebrush (Lyon 2000).

Both quantity and quality of the sagebrush environment determines its suitability as sage-grouse habitat. Suitable habitat consists of shrubs, grass and forbs that vary with the subspecies of sagebrush. Preferred seasonal habitats must occur in a patchwork or mosaic across the landscape. The spatial arrangement, amount and vegetative condition of the habitat determines its potential use by sage-grouse. Even if disturbed sites are reclaimed at a later date, they may fail to return to previously used habitats. This has been the case for several leks in Canada. In recent years, six traditional lek sites have been temporarily disturbed by oil and gas operations, and four of these are no longer active (Aldridge 1998).

Human Disturbances

New access roads could increase the number of predators in sage-grouse habitat. Predation, especially during nesting, egg laying, and brood rearing, limits the growth of sage-grouse populations. Predators cause approximately 50 percent of sage-grouse mortality. Adults are most vulnerable to predators in the winter because the snow makes them more visible (Aldridge 1998).

An increase in the number of roads would potentially contribute to direct, short-term negligible effect from mortality of sage grouse and fragmentation of the habitat. Sage-grouse cross roads to and from foraging grounds and leks, increasing the potential for road kills (Aldridge 1998). Roadways may render leks more visible to humans, which could lead to abandonment of the leks.

Accidental Spills

Accidental spills of produced water, oil, condensate, metals, and radionuclides could accumulate in sediments and in plants. These constituents present a source of exposure when birds ingest contaminated sediment (Ramirez 1993, Rattner et al. 1995, Grau et al. 1977). Accidental oil spills can reduce the insulating capacity of feathers or expose birds to toxic substances (USGAO 2003). However, studies have shown no signs of toxicity, reduction in feeding, loss of body weight or grossly visible pathological abnormalities in mallards fed up to 100,000 parts per million of weathered Exxon Valdez crude oil (Neff and Stubblefield 1995).

Effects Determination

Overall, the impacts of the Proposed Action to the greater sage-grouse and its habitat would be minor and long-term.

4.9.3.7 Mountain Plover

In 1999 the mountain plover was designated as a “proposed” species for listing as threatened under the ESA. On September 9, 2003, the USFWS withdrew the mountain plover as a proposed species (USFWS 2003b; Hnilicka, 2003a; USFWS 2003c). The mountain plover remains a Wyoming state sensitive species and a species of concern to the USFWS because it is considered rare (Hnilicka 2003a).

Habitats

Oil/gas project development has the potential to cause both direct and indirect, long term minor disturbances to the mountain plover. Direct disturbances include destruction of nests, loss of habitat, and mortality. Indirect impacts include avoidance, reduction in reproductive potential, and reduction in food availability.

Mixed-grass prairie on low slopes provides optimal mountain plover nesting habitat (Parrish et al. 1993). A total of 59,640 acres of potential mountain plover nesting habitat exists in the WRPA within the mixed prairie, desert shrub and sagebrush grassland habitat types (See Section 3.9). These habitat types comprise 65 percent of the WRPA. During field surveys, plovers were observed using these habitat types within the Pavillion field, and a 2-mile buffer surrounding the WRPA, particularly in areas near prairie dog colonies.

Degradation of an area may have an adverse effect on species richness, indicating a loss of ecological resources or a decrease in ecological function in that area. The development of gas and oil resources has the potential to disrupt complex associations of vegetation and wildlife in the WRPA, potentially warranting greater care or mitigation in certain areas to maintain an acceptable level of ecological function (LaTurrette et al. 2003). There is potential overlap between mountain plover habitat and white-tailed prairie dog colonies in the northwest corner within and immediately outside the boundaries of the WRPA (See Figure 4.8-1).

Minor, beneficial effects of the Proposed Action include the creation of bare ground that could be used as nesting habitat. Although increased suitable habitat might result from construction and drilling, these activities are also likely to cause nests to be abandoned or destroyed when these activities occur during the nesting season.

Human Disturbances

Indirect adverse effects may result from heavy equipment, vehicles and other motorized equipment that generate noise in or adjacent to potential mountain plover habitat. These disturbances could result in loss of potential nesting habitat, nest abandonment, impact to eggs and young, and increased mortality from predation.

Mountain plovers have been reported to vacate nesting habitat near wind turbines (USFWS 2003c). Nesting may be re-initiated, but a net loss in reproductive potential would have occurred because of the loss of the initial nest. Mountain plovers also show a high rate of fidelity to nest sites, often using the same area year after year. Modifications that make these areas less suitable for nesting may result in decreased reproductive success.

Accidental Spills

Depending on the proximity of mountain plover habitat to areas of development activity, and the frequency and scale of accidental spills of produced water, oil, gas condensate, metals, and radionuclides could accumulate in sediments. These constituents present a source of exposure when birds ingest contaminated sediment (Ramirez 1993, Rattner et al. 1995, Grau et al. 1977). Studies have shown no signs of toxicity, reduction in feeding, loss of body weight or grossly visible pathological abnormalities in mallards fed up to 100,000 parts per million of weathered Exxon Valdez crude oil (Neff and Stubblefield 1995).

Effects Determination

Overall, the adverse effects of the Proposed Action to the mountain plover would be minor and short-term.

4.9.4 Alternative A (485 wells) – Direct and Indirect Impacts

Under Alternative A oil/gas development would impact approximately 2,818.7 acres of wildlife habitat over the next twenty years. The residual disturbance would be 611.9 acres. Similar to the Proposed Action, it was assumed that well placement could be in any area within the Pavillion, Muddy Ridge, Coastal Extension, Sand Mesa, and Sand Mesa South fields.

The effects of Alternative A are similar to those presented under the Proposed Action, except that the potential for impacts under Alternative A is proportionately higher than the Proposed Action because of the greater number of well pads (485 vs 325), and increases in disturbance (836.7 acres) and post-reclamation disturbance to 611.9 vs 422.7 acres, (see Table 4.8-2), totaling 189.2 more acres of disturbance than the Proposed Action Because there would be more habitat disturbances than in the Proposed Action, there would potentially be more effects to threatened and endangered species and their habitats.

4.9.4.1 Bald Eagle

This species winters in the WRPA. Construction and drilling operations in the Pavillion field irrigated areas would be highest in the winter when bald eagles might roost within the WRPA. Impacts to the bald eagle from drilling operations would, therefore, be greater in the winter. In the other four development areas, drilling would occur throughout the year. The occasional disturbance of individual eagles by heavy equipment or vehicles passing nearby during the winter season would be minor, short-term, and indirect under Alternative A. Avoidance of foraging habitat in or adjacent to oil/gas operations during the wintering period would also impact the bald eagle. Therefore, construction and drilling operations “may affect, but are not likely to adversely affect” the bald eagle.

4.9.4.2 Black-footed Ferret

Under Alternative A, more frequent occurrences of noise, ground vibrations, and other development activities generated by oil/gas operations would occur in close proximity to areas potentially occupied by ferrets. However, since drilling operations would not be permitted in to white-tailed prairie dog colonies, Alternative A “may affect, but is not likely to adversely affect” the black-footed ferret.

4.9.4.3 Canada Lynx

Due to the lack of habitat within the WRPA there would be “no effect” on the Canada lynx under Alternative A.

4.9.4.4 Gray Wolf

The potential impact to the gray wolf under Alternative A would be similar to that previously described under the Proposed Action, except the increased potential for habitat fragmentation and degradation could temporarily decrease available prey in some areas of the WRPA. However, effects to gray wolf habitat would be short-term and negligible. Thus Alternative A “may affect, but is not likely to adversely affect” the gray wolf.

4.9.4.5 Grizzly Bear

The effects of Alternative A would be similar to that previously described under the Proposed Action. Current use of the WRPA by the grizzly bear is rare, and it would be unlikely that this usage would change with the oil/gas development. Impacts on the grizzly bear due to Alternative A would result in negligible, short-term impacts. Therefore, Alternative A "may affect, but is not likely to adversely affect" the grizzly bear.

4.9.4.6 Greater Sage-Grouse

The effects of Alternative A would be similar to that presented under the Proposed Action, except that the potential for impacts under Alternative A is proportionately higher. Overall, impacts from construction and drilling operations under Alternative A would be a direct short-term, negligible adverse effect.

4.9.4.7 Mountain Plover

The potential for impacts to the mountain plover under Alternative A is proportionately higher, than that of the Proposed Action. Alternative A would have minor impacts since operations would be prohibited near nesting areas. Overall, the adverse effects from Alternative A would be short-term and minor.

4.9.5 Alternative B (233 wells) – Direct and Indirect Impacts

The effects of Alternative B would be the similar to those identified for the Proposed Action, except that Alternative B would involve comparatively less direct disturbance to threatened and endangered species and their habitat. The reduced number of well locations (233 vs 325, or a decreased disturbance of 372.4 acres) and post-reclamation habitat disturbance of 325.1 vs 422.7 acres (or 97.6 acres less disturbance) would reduce the effects on listed species.

4.9.5.1 Bald Eagle

Effects on the bald eagle would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B "may affect, but is not likely to adversely affect" the bald eagle.

4.9.5.2 Black-footed Ferret

The effects on the black-footed ferret would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B "may affect, but is not likely to adversely affect" the black-footed ferret.

4.9.5.3 Canada Lynx

Due to the lack of habitat within the WRPA there would be "no effect" from Alternative B on the Canada lynx.

4.9.5.4 Gray Wolf

The effects of Alternative B on the gray wolf would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B "may affect, but is not likely to adversely affect" the gray wolf.

4.9.5.5 Grizzly Bear

The effects of Alternative B on the grizzly bear would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B "may affect, but is not likely to adversely affect" the grizzly bear.

4.9.5.6 Greater Sage-Grouse

The effects of Alternative B on the greater sage-grouse would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B would result in minor short-term effects on the sage-grouse.

4.9.5.7 Mountain Plover

The effects of Alternative B on the mountain plover would be similar to those described for the Proposed Action, except that they would be proportionally lower. Therefore, Alternative B would result in minor short-term effects on the mountain plover.

4.9.6 Alternative C (No Action 100 wells) – Direct and Indirect Impacts

Under the No Action Alternative, the current level of oil/gas activity associated with the existing wells would continue. Further drilling would only be allowed on private minerals and drainage protection wells under individual APD's that would be approved on a case-by-case basis. Since only 100 new wells would be drilled in the Pavillion field, impacts would be reduced as compared to the Proposed Action. However, drilling on a case-by-case basis could result in an overall increase in impacts, since development may not occur in a well-planned manner.

The No Action Alternative would result in negligible to minor and short-term to long-term, localized effects on federally listed species and species of special concern. Those species that may utilize road corridors (i.e., bald eagle, gray wolf, and grizzly bear) would likely be disturbed and possibly displaced temporarily by vehicles on the access roads. The disturbance and potential displacement would be short-term and generally would not adversely affect the federally listed endangered, threatened, protected or state species of concern. Therefore, Alternative C "may affect, but is not likely to adversely affect" the bald eagle, black-footed ferret, gray wolf and grizzly bear. Alternative C would have "no effect" on the Canada lynx, since no habitat or primary prey species are present within the WRPA.

4.9.7 Impacts Summary

With the implementation of the Proposed Action or Alternatives A, B and C, direct loss of habitat would result from surface disturbance associated with the construction of wells and related access roads and pipelines. Small portions of potential bald eagle, sage-grouse, mountain plover, grizzly bear, gray wolf, and black-footed ferret habitat may be disturbed.

The probability or impacts to wildlife and the intensity of such impacts would be greater under Alternative A than for the Proposed Action. The application of prescribed avoidance, monitoring (Wildlife Monitoring/Protection Plan, Appendix P), and mitigation measures identified in Chapter 2 would minimize the potential impact to federally listed species and state sensitive-species.

Impacts resulting from the development of the Proposed Action or Alternatives A, B and C are not expected to adversely affect threatened, endangered, and state-sensitive species following implementation of the mitigation measures, since:

- Project development is not expected to jeopardize the recovery program of any federally listed, or proposed species.
- The Biological Assessment (Appendix L) concluded that the proposed development is not likely to adversely affect threatened or endangered species within the WRPA.

4.9.8 Additional Mitigation Measures

The following additional mitigation measures are suggested to minimize impacts to threatened, endangered, or State sensitive wildlife species:

- Educate all project employees about applicable wildlife laws and penalties associated with unlawful “take” and harassment of threatened and endangered species.
- Minimize wildlife/human conflicts within the WRPA by reducing speed limits on roads throughout the WRPA.
- Minimize the number of road upgrades and of new roads to reduce habitat fragmentation.
- Retain all live trees and snags within the WRPA as hunting perches for bald eagles and other raptors.
- Avoid disturbances to, enhance where practicable, or restore habitats of unusually high value for threatened or endangered species or other species protected by state or federal law.
- Restore mountain plover habitat by using seed mixes and application rates for reclamation that produce stands of sparse, low-growing vegetation suitable for plover nesting.
- Realign access roads to avoid identified mountain plover occupied habitats.
- Restore habitat utilized by sage-grouse by using seed mixes to produce sagebrush vegetative communities suitable for greater sage-grouse nesting, along with higher herbaceous cover (especially forbs) for brood rearing.
- Maintain areas of low sagebrush canopy cover and high herbaceous composition adjacent to greater sage-grouse nesting habitat and retain linkages of sagebrush habitats to allow the sage-grouse to move between late brood-rearing and winter habitats.

- Reduce, control and prevent the introduction of invasive plants in known sage-grouse habitat.

4.9.9 Residual Impacts

Residual disturbance would include the following:

- Disturbance in areas not reclaimed (e.g., access roads).
- Loss of corridors for movement of large carnivores, such as grizzly bears and gray wolves, would prevent them from utilizing suitable habitats that become isolated because of past or existing land uses (WGFD 2003b).
- Reclaimed habitat utilized by nesting mountain plovers prior to disturbance from oil/gas activities may be less suitable and result in decrease in reproductive success.
- Sage-grouse may fail to return to previously used lek sites, even if they are reclaimed.

4.10 RECREATION

4.10.1 Introduction

This section addresses the potential impacts of the Proposed Action and Alternatives to recreational opportunities and the recreational experience in and near the Wind River Project Area (WRPA).

The analysis focuses on recreation resources in the WRPA and nearby. It considers Tribal lands, as well as public lands in the Sand Mesa Wildlife Habitat Management Area (WHMA), Boysen State Park, and the Ocean Lake WHMA. These resources support hunting, fishing, water sports, camping, bird watching and off-road vehicle (ORV) use. The assessment also considers whether the Proposed Action and alternatives are compatible with recreation planning by jurisdictions in the WRPA.

The recreation analysis considers both direct and indirect impacts to recreation. Direct impacts are changes to recreation from land disturbance. Examples of direct impacts include causing change in game populations because of habitat disturbance or eliminating a hunting or fishing area entirely or in part. Indirect recreation impacts are those that occur because of other effects of the drilling and production process. Examples are disturbances of the recreation setting by traffic, noise and landscape changes.

Direct effects would mainly be associated with the field development phase of the project. Development activities potentially disturb big game habitat and render some hunting areas unavailable or less attractive during drilling, completion, and other construction activities. Indirect impacts potentially would occur during both the development and production phases. Indirect effects like human presence, visibility of facilities, traffic, and noise would potentially affect the setting for recreation use and the experience of some recreation users, although not all users react to these effects in the same way.

In general, impacts to recreation are higher during the construction and drilling phase of the Wind River Development Project. They decrease as production takes over, because land disturbance is reclaimed and human activity declines during production. However, impacts to recreation from development generally are short-lived as drilling and pipeline construction moves from place to place during wellfield construction. Potential impacts from all phases would be determined somewhat by the density of sites to be developed, as well.

Most effects to recreation are considered to be adverse, because they tend to decrease recreation opportunities in the WRPA and decrease the appeal of the setting for some recreationists. However, some parts of the project may be beneficial to some users. An example is new roads on tribal and public lands that may provide access to new areas for hunting.

Indirect impacts to recreation also can occur from population growth associated with the project's workforce. This factor was considered but not pursued further in the analysis of the Proposed Action and alternatives because the project is unlikely to cause significant population effects, as described in Section 4.13 (Socioeconomics). Impacts to recreation from potential residential development in the future also are described in Chapter 5 (Cumulative Impacts Analysis).

The analysis that follows assumes a non-uniform distribution of wells and support facilities across the landscape. More specific characteristics are described below for the Proposed Action and Alternatives A through C.

4.10.2 Proposed Action (325 wells) – Direct and Indirect Impacts

With the Proposed Action, new wells would be developed in the Pavillion and Muddy Ridge fields, where there are already 113 and 89 existing wells, respectively. The maximum density of new well development in Pavillion and Muddy Ridge (excluding existing development) would be 32 wells per section.

New wells also would be developed in the Sand Mesa, Sand Mesa South and Coastal Extension fields where almost no wells exist now. The maximum density of new well development would be 16 wells per section in Sand Mesa, Sand Mesa South, and Coastal Extension.

Well density in each section would vary, up to the maximum anticipated density, because development would not be uniform. Direct effects would be limited to recreation resources within the development areas, but indirect effects could potentially spill over to recreation resources nearby.

4.10.2.1 Development

With the Proposed Action, impacts to recreation from development could last for 11 years in Pavillion (10 to 18 wells drilled per year), five years in Muddy Ridge (12 wells drilled in all years but one), 13 years in Sand Mesa (8 wells drilled in all years but one), four years in Sand Mesa South (3 wells per year) and seven years in Coastal Extension (1 well per year).

In each field, as much as three percent per year of the acreage in the field would be disturbed consisting of areas being drilled and areas in the process of being reclaimed as production begins. This assumes that drilling and production proceeds one well at a time, that the level of human activity decreases to production levels after completion (2 weeks to three months, depending on the field) and that land disturbance from drilling is substantially re-vegetated in about three years, the minimal time for typical crops to become mature and productive and for the reestablishment of rangeland vegetation. The impacts of this process to recreation resources are described next.

Impacts to Recreation on Tribal Lands

Tribal lands in the WRPA support some hunting, trapping and fishing. Tribal lands where there are known recreational opportunities are all or part of three sections in the 11-section Muddy Ridge field and all or part of seven sections in the eight-section Coastal Extension field. Recreation also occurs on Tribal lands in the Sand Mesa field (in 3 of 12 sections) but recreational use of the area is low because of remoteness, habitat quality and access.

Development in the Muddy Ridge and Coastal Extension fields would introduce a greater density of land disturbance and activity compared to what is there now. As noted, the development effects are anticipated to be short-lived as drilling and pipeline construction moves from place to place, and would generally depend on the location of construction sites in relation to recreation resources.

Disturbance and activity during development would potentially affect the number and distribution of game animals and the quality of the hunting experience, which depends on game availability for hunting success. The effect would be more pronounced in the Coastal Extension field, where there has been no previous resource extraction.

Tribal members who hunt in these specific areas may be temporarily displaced from using the locations associated with drilling activities. Or, if they continue to use the area, Tribal members may experience a lower quality hunting experience.

These effects would be greatest during antelope season (typically late September through late October) when most hunters are in the area, including hunters of other big game animals. However, use of these Tribal lands for hunting is very small, according to estimates prepared for this analysis. Therefore, impacts to hunting on Tribal land from development under the Proposed Action would be minor and short term (see Chapter 3—Affected Environment, Recreation Resources).

Some fishing occurs in Stockpond Reservoir on Tribal land within the Coastal Extension field (T 4N, R4E, Sect. 18). Noise, human presence and associated activity may occur during development, potentially affecting the recreation setting for anglers at Stockpond Reservoir. The intensity of these effects would depend on the location of drilling within the Coastal Extension field, and in the case of the fishing resource, would potentially be mitigated by prohibiting construction within 500 feet (one-tenth of a mile) of surface water and riparian areas. Although the number of anglers who use Stockpond Reservoir is not known, use is believed to be low. This would reinforce the likelihood that potential adverse impacts to this recreation setting would be minor and short term.

Impacts to Recreation in the Sand Mesa Wildlife Habitat Management Area

The recreation resources of the Sand Mesa Wildlife Habitat Management Area (WHMA) inside the WRPA are Middle and Upper Depression reservoirs and the corridors of Cottonwood Drain, Fivemile Creek and Muddy Creek. Lake Cameahwait, Muddy Ridge Reservoir, Antelope Flats Wetland and the Sand Mesa Ponds, also known as Lower Depression Ponds, are part of the Sand Mesa WHMA and are near but outside of the WRPA boundary.

Sand Mesa WHMA Recreation Resources within Fields

Under the Proposed Action, land disturbance, drilling and completion operations, and traffic associated traffic with development would potentially affect recreational opportunities and the recreation setting. This would occur mainly in parts of the Sand Mesa WHMA that are located in four of the five development areas of the WRPA. (The Coastal Extension field does not contain lands of the Sand Mesa WHMA). As noted, the development effects are anticipated to be short-lived as drilling and pipeline construction moves from places to place, and would generally depend on the location of construction sites in relation to recreation resources. The potentially impacted areas include the following:

- Leased development areas and parts of the Fivemile Creek corridor located on nine of 15 sections in the Pavillion field would potentially be affected. Recreation activities that may be affected would include pheasant, antelope and deer hunting.

- Parts of the Muddy Creek corridor located on four of 11 sections in the Muddy Ridge field, would potentially be affected by drilling of about 12 wells per year for four years.

Recreation potentially affected by the development would include pheasant, deer and antelope hunting.

- Middle Depression Reservoir, parts of the Cottonwood Drain corridor, and part of Bass Lake Road, located on 12 of 18 total sections in the Sand Mesa field would potentially be affected by drilling of about eight wells per year for 12 years and four wells in the thirteenth year by one rig. This would potentially affect waterfowl and pheasant hunting, deer and antelope hunting, and fishing. Associated traffic on the Bass Lake Road would potentially affect access to Lake Cameahwait and Sand Mesa Ponds for waterfowl hunting, deer and antelope hunting, fishing, boating and other non-consumptive recreation.

- In the Sand Mesa South field, development of about three wells per year for four years would potentially affect parts of the Muddy Creek corridor located on six of eight total sections in the field. Potentially affected activities are pheasant, deer and antelope hunting.

The pheasant season in November and December attracts more than 300 hunters to the WRPA, most of which includes the creek, canal and drain corridors of the Sand Mesa WHMA. Impacts to hunting in the Sand Mesa WHMA are likely to be highest during pheasant seasons, because of the accumulated use attracted to the resource by the overlap of the pheasant, deer, and waterfowl seasons. Surface disturbance, as well as noise, human activity, visibility of facilities, and traffic associated with gas development, potentially would disturb game populations and the experience of hunters who prefer a more natural setting. The potential for impacts would last for four to 13 years, depending on the proximity of hunting areas to different development areas.

Potential impacts to hunting near the Pavillion field would be somewhat higher because drilling in the Pavillion field would occur from November to April and would partly overlap within the fall hunting seasons. At the same time, impacts to hunting near surface water and riparian areas would be partially mitigated by prohibiting construction within 500 feet (one-tenth of a mile) of surface water and riparian areas.

Middle Depression Reservoir in the Sand Mesa Field also has the potential for somewhat higher impacts because anglers, boaters and waterfowl hunters would have views of gas development facilities and of project-related traffic on the Sand Mesa Road. The amount of use potentially subject to these impacts is not available for this site. The potential for impacts to hunting at Middle Depression Reservoir also may be somewhat higher because drilling in agricultural areas nearby would occur from November through April and could partly coincide with fall and winter hunting seasons. At the same time, impacts to hunting near surface water and riparian areas would potentially be mitigated by prohibiting construction within 500 feet (one-tenth of a mile) of surface water and riparian areas.

Overall, impacts to hunting are distributed among development areas that overlap parts of the Sand Mesa WHMA without covering it completely. On the whole, impacts from the Proposed Action to hunting resources of the Sand Mesa WHMA would be minor and short term.

Other Sand Mesa WHMA Recreation Resources

Future development is unlikely to occur in outlying areas of the WRPA beyond development areas targeted by the Proposed Action, and development would not occur outside of the

WRPA boundary. However, views of well-field development and associated noise, traffic and human activity may diminish the quality of the recreation setting and cause a temporary displacement of some use from some popular Sand Mesa WHMA resources. As noted, the development effects are anticipated to be short-lived as drilling and pipeline construction moves from place to place, and would generally depend on the location of construction sites in relation to recreation resources. The potentially impacted areas in other portions of the Sand Mesa WHMA include the following:

- Lake Cameahwait and the Sand Mesa Ponds, east of the Sand Mesa field and also accessed by the Bass Lake Road would potentially be affected. Potentially affected recreation includes waterfowl hunting, fishing, non-consumptive uses like boating and wildlife viewing, and picnicking and camping at Lake Cameahwait's developed facilities.

- Upper Depression Reservoir, west of the Sand Mesa field, and accessed by Sand Mesa Road would potentially be affected. Waterfowl hunting would potentially be affected. There are no developed recreational facilities at this site.

- Muddy Ridge Reservoir, Antelope Flats Wetland and other Sand Mesa WHMA land along North Portal Road, which accesses the Coastal Extension field would potentially be affected. Potentially affected recreation would include deer and antelope hunting, fishing, waterfowl hunting and day use on Muddy Ridge Reservoir. These sites and areas do not include developed recreational facilities.

Impacts to recreation in outlying parts of the Sand Mesa WHMA would vary, depending on the proximity and visibility to gas development, level of exposure to traffic, and compatibility of gas development with different types of recreation and levels of recreational use.

The potential for impacts is highest at Lake Cameahwait from late spring through early fall; these seasons attract most of the five-year average of 46,200 recreation visits a year. Users of Lake Cameahwait are likely to be affected most as they travel to and from the recreation area on the Bass Lake road and potentially encounter views of gas development facilities and project-related traffic. At Lake Cameahwait proper, the topography would screen users of the lake and its facilities from direct exposure to project related disturbance.

Visitation data are not available for other outlying sites and areas of the Sand Mesa WHMA, but usage of these areas is likely much less, because their location, size and quality limit the intensity of potential impacts.

Overall, impacts from the Proposed Action to other recreation resources in the Sand Mesa WHMA are distributed among the development areas that overlap parts the WHMA and do not cover the whole management area. From this perspective, impacts from development under the Proposed Action to other recreation resources in the San Mesa WHMA, as a whole, would be minor and short term.

Impacts to Recreation in the Ocean Lake Wildlife Habitat Management Area

Ocean Lake WHMA contains developed recreation and state lands managed primarily for hunting. Potentially affected recreation resources are located north of Ocean Lake along WYO 134 (Missouri Valley Road). Potentially affected recreation resources near Ocean Lake are about one-and-a-half miles south of the Pavillion field, outside of the WRPA. These areas and facilities receive relatively high use. The Ocean Lake WHMA also contains an outlying unit consisting of 160 acres of leased, irrigated fields. This area, called the Maxson unit, is southeast of and adjacent to the Pavillion field, inside the WRPA.

Because of their proximity to gas development activity in the Pavillion field, visitors to parts of the Ocean Lake WHMA near SH 134 would potentially view and hear drilling and completion operations at a distance and experience traffic associated with development. This would most likely occur in cases where wells are developed near the southern boundary of the Pavillion field. The views, noise and traffic from gas development in the Pavillion field may adversely affect the experience of recreation visitors to these Ocean Lake WHMA lands.

Potentially affected visitors are likely to be engaging in recreation activities that include hunting (during fall and early winter), fishing (year-round, with ice fishing in winter), and non-consumptive uses like boating, camping, and wildlife observation (mostly in the spring through the fall). Potential impacts to hunting in parts of the Ocean Lake WHMA near the Pavillion field would be somewhat higher because drilling in the Pavillion field would occur from November to April and would partly overlap fall hunting seasons and other recreation in the spring. At the same time, the potential for adverse effects to recreation within these areas of would be mitigated by November to April drilling because no drilling would occur for seven months a year, avoiding conflict with recreational activities occurring in spring through mid fall.

As noted, these development effects are anticipated to be short-lived as drilling and pipeline construction moves from place to place, and would generally depend on the location of construction sites in relation to recreation resources. Viewed in their entirety, impacts from the Proposed Action to recreation resources at Ocean Lake WHMA would be minor and short term.

Impacts to Recreation at Boysen State Park

Boysen State Park contains developed recreation sites that are managed to support fishing and other water-based recreation, as well as surrounding areas of parkland available for big-game hunting. The potentially affected recreation resources are developed campsites and boat ramps on the western shore of Boysen Reservoir, about two miles east of the WRPA and three to four miles east of the Sand Mesa and Sand Mesa South fields. The state park's western shoreline and areas of adjacent parkland are accessed from the Bass Lake Road, which also provides access to the Sand Mesa and Sand Mesa South fields. Effects to these recreation resources from development are anticipated to be short-lived as drilling and pipeline construction moves from place to place, and would generally depend on the location of construction sites in relation to recreation resources.

Gas development traffic on Bass Lake Road may affect the experience of some Boyson State Park visitors. Noise from gas development in the Pavillion and Sand Mesa fields may diminish the quality of recreation experiences for visitors at park locations near the WRPA. Options exist for relocation because campgrounds in the state park are rarely full, but only some of the remaining sites and areas of the park are as isolated as the western shoreline nearest the WRPA, an appealing quality for some users.

The potential for impacts is highest at Boysen Reservoir from late spring through early fall, the period that attracts the most visitors to the recreation area. Visitors to the western shoreline would be affected most as they travel to and from the recreation area on the Bass Lake Road and potentially encounter views of gas development facilities and project-related traffic. At boat ramps and campsites on the shoreline, the topography would screen recreationists from direct exposure to project-related disturbance. In addition, use of the western shoreline is relatively low. In the five years ending in 2002, this part of Boysen State Park attracted about four percent of all visits, or about 6,000 visits a year.

About 10 percent of all Boysen State Park visitors also ride ORVs. This equates to about 600 ORV riders a year on roads and trails connected to the western shoreline of the state park. Over time, the attraction of the WRPA as a resource for ORV riders may increase if resource development roads are available for public use. On the Bass Lake Road, which is a public road outside of the park, the potential for conflict between ORV riders and traffic from gas development or other activities would be mitigated by the fact that ORVs using the public road are assumed to be street-legal, licensed and operated as on-road vehicles. In addition, the potential for conflict between project traffic and recreation traffic would be mitigated by posting appropriate warning signs, implementing operator safety training, and requiring project vehicles to adhere to low speed limits. This measure and other resource-specific mitigation requirements, including mitigation for resources that indirectly affect recreation, are presented in Chapter 2, (Proposed Action and Alternatives).

Overall, impacts of development under the Proposed Action to recreation resources at Boysen State Park would be minor and short term.

Impacts to Recreation on Private Lands

Surface disturbance, noise, views, development activity and traffic during the development phase of the Proposed Action may adversely affect the limited hunting resources on private land in and near the WRPA. Most public hunting on private land occurs at WGFD “Walk-In” areas that overlap the Pavillion field or are within Muddy Ridge field. Each of these adjoins or is close to Sand Mesa WHMA lands.

Nearness to well-field development would potentially affect pheasant and big-game hunting in these areas. In the case of the walk-in area overlapping the Pavillion field, the potential for adverse effects to recreation may be somewhat higher because drilling would be concentrated from November to April and would partly coincide with hunting seasons.

There are also limited opportunities to hunt on private lands in and near the WRPA by permission of the landowner, as well as very limited opportunities for commercially outfitted hunting on private land. The location and size of these resources were not identified, so their exposure to impact and the intensity of impacts were not determined.

Considered as a whole, impacts of development under the Proposed Action to recreation resources on private lands would be minor and short term.

4.10.2.2 Production

With the completion of development activities, the intensity of impacts would be reduced during the production phase. However, some project-related structures and activity would remain, potentially affecting recreation resources and the recreation experience for some users for the life of the project. Because the life of project is potentially up to 40 years, these impacts would be long-term.

Most impacts to recreation decrease in intensity after the development phase because disturbed areas would be reclaimed as the wells are completed, as personnel, traffic and equipment levels decline, and as the workforce in the field decreases to lower levels typical of the production phase.

During production, however, there may be some long-term displacement of hunters and wildlife viewers. This would potentially occur if patterns of game use and the density of game populations change because of the project's long-term effects. Areas where this impact is most likely to occur are areas in the Sand Mesa WHMA that support limited white-tail deer hunting and wildlife observation.

In addition, the continued presence of production facilities would potentially affect the recreation experience in areas where facilities can be seen and where recreationists are sensitive to seeing industrial features on the landscape. Areas where this impact is most likely to occur and where recreationists could experience a decrease in satisfaction from changes in the recreation setting are on the Bass Lake Road, where recreationists access Lake Cameahwait (Sand Mesa WHMA) and the western shoreline in Boysen State Park; at Middle Depression Reservoir in Sand Mesa WHMA, which attracts fishing and waterfowl hunting; and at Ocean Lake WHMA sites and areas nearest SH 134 where there is fishing, hunting and non-consumptive use. Middle ground and background views of facilities would be obtainable from these vantage points, depending on the location of the facilities themselves.

Overall, impacts of production under the Proposed Action to recreation resources on private lands would be minor and short term.

4.10.3 Alternative A (485 Wells) – Direct and Indirect Impacts

Under Alternative A, the maximum density of new well development in each field would remain the same as the Proposed Action, except for the Coastal Extension field, where drilling would reflect a higher allowable density, but the number of sites actually drilled, given the anticipated spacing, would increase substantially.

The total number of wells drilled in the Pavillion, Muddy Ridge and Sand Mesa fields would be about one-third higher than the Proposed Action, and the number of new wells drilled in the Sand Mesa South and Coastal Extension fields would be four times the Proposed Action.

Concentrations of wells would vary in each section, up to the maximum allowable density, since development would not be uniform. Direct effects would be limited to recreation resources within the fields, but indirect effects could potentially spill over to recreation resources nearby.

4.10.3.1 Development

Under Alternative A, impacts to recreation from development could last longer than the Proposed Action. The projected duration of the development phase is 15 years in Pavillion (14 wells drilled in all years but one), six years in Muddy Ridge (12 wells drilled in all years but one), 17 years in Sand Mesa (8 wells drilled in all years but one), 16 years in Sand Mesa South (3 wells drilled per year) and 16 years in Coastal Extension at the rate of two wells per year. This extends the length of the development phase by four years in the Pavillion field, one year in Muddy Ridge, four years in Sand Mesa, 12 years in Sand Mesa South, and nine years in Coastal Extension. The development phase for the WRPA as a whole would last five years longer under Alternative A than the Proposed Action.

The percentage of the acreage disturbed in each field would remain about the same, ranging from one to three percent of the total area disturbed at any one time. As with the other alternatives, this occurs because drilling progresses one well at a time and assumes that disturbance from drilling is substantially re-vegetated and activity at a well site has decreased to production levels in the third year after the start of drilling.

Impacts to recreation resources would be similar in character, at a point in time, to the impacts of the Proposed Action. Overall, there would be a somewhat higher density and duration of development in each field, and in the WRPA overall, under Alternative A.

Recreational users of various resources, including hunters, anglers and visitors to nearby recreation sites—particularly Lake Cameahwait, Ocean Lake and the western shoreline of Boysen State Park—potentially would experience somewhat more impact to the recreation setting. Since exposure to disturbances would be sustained for a somewhat longer period of time, there may be incremental change of recreational use from these areas to alternative areas and sites.

Despite development under Alternative A being somewhat longer and denser than the Proposed Action, the intensity of impacts to recreation resources in and near the WRPA, would be minor and short term.

4.10.3.2 Production

As it would be for the Proposed Action, the completion of development activities under Alternative A would lead to lower impacts during production. However, project-related structures and activity would remain and would potentially affect recreation resources and the recreation experience for the life of the project, potentially up to 40 years.

Under Alternative A, production facilities and activity potentially would have a somewhat higher long-term impact on hunters and wildlife viewers than the Proposed Action because of more facilities at a somewhat higher density in each field. This would potentially impact game use patterns and game population densities and, in turn, potentially displace hunters or affect the hunting experience.

Alternative A would potentially impact habitats in the Sand Mesa WHMA. Hunting areas in the Sand Mesa WHMA that overlap the Sand Mesa South and Coastal Extension fields would be impacted somewhat more than under the Proposed Action because of the somewhat higher well density anticipated for those development areas. Impacts to habitats would potentially affect both hunting and wildlife viewing.

In addition, production facilities that stay in place for a long time would potentially affect recreation areas where facilities can be seen and where there are recreational users that are sensitive to industrial features on the landscape. Impacts are potentially more likely on the Bass Lake Road (accessing Lake Cameahwait and the west side of Boysen State Park); at Middle Depression Reservoir in the Sand Mesa WHMA where there is fishing and waterfowl hunting; and at Ocean Lake WHMA near SH 134 where there are both consumptive and non-consumptive recreation use. Recreational users on the Bass Lake Road would be affected somewhat more because views from the road include a view of the Sand Mesa South field where a somewhat higher density of facilities could be encountered during production under Alternative A than the Proposed Action.

Although production well density is higher under Alternative A than the Proposed Action, the increment would not be enough to affect the project's overall impact. As for the Proposed Action, impacts to recreation would be minor and short term from production for Alternative A.

4.10.4 Alternative B (233 Wells) – Direct and Indirect Impacts

Under Alternative B, the maximum density of new well development in each field would be the same as the Proposed Action, but the number of sites actually drilled, given the anticipated spacing, would decrease substantially.

The number of wells drilled in the Pavillion, Muddy Ridge and Sand Mesa fields would be about one-third lower than the Proposed Action, and the number of new wells drilled in the Sand Mesa South and Coastal Extension fields would be about 15 percent less than the Proposed Action.

Concentrations of wells would vary in each section, up to the maximum allowable density, since development would not be uniform. Direct effects would be limited to recreation resources within the development areas, but indirect effects would potentially spill over to recreation resources nearby.

4.10.4.1 Development

Under Alternative B, the duration of impacts to recreation from development would be shorter than for the Proposed Action. The duration of the development phase for Alternative B is seven years in Pavillion (14 wells drilled in all years but one), four years in Muddy Ridge (12 wells drilled in all years but one), ten years in Sand Mesa (8 wells drilled each year), four years in Sand Mesa South (3 wells drilled in all years but one) and seven years in Coastal Extension at the rate of one well per year.

This shortens the development phase by four years in the Pavillion field compared to the Proposed Action, one year in Muddy Ridge, three years in Sand Mesa and one year in Coastal Extension. In Sand Mesa South, the development phase would last as long as the Proposed Action, but would end earlier in the last year. The development phase for the WRPA as a whole would be three years shorter under Alternative B than the Proposed Action.

The percentage of the acreage disturbed in each field would remain about the same, ranging from one to three percent of the total area disturbed at any one time. As with the other alternatives, this occurs because drilling proceeds one well at a time and assumes that disturbance from drilling is substantially reclaimed and activity at a well site has decreased to production levels in the third year after the start of drilling.

Impacts to recreation resources under Alternative B would be similar in character, at a point in time, to the impacts of the Proposed Action. However, there would be a somewhat lower density and duration of the development phase in each field, and in the WRPA overall, under Alternative B.

Recreational users of various resources, including hunters, anglers and visitors to nearby recreation sites—particularly Lake Cameahwait, Ocean Lake and the western shoreline of Boysen State Park—potentially would experience somewhat less impact to the recreation setting. Since exposure to disturbances potentially would occur over somewhat less time, there may be less change of use from these areas and sites to others.

Despite development under Alternative B being somewhat shorter and sparser than the Proposed Action, Alternative B would still cause minor short-term impacts to recreation resources in and near the WRPA.

4.10.4.2 Production

As it would be for the Proposed Action, the completion of development under Alternative B would lead to lower impacts during production. However, the project-related structures and activity that would remain and would potentially affect recreation resources and the recreation experience for the life of the project, perhaps up to 40 years.

Under Alternative B, production facilities and activity would have a somewhat lower long-term impact on hunters and wildlife viewers would be smaller than the Proposed Action because of fewer facilities at a somewhat lower density in each field. This would potentially impact game use patterns and game population densities and, in turn, potentially displace hunters or affect the hunting experience, thought to a somewhat lesser degree than the Proposed Action.

Alternative B would potentially impact habitats in the Sand Mesa WHMA. Hunting areas in the Sand Mesa WHMA that overlap with the Sand Mesa South and Coastal Extension fields would be impacted, though to lesser degree than the Proposed Action because of the somewhat lower anticipated for those development areas. Impacts to habitats would potentially affect both hunting and wildlife viewing.

Production facilities that stay in place for a long time would potentially affect recreation areas where facilities can be seen and where there are recreational users that are sensitive to industrial features on the landscape. Impacts are potentially more likely on the Bass Lake Road (accessing Lake Cameahwait and the west side of Boysen State Park); at Middle Depression Reservoir in the Sand Mesa WHMA where there is fishing and waterfowl hunting; and at Ocean Lake WHMA near SH 134 where there are both consumptive and non-consumptive recreation use. Recreational users on the Bass Lake Road would potentially be affected to about the same degree by Alternative B as the Proposed Action because the Sand Mesa South field, which impacts views from the road, is projected to have about the same amount of production facilities under the Proposed Action and Alternative B.

While production facilities are less dense overall under Alternative B than the Proposed Action, the change is not likely to be enough to affect the project's overall impact. As for the Proposed Action and Alternative A, impacts to recreation would be minor and short term from production for Alternative B.

4.10.5 Alternative C (No Action 100 wells) – Direct and Indirect Impacts

With Alternative C, new well development would occur only in the Pavillion field. No new development would occur in the four other development areas. In the Pavillion field, the maximum well density anticipated per section would be the same, but the number of sites where wells would actually be drilled would be substantially less (i.e. 100 new wells) than the Proposed Action (325 new wells). As with other alternatives, well density would vary in each section, up to the maximum anticipated density of 32 wells/section, because development would not be uniform. Direct effects would be limited to recreation resources within the development areas, but indirect effects would potentially spill over to recreation resources nearby.

4.10.5.1 Development

For Alternative C, the duration of impacts to recreation from development in the Pavillion field would be shorter than for the Proposed Action. The duration of the development phase with Alternative B is eight years in Pavillion (14 wells drilled in all years but one), compared to 11 years with the Proposed Action. Limited as Alternative C is to one field, the development phase for the WRPA as a whole would last eight years, compared to 13 years with the Proposed Action.

The percentage of the acreage disturbed in the Pavillion field would remain about the same as with the Proposed Action, ranging from one to three percent of the total area disturbed at any one time. As with the other alternatives, this occurs because drilling and reclamation progresses one well at a time and assumes that disturbance from drilling is substantially re-vegetated and activity at a well site has decreased to production levels in the third year after the start of drilling.

Impacts to recreation resources with Alternative C would be similar to impacts related to the Pavillion field with the Proposed Action. The new development in the Pavillion field would potentially affect hunters, anglers and visitors to areas and sites in the Ocean Lake WHMA and closest to SH 134. Since exposure to disturbance from Alternative C potentially would be sustained for somewhat less time, there may be somewhat less displacement of use from recreation resources in and near the Pavillion field than may occur with the Proposed Action.

Impacts to hunters, anglers and recreation users of other resources in the WRPA—particularly Lake Cameahwait and the western shoreline of Boysen State Park—potentially would experience negligible impacts to recreation settings and experiences under Alternative C since no new drilling would occur in the development areas closest to these sites and areas.

Despite avoiding some of the impacts of the Proposed Action, Alternative C would still have minor short-term impacts to recreation in and near the WRPA in the areas affected by new development in the Pavillion field.

4.10.5.2 Production

As with the Proposed Action, the impacts of production with Alternative C would be lower than the impacts of development. However, project-related structures and activity would remain and would potentially affect recreation resources and experiences for the life of the project, perhaps up to 40 years.

With Alternative C, production facilities and activity potentially would have a similar effect to the Proposed Action on resources in and near the Pavillion field. This would potentially decrease the impact patterns of game use and the density of game populations and, in turn, potentially displace hunters or affect the hunting experience. With Alternative C, these affects would be limited to hunting areas and other wildlife habitats where the Sand Mesa

WHMA overlaps the Pavillion field or where related activities affect the Ocean Lake WHMA. Impacts to habitats would potentially affect both hunting and wildlife viewing.

During production, the facilities that stay in place for a long time would potentially affect recreation areas where facilities can be seen and where recreationists are sensitive to seeing industrial features on the landscape. This impact is most likely to occur at Ocean Lake WHMA near SH 134 where there are both consumptive and non-consumptive recreation uses.

Because Alternative C proposes no development in fields in the eastern part of the WRPA, the potential would likely be negligible for conflict with ORV use or recreation traffic on the Bass Lake Road related to Boysen State Park or Lake Cameahwait.

Although new well development is limited to the Pavillion field with Alternative C, the expansion of production with Alternative C would still have minor short-term impacts to recreation in and near the WRPA, limited for the most part to areas affected by facilities and activity in the Pavillion field.

4.10.6 Impacts to Recreation Planning

Gas development's consistency with draft land use plan of the Tribes or the land use plans of the Fremont County are addressed in Section 4.7 (Land Use). These jurisdictions have no recreation plans in the WRPA or adjacent lands.

An update of the master plan for Boysen State Park has not been prepared to date. However, state park facilities are not subject to direct impacts related to the Proposed Action. In the future, a substantial increase in visitation to the park, and a corresponding increase in ORV use in and out of the park may create a need for park planning directed toward ORV use to mitigate the potential for conflict between recreational ORV use and project-related traffic. This need may arise for the Proposed Action and all alternatives, roughly in proportion to the scale of new development in the Sand Mesa and Sand Mesa South fields. The exception is Alternative C; it likely would pose no potential for conflict with ORV use in the future because it limits future development to the Pavillion field, which is somewhat distant from Boysen State Park. In addition, the Proposed Action and alternatives would mitigate the potential for conflict between recreation traffic and project traffic, assuming project procedures include a requirement to post appropriate warning signs, a requirement to implement operator safety training, and requirement that project traffic obey low speed limits.

Planning by the WGFD for the Sand Mesa WHMA and Ocean Lake WHMA is scheduled to begin in 2004. New plans are likely to reinforce the current policy of maintaining but not expanding the capacity of the area's resources (Cowling, B., WGFD, personal communication, September 8, 2003). Given that prohibiting construction of facilities within 500 feet (one-tenth of a mile) of surface water and riparian areas would substantially mitigate effects to the principal hunting and fishing resources of Sand Mesa WHMA, the Proposed Action is unlikely to conflict with such a policy for the area. The recreation resources of Ocean Lake WHMA are not subject to direct impacts related to the Proposed Action.

4.10.7 Impacts Summary

Impacts to specific recreation resources in the WRPA would be minor and short term to the WRPA overall regardless of whether the project is developed as proposed or under one of the alternatives. Significant impacts are avoided to the most important resources, in terms of usage, sensitivity of the resources and their users, and the relationship of recreation to resource development planning in and near the WRPA.

Although the level of development varies from alternative to alternative, the development and production of more or fewer wells at different well locations, despite its effect on the duration of development, would lead to perceptions of the intensity of impact that are neither large enough nor clear enough to distinguish among potential impact levels from alternative to alternative. This would be the case even for Alternative C. Since for Alternative C new development would only occur in the Pavillion field, no impacts to recreation resources would occur from new development in the Muddy Ridge, Sand Mesa, Sand Mesa South and Coastal Extension fields. Potential incremental impacts that would otherwise be minor in intensity would be negligible (or perhaps avoided entirely) since Alternative C anticipates no drilling in any of these fields. However, minor impacts would remain for the alternative as a whole because of additional activity in the Pavillion field under Alternative C.

Focusing on the important recreation resources and uses in and near the WRPA, the analysis considered all kinds of hunting, fishing, and non-consumptive recreation use that occurs in the Sand Mesa WHMA, in parts of the Ocean Lake WHMA near the WRPA, and in parts of Boysen State Park near the WRPA. As a whole, for areas studied in and near the WRPA, the potential impact to recreation resources would be minor, regardless of whether development occurs under the Proposed Action or the alternatives.

The analysis also finds the potential for conflict to be minor between recreational ORV use, other recreation traffic and project traffic near Boysen State Park with the Proposed Action or the alternatives. Impacts to wildlife observation in the Sand Mesa and Ocean Lake WHMAs also would be minor regardless of alternative, despite the high sensitivity to disturbance of the resource and its users. Potential impacts to hunting and fishing on Tribal land are also minor with the Proposed Action and Alternatives A and B, and avoided entirely with Alternative C.

The analysis reflects all of the project characteristics presented in Chapter 2 (Proposed Action and Alternatives), and their implications for the duration of disturbance from development, the amount of disturbance in each field from development, the amount of residual disturbance that would remain during production, and the location of facilities and activity during development and production in relation to the important recreation resources. The analysis assumes several constraints on development that apply directly to other resources but also affect recreation. These include drilling in agricultural areas only from November to April, prohibiting construction within 500 feet (one-tenth of a mile) or more of surface water and riparian areas, and a number of constraints on disturbance to important wildlife habitat of various kinds. These constraints would likely have an especially important effect on recreation resources and experiences within the Sand Mesa WHMA, which is the dominant resource for most recreational use in the WRPA.

4.10.8 Additional Mitigation Measures

No additional mitigation measures are needed to avoid unnecessary or undue impacts to recreation resources in and near the WRPA, assuming that the constraints on development and production mentioned earlier are observed and enforced.

4.10.9 Residual Impacts

The long-term residual impacts to the recreation resource in and near the WRPA are the disturbances and the direct and indirect impacts related to those disturbances that were described earlier for the production phase of the Proposed Action and alternatives. Residual impacts to recreation, that may or may not occur after the end of production, potentially sometime after 2040, assuming 40 years for the production phase, have not been analyzed at this time.

4.11 VISUAL RESOURCES

4.11.1 Introduction

Visual impacts would be caused by contrasts in the line, form, color, and texture between the characteristic landscape and the proposed facilities. Descriptions of visual impacts are described as short-term and long-term. Short-term visual impacts would occur during the construction of access roads, pipelines, well pads, and compressor stations, and would also include the drilling and completion activities and partial reclamation of well pads after the drilling and completion activities. These activities would typically occur at each location for a period of several days to 60 days. Long-term impacts would occur within and adjacent to the WRPA for the duration of the project. Permanent facilities would include access roads, well pads, well heads, storage tanks, production units, gas meters, compressor stations, operational vehicular traffic and the associated dust production. Areas seen by large numbers of viewers, such as along major travel routes, and near recreation and residential areas, would have higher impact levels than those in seldom seen zones of the WRPA.

The BIA, as managing agency for the WRPA, lacks a system of identifying and measuring visual quality, contrast, and mitigation. Accordingly, the BLM's Visual Resource Management (VRM) system was used as the basis to evaluate potential impacts to visual resources. The BIA, in consultation with the Shoshone and Arapaho Tribes, may elect to incorporate the BLM's VRM evaluation. The BLM VRM classes were determined based on combinations of scenic quality, viewer sensitivity level, and the viewing distance of an area as described in Section 3.11.

Using the BLM VRM system, more than 99 percent of the WRPA was inventoried as being equivalent to the BLM's VRM Class IV and is designated as Visual Resource Inventory (VRI) Class IV. The objective of this class is to provide for management activities which require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements (BLM 2003b).

Two areas encompassing less than one percent of the WRPA have been inventoried as VRI Class III. The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape (BLM 2003b).

The two VRI Class III areas consist of a waterbody within the Sand Mesa Wildlife Habitat Management Area (WHMA) in the Pavillion field, and Middle Reservoir in the Sand Mesa field. Both areas consist of a pond, wetlands, and lush vegetation, comprising a scarce land-type within the WRPA and the region. Both areas are undeveloped, and the surrounding land is also relatively natural in appearance with little gas well development. The development of gas production facilities within or in close proximity to these areas would impact the visual quality by creating contrasts in line, form, color and texture with the existing landscape and through the introduction of industrial equipment to a landscape that is relatively unencumbered by such objects. Class III objectives would not be met if the development in the area were not subordinate to the surrounding landscape. Resource production facility development has a high potential to visually dominate the landscape, which could detract from the scenic quality of these areas.

Implementation of the Proposed Action or alternatives would meet the management objectives for more than 99 percent of the WRPA. However, the management objectives of the two small Class III VRI areas may not be met without additional mitigation applied on a case-by-case basis during the well-siting process.

The degree of visual impacts would be dependent on the Science Quality Rating Unit (SQRU) in which the development would occur. There are areas within the WRPA where natural gas development has been minimal and these lands remain relatively natural in appearance. These areas, shown on Figure 4.11-1, include Upper Rangeland, Lower Rangeland, Wildlife Habitat Management Area, Middle Reservoir, Bluffs and Muddy Creek. The construction of new gas facilities in these areas would introduce an industrial character to the landscape.

The degree of visual impacts would also be affected by topography and landscape. The WRPA landscape is characterized by open, rolling and horizontal valleys punctuated by distinct ridges and mesas. The open quality of the valleys, found in the Upper Rangelands, Lower Rangelands, Agricultural, Middle Reservoir, and Habitat Management Area SQRU's, provides extensive vistas which make natural gas facilities visible for greater distances. In the western portion of the WRPA, Muddy Ridge and Indian Ridge are distinguishing landmarks that create prominent horizons. If gas development occurs on the tops or edges of these mesas, they would cause distinct contrasts with the line of these ridges and would be clearly visible from various areas within and outside the WRPA. Development on these ridgelines would alter the character of these landforms. These well facility structures may also be visible from outside the field in which the development occurs. For example, Muddy Ridge gas facilities would be visible from the northern portions of the Pavillion field. Well facility development towards the interior of Muddy Ridge is only visible from the mesa top itself and would consequently have a limited impact on the visual quality of the surrounding area.

Well development on mesa side slopes would create distinct contrasts with the line, form, color and texture of the landscape. Angular access road cuts along side slopes would cause a distinct contrast with the lines of the existing geography and be visible to area residents, visitors, and workers. Side slope cuts associated with well pad clearings would cause contrasts in color, texture and form with the adjacent landscape. Gas well facility structures on side slopes would stand in distinct contrast to the remainder of the ridge by introducing contrasts in line, form color and texture. Since these well facilities would be elevated above the valley floor, they would be visible from further distances and would impact the visual resources of the surrounding land.

Visual impacts are also dependent on the character of the land-type within the WRPA. In the more arid and sparsely vegetated areas of the WRPA, long-term surface disturbance would cause a visible contrast with the surrounding landscape. Even though vegetation throughout these areas is sparse, the surface exposure caused by well pads, roads and other surface disturbance areas would contrast in line, form and texture with the surrounding landscape. In the greener areas of the WRPA, such as near Muddy Creek and the WHMA, surface disturbance associated with facility development would contrast strongly with the surrounding land. In the agricultural areas, individual production facility structures do not cause as much visual impact since these landscapes are culturally modified and contain many similar structures.

Within the WRPA the landscape has an agricultural character. As the concentration of well facilities becomes higher, the character of the landscape would shift from agricultural to multiple use multiple use industrial. Well pads, roads and other cleared areas would create contrast with the surrounding landscape and would consequently contribute to the overall visual impact. During the growing season, the landscape within the agricultural areas tends to be green, which can contrast with the light brown exposed earth typically found in the WRPA.

There are several areas outside the WRPA boundaries that may be affected by changes in the visual resources within the WRPA. These adjacent areas are sensitive due to the types and levels of use they receive. There are several areas within the WRPA that are in the foreground/middleground distance zone from major travel routes and popular recreation area access points. These areas include the southern portion of the Pavillion field as viewed from WYO 134 and Ocean Lake WHMA, and the eastern portion of the Sand Mesa field and the entire Sand Mesa South field as viewed from Bass Lake Road. These areas constitute a higher sensitivity level than those in seldom-seen areas of the WRPA.

In accordance with the BLM's Visual Resource Management System (VRM), several Key Observation Points (KOP's) were identified within and adjacent to the WRPA (see Figure 4.11-1). Ten KOP's were chosen based upon amount of visitation, types of users, and visibility to proposed development areas. KOP's were concentrated in areas deemed to be of higher sensitivity, primarily near the Pavillion and Sand Mesa areas. Contrast rating evaluations were performed at each of the KOP's based upon existing conditions and proposed development. Contrasts of proposed facilities to existing land, water bodies, and vegetation were found to be moderate to strong in most cases, while contrasts to existing structures were found to be weak to moderate.

4.11.2 Proposed Action (325 Wells) – Direct and Indirect Impacts

The Proposed Action would result in the development of 325 new gas wells and associated roads, pipelines, and facilities. The majority of the development in the Proposed Action would occur in the Pavillion (155 new wells) and Sand Mesa (100 new wells) fields. More than 99 percent of these areas were inventoried as equivalent to the VRI Class IV lands. Visual impacts to the VRI Class IV areas would be negligible per the Class IV designation; however the construction and operation of natural gas facilities would alter the visual character of the landscape from primarily farming and ranching with some resource extraction, to a more multiple use industrial character. The Proposed Action would be consistent with the management objectives within 99 percent of the WRPA inventoried as VRI Class IV. Impacts to VRI Class III areas would be minor and long term, and the two areas inventoried as VRI Class III would meet the management objectives, if mitigation practices were used.

Figure 4.11-1. Key Observation Points (KOP) in and near the Wind River Project Area.

Impacts to scenic quality would be moderate and long term. Implementation of the Proposed Action would not introduce new visual elements into the greater landscape since natural gas facilities currently exist throughout much of the WRPA. Rather, it is primarily the number and distribution pattern of new wells within the WRPA that would change the visual character of the landscape. There are existing areas within the WRPA where production facilities are few or absent, and these areas may be more sensitive to the development of new facilities. The reduction in night sky quality would also be moderate and short term, due to nighttime drilling operations and the introduction of lighted facilities at new compressor stations.

This alteration of landscape character from the Proposed Action would be evident to motorists traveling along WYO 134 and Bass Lake Road. These motorists may include regional residents, area workers, tourists and recreationists. These people need to realize they are guests on the Indian Reservation, which is not public land. Some of these groups may be sensitive to the visual impact of gas development in the area. The indirect result of the aesthetic changes within the WRPA as a result of the Proposed Action may include a decrease in visitation to nearby recreation areas and potential negative response expressed by local residents, tourists, travelers and recreationists. Therefore, the alteration of landscape character would be moderate and long term.

4.11.2.3 Short-Term and Long-Term Impacts

Short-term impacts to the visual character of the landscape would occur during the construction of well pads, ancillary facilities, such as roads and pipelines, and drilling and completion activities. Well pad, road and pipeline construction would involve dozers, graders, and associated vehicular traffic and would generally last less than one to two weeks for each particular well pad and road segment. Drilling and completion activities would involve the temporary use of drilling rigs and associated vehicular traffic and would generally occur for one or two months at each particular location.

It is expected that up to four drilling rigs would operate at any time. Drilling rigs and reserve pits used during the establishment of new wells would be most noticeable during the short-term construction period. Reserve pits are typically rectangular in shape and lined with a black impervious material. The pits are also strung with lines of triangular plastic flags to discourage birds from landing in them. The shape of the pits and the color of their linings would create contrasts in line and color with the surrounding landscape. The plastic flags may draw the eye when they move in the wind, and attract attention. Drill rig towers would be visible to residents, tourists, area workers and recreationists with a direct line-of-sight to the well pad. Because of the height of the towers, these structures would be visible from further distances than more permanent facility structures. In the Muddy Ridge field the towers would also disrupt the skyline, since they would be located on ridge tops and mesas. These towers would be especially visible at night because of the drill rig lighting.

Fugitive dust from construction operations would affect visual resources throughout the WRPA. Because it has the potential to be visible for great distances, fugitive dust may also affect the visual resources of areas adjacent to, and downwind of the WRPA.

Long-term impacts would result from the addition of well pads, access roads, compressor stations, and ancillary facilities for the duration of the Proposed Action.

4.11.3 Alternative A (485 Wells) – Direct and Indirect Impacts

Alternative A would result in the development of 485 new gas wells and associated facilities within the WRPA. This development increase would occur in all production fields within the WRPA. This would represent an 70 percent increase in short-term surface disturbance and a 44 percent increase in long-term surface disturbance over the Proposed Action. The increase in development under Alternative A would intensify the visual impacts described under the Proposed Action, resulting in a moderate reduction in scenic and night sky quality. The increased visual impact would further affect the visual resources for area recreationists and residents, as well as tourists and regional residents traveling along WYO 134. These people are guests on the Reservation, which is not public land.

The increase in gas well development throughout the WRPA under Alternative A would increase the intensity of the short and long-term visual impacts as described under the Proposed Action. The increase in visual impacts would further affect the character of the landscape within the WRPA. The alteration of landscape character would be moderate and long term. Sensitive areas within and adjacent to the WRPA, as well as the VRI Class III areas, would be further affected by this increased development. These increased impacts would further affect local residents and workers within the WRPA, in addition to regional residents, motorists, and recreationists traveling through or adjacent to the WRPA.

The impact to VRI Class IV areas would be negligible and Alternative A would meet management objectives for Class IV areas, which accounts for the majority of the WRPA. Development associated with Alternative A may potentially impact the management objectives of the VRI Class III areas within the WRPA, with the impact to these areas being moderate and long term. In order to maintain the management objectives for these areas, gas well development would be required to partially retain the existing character of the landscape. This could be accomplished through mitigation measures (discussed in detail in Chapter 2, Section 2.8 and 4.11.9) and through the selective placement of the new wells in the landscape to avoid visual encroachment in these areas.

4.11.4 Alternative B (233 wells) – Direct and Indirect Impacts

Alternative B would result in the development of 233 new gas wells and associated facilities within the WRPA. This level of development would result in a 19 percent decrease in short-term surface disturbance and a 23 percent decrease in long-term surface disturbance relative to the Proposed Action. Alternative B would decrease resource extraction in all development areas within the WRPA relative to the Proposed Action. This reduced level of development would lessen the overall visual impacts described under the Proposed Action for all production fields within the WRPA, creating a minor, long-term alteration of landscape character, a moderate long term reduction in scenic quality, and a moderate, short-term impact on night sky quality.

Reduced well development in the irrigated portion of the Pavillion field relative to the Proposed Action would reduce visual impacts to local residents, but would still affect the character of the landscape in this area. Even though Alternative B would result in a reduced level of well development, visual contrasts in line, color, form, and texture at individual production sites would be similar to those described under the Proposed Action. These short and long-term impacts would affect local residents, area workers, recreationists, tourists, and travelers who are guests on the Reservation (which is not public land), although to a lesser degree than under the Proposed Action.

Impacts to VRI Class IV areas would be negligible under Alternative B, as it would meet management objectives for VRI Class IV areas, which account for the majority of the WRPA. Impacts to VRI Class III areas within the WRPA under Alternative B would also be negligible. In order to maintain the management objectives for these areas, gas well development would be required to partially retain the existing character of the landscape. This could be accomplished through mitigation measures discussed in Section 2.8 in Chapter 2 and in Section 4.11.7, or through the selective placement of the new wells in the landscape to avoid visual encroachment in these areas.

4.11.5 Alternative C (No Action) 100 wells – Direct and Indirect Impacts

Alternative C would result in the development of 100 new gas wells on private minerals and on Tribal minerals to offset drainage of the gas reserves. Under Alternative C (No Action), all of the wells and new facilities would be developed in the Pavillion field. No further development would occur in the Muddy Ridge, Sand Mesa, Sand Mesa South or Coastal Extension fields.

Although the total number of wells is less than under the Proposed Action, the overall visual impacts would be similar, but less than those described under the Proposed Action. The level of development under Alternative C would still potentially affect local residents and area workers, as well as tourists traveling on WYO 134 and recreationists who are guests on the Reservation (which is not public land) using Ocean Lake WHMA and other nearby recreation areas. The alteration of landscape character and scenic quality would be minor and long term. However, some of these groups may be sensitive to this alteration in landscape character caused by gas well development in this rural landscape. The reduction of night sky quality under Alternative C would be minor and short term.

The impact to VRI Class IV areas would be negligible, as gas well development under Alternative C would meet the management objectives for VRI Class IV areas, which comprises the majority of the Pavillion field. There is one small VRI Class III area within the Pavillion field, and impacts to this area would also be negligible. VRI Class III management objectives may be impacted if gas well development does not partially retain the existing character of this landscape through recommended visual mitigation techniques (see Section 2.8 in Chapter 2 and Section 4.11.7) and by individual facility siting.

4.11.6 Impacts Summary

The Proposed Action, and each alternative, would meet management objectives for VRI Class IV areas, which accounts for the majority of the WRPA. The gas well development associated with the Proposed Action and Alternatives A, B and C (No Action), may potentially impact the management objectives of the VRI Class III areas within the WRPA. In order to maintain the management objectives for these areas, gas well development would be required to partially retain the existing character of the landscape. This could be accomplished through mitigation measures discussed in Section 2.8, in chapter 2 and Section 4.11.7, and through the selective placement of the new wells in the landscape to avoid visual encroachment in these areas. Mitigation measures should also be employed where visual impacts affect areas outside the WRPA, including the southern portion of Pavillion field and the eastern portion of Sand Mesa and the entire Sand Mesa South field.

Alternative A would increase well development in the WRPA relative to the Proposed Action. This development increase would occur in all production fields within the WRPA. The increase in gas well development throughout the WRPA would increase the level of the short and long-term visual impacts as described under the Proposed Action. Sensitive areas within an adjacent to the WRPA, such as along Bass Lake Road and WYO 134, as well as the two VRI Class III areas, would be further affected by this increased development.

Alternative B would decrease the level of gas well development in the WRPA relative to the Proposed Action. Development levels would decrease in all production fields within the WRPA. This reduced level of development would lessen the overall visual impacts described under the Proposed Action for all production fields within the WRPA, depending on the extent of the reduction.

Under Alternative C (No Action) gas well development is limited to the Pavillion field. Development in the Pavillion field under Alternative C would meet the management objectives for VRI Class IV areas. There is one VRI Class III area in the Pavillion field that may be impacted if gas development in this area is not visually mitigated.

4.11.6.1 Long-term Impacts

Long-term impacts would affect the WRPA for the Life of Project. These impacts include bare ground surface conditions at well pads, production units and access roads, and the addition of facility structures such as gas meters, storage tanks and compressor stations. Visual contrasts in line, color, form and texture with the surrounding landscape would be caused by these long-term impacts. The degree of visual contrast would depend on the SQRU and the area of the WRPA in which these impacts occur.

The irrigated agricultural lands within the WRPA contain the majority of the residential development. These residents may be affected by the shift in landscape character caused by an increase of gas well facility structures, access roads and well pad clearings.

The development of production facilities in the southern and eastern portions of the WRPA may impact visual resources as viewed from outside the WRPA along WYO 134 (from KOP #2 and #5), Ocean Lake WHMA (from KOP #3 as well as from watercraft on the lake surface) and from Bass Lake Road (KOP #8, #9, and #10). Well pad clearings and access roads would accentuate the presence of the facilities in the landscape by creating contrasts with the surrounding landscape color, line, form and texture. This contrast may draw the eye towards the clearings and the production facilities because they are distinct in the landscape. Travelers on WYO 134 may be sensitive to the presence of gas well facilities in a landscape that is currently agricultural/rural. Recreationists using the Ocean Lake area or traveling to recreation areas accessed from Bass Lake Road may perceive the presence of industrial structures as an intrusion on their outdoor experience. These people are guests on the Reservation, which is not public land.

The addition of compressor stations in the WRPA may impact night sky visibility in the immediate area of the structures due to the addition of facility night-lighting. The night lighting would impact permanent residents more than other types of users. The compressor buildings may be visible from greater distances due to their size relative to the open character of the landscape. This is especially true if the stations are located within view of the KOP's located on WYO 134 and Bass Lake Road.

4.11.6.2 Residual Impacts

After the LOP and well sites have been abandoned and reclaimed, there may be residual visual impacts associated with gas well development in the WRPA. The majority of these residual visual impacts would be caused by unsuccessful reclamation efforts at production locations. Bare ground conditions due to unsuccessful re-vegetation efforts would cause visual contrasts with the surrounding landscape. These conditions may occur where ground has been cleared for well pads, production units and access roads. Invasive weeds that colonize reclamation areas would cause contrasts in color and texture with the surrounding landscape. Additionally, due to the slow growing rate of vegetation in this arid region, areas that are in the process of being reclaimed will contrast with surrounding areas covered with more mature vegetation. This would cause visible impressions in the landscape where clearings were located. This condition may persist for a period of a few years to a decade or more, depending on the type and maturity of the surrounding vegetation. Road cuts that traverse side-slopes or require significant amounts of cut and fill or rock removal may permanently alter the landscape. These areas may be restored and obscured to a certain extent, but it is unlikely that the landscape will be fully rehabilitated to its previous condition. Residual structures, such as well cap pipes, would introduce vertical elements in a landscape that is dominated by horizontal lines. These vertical elements would be visible to the casual observer, however well cap pipes are 2 to 4 feet high and not visible beyond a few feet.

4.11.7 Additional Mitigation Measures

Although the development of natural gas facilities would meet the VRI Class IV management objectives for more than 99 percent of the WRPA, the following additional mitigation measures could be implemented to mitigate the visual impacts on the two VRI Class III areas and at other locations that are determined to be sensitive locations.

4.11.7.1 Well Placement and Distribution

- If wells are to be located on mesa tops, efforts should be made to avoid placing the wells near mesa edges, where they would be visible for greater distances. Mesa side-slopes would also be avoided due to the contrasts caused by access road cuts and gas well facilities. If mesa tops, edges, and side slopes cannot be avoided, the off-site wellhead technique should be utilized.

- Facilities should be located away from sensitive viewing areas, such as Bass Lake Road, areas east of the Town of Pavillion, and along the 12-mile portion of WYO 134 adjacent to the WRPA. Areas just outside the project boundaries, that should also be considered sensitive, include Cameahwait Lake, Boysen State Park, and Ocean Lake WHMA.

- If drilling is necessary within sensitive viewing areas, the use of off-site well heads and the consolidation of resource extraction facilities to a central location outside the immediate viewshed are recommended. Clustering resource extraction facilities outside sensitive areas would also mitigate the impacts caused by well pad and access road surface disturbance. Where feasible, directional drilling may also provide a suitable alternative for reducing visual impacts in sensitive areas.

4.11.7.2 Form, Line, Color and Texture

- The form, line, and color of individual gas well facilities and the collective texture that they produce in the landscape is a factor that should be managed to mitigate visual resource impacts. The reduction of visual contrast in the landscape can be accomplished by emulating the natural landform, color, and texture within the WRPA.

- The edges of the well pads could be constructed more curvilinear and retain natural rock formations thus reducing the visual contrast of the well pad to the surrounding landscape. Well pad grading and leveling on rolling or hilly terrain should be designed to minimize slope cutting and filling.

- The size of well pad areas may be further reduced by re-vegetating the seldom-used zones within the well pad upon the completion of construction

- Access roads within the WRPA typically create lines that contrast with the surrounding landscape. Access road location should be considered when placing facilities on mesa inclines. Roads that cut diagonally up the sides of mesas contrast with soil colors and horizontal ridgelines. Where possible, berming and undulating the outer edge of the access roadways on mesa side-slopes would partially disguise their appearance when viewed from the valley floor. Utilizing slope-rounding techniques and minimizing road cuts would also help to reduce the level of impact to these areas.

- Production facilities are currently painted to match the natural landscape. Some facilities could be painted in a camouflage pattern that utilizes several colors from the surrounding landscape. The colors used should also reflect seasonal color variations. The paints used should be matte or flat finish, rather than semi-gloss or gloss. In agricultural lands, storage tanks could be painted silver in order to mimic the silver-colored grain storage structures and silos that are common throughout the landscape in these areas.

4.11.7.3 Site Construction and Reclamation Methods

- Lights on drilling rigs should be downlighting, shrouded, and directed towards the drilling platform in order to reduce glare and negative night lighting impacts to residents and others.

- Any non-essential well pad area should be reclaimed upon the completion of construction. Proper reclamation of well pads should be carried out soon after each well is removed from service or abandoned.

- The WRPA is located in an arid climate and, therefore, well pad and pipeline restoration may require temporary supplemental irrigation to be successful. The restoration of the well pads, pipelines, and other disturbed areas should be monitored to ensure that native plants are re-colonizing the disturbed area and noxious weeds are eliminated. Pas reclamation efforts have been marginally successful with respect to visual resources, and therefore efforts should be taken to improve reclamation strategies for any future development in order to reduce visual impacts.

4.11.7.4 Night-Lighting at Compressor Stations

- Night lighting may be visible beyond the WRPA especially in the rural landscape that characterizes the WRPA. Lights that are uncovered and non-directional can cause light pollution in the night sky and can obscure stars, or impact local residences and properties. Night lighting at compressor stations should be shrouded downlighting, directed toward the ground within the affected area. Lights should be mounted at the lowest height possible in order to achieve the proper lighting, while minimizing disturbance to visual resources for residents and others.

4.12 CULTURAL RESOURCES

4.12.1 Introduction

Cultural resources are the products of human history in the form of material items produced by human workmanship or use, and elements of the natural environment that were altered by people's activities. Physical manifestations of human activity must normally be more than 50 years old to be considered cultural resources, but sites, structures or objects related to exceptional historical events within the past 50 years may also be considered to be cultural resources. Cultural resources may also include Traditional Cultural Properties (TCPs), which are properties that are critical to a living community's beliefs, customs, and practices.

Approximately 20 percent of the WRPA has been surveyed for cultural resources. One hundred fifty (150) cultural resource properties have been recorded within the WRPA. A majority of the recorded properties are small prehistoric lithic scatters, but other prehistoric sites include camps, lithic procurement sources, stone alignments, a rock shelter, and rock art. Historic cultural properties include portions of the Wyoming Canal, which is an irrigation canal; homesteads dating to the 1920s and 1930s, bridges, modern rural residences, and dumps or debris scatters. Five cultural resource properties within the WRPA have been formally determined to be eligible for nomination to the National Register of Historic Places (NRHP): three rock art sites, a prehistoric campsite, and the Wyoming Canal. Three other properties have been recommended to be eligible for the NRHP but have not been formally determined to be eligible: a prehistoric campsite/occupation, a prehistoric rock art site, and an historic bridge. Fifty-three recorded properties have been formally determined to be not eligible for the NRHP, and an additional 66 properties have been recommended to be not eligible but have not been formally evaluated. Twenty-three other recorded properties have not been evaluated formally or informally. Traditional Cultural Properties have not been identified within the WRPA and are unlikely to exist within the WRPA.

4.12.2 Proposed Action (325 wells) – Direct and Indirect Impacts

Direct impacts to cultural resources could include destruction or damage of archaeological and historical resources as a result of ground surface and subsurface disturbance during site preparation, construction, operation, or reclamation of well locations, supporting facilities, pipelines, access roads, and electrical transmission lines. Direct impacts could also include erosion of cultural resource properties, siltation resulting in burying or degradation of cultural resource sites, chemical degradation of sites and structures, and visual impacts to historic structures and prehistoric rock art sites. Direct impacts are often avoidable during location of well sites, because the well sites occupy a relatively small area and can often be offset to avoid typically small archaeological sites. Direct impacts from pipeline and road construction are often more difficult to avoid because of the linear nature of these features and constraints imposed by topography and other factors.

Indirect impacts could include damage or destruction of cultural resources as a result of increased visitation of otherwise remote areas during installation and operation of well development areas and pipelines, and as a result of improved public access to these areas provided by well field access roads.

Potential effects to cultural resources are addressed under NEPA, but potential effects are also considered and addressed under provisions of the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act, and other federal and state laws and regulations.

Under Section 106 of NHPA and the Advisory Council on Historic Preservation's implementing regulations in 36CFR800, federal agencies responsible for funding or permitting projects are required to identify cultural resources within proposed project areas, evaluate the cultural resources for eligibility for nomination to the NRHP, assess potential effects of the project on cultural resources that are eligible for the NRHP, and mitigate unavoidable adverse effects to eligible cultural resources. The Bureau of Indian Affairs and the Bureau of Land Management share federal agency responsibilities under NHPA for lands with Tribal surface ownership, Tribal minerals, other federal ownership, or non-Tribal and non-federal lands that are included in projects that otherwise require federal agency consideration under NHPA. Project development on lands with Tribal surface ownership is also reviewed and approved by the Joint Business Council of the Eastern Shoshone and Northern Arapahoe Tribes, and tribal review includes consideration of cultural values that may exist regardless of NRHP eligibility of cultural resources within a project area.

The Proposed Action would include potential disturbance of 1982 acres, or about 2.15 percent of the land area of the WRPA. Disturbance areas for 325 well locations would range from 1.15 to 3.06 acres/well depending on the well field, and the remaining potential disturbance areas would be sites of gathering and compression facilities, pipelines, and access roads. Cultural resources surveys in the vicinity of the proposed well development areas have primarily addressed well locations and ancillary development for the current 178 producing wells and other non-successful or depleted wells. Specific potential impacts to cultural resources for the Proposed Action will not be known until surveys are completed for the 325 well locations and ancillary facilities and, if necessary, cultural resource properties are evaluated for eligibility to the NRHP.

A substantial part of the Proposed Action would occur within and adjacent to currently existing well development areas, where extensive cultural resources survey has occurred since 1975. Inference of potential impacts of the Proposed Action can be drawn from previous well field development within the WRPA. Records of the Wyoming SHPO and the Joint Business Council include reports of 191 cultural resources investigations in the WRPA as a whole, and none of those reports concerns mitigation of potential effects to NRHP-eligible cultural resources. Well field development within the WRPA began before the earliest of the well field-related cultural resources records in 1975, and therefore it is possible that adverse effects occurred to significant cultural resources prior to that date. However, cultural resources records for the WRPA since 1975 indicate that natural gas well field development has occurred in this area without direct impacts to eligible cultural resources.

On the basis of current information and if previous policies of avoiding archaeological sites are continued, the Proposed Action is likely to result in negligible to minor long-term impacts to cultural resources that are eligible for the NRHP. The potential for direct impacts to eligible cultural resources is likely to increase with increased well density, because opportunities for avoidance will decrease in placement of wells, gathering pipelines, and access roads. This increased potential for direct impacts might be lessened by means of block surveys of relatively large areas of proposed well development areas, which would allow system planning to avoid cultural resources. Potential direct impacts to eligible cultural resources can be mitigated by preparation and execution of a mitigation plan approved by the responsible federal agency(ies) and, if appropriate, the Joint Business Council of The Shoshone and Arapaho Tribes.

The Proposed Action would include increased numbers of persons in the WRPA during well field development and operation, and well field roads might provide public vehicular access to some areas that contain rock art and other cultural resources. Vandalism of cultural resources, particularly prehistoric rock art sites, could occur as an indirect effect of the Proposed Action. The potential for these indirect effects could be lessened by restriction of workers to confined areas, and by systematic survey and documentation of rock art sites in the vicinity of proposed well field and ancillary development. Impacts to cultural resources under the Proposed Action as a result of vandalism unauthorized collection, and construction damage to sites are likely to be minor, but long term.

4.12.3 Alternative A (485 wells) – Direct and Indirect Impacts

Alternative A is likely to have potential direct and indirect impacts similar in kind to those of the Proposed Action. The potential for direct impacts will be relatively higher under Alternative A because denser spacing of wells and gathering pipelines is likely to decrease opportunities to avoid cultural resources. Alternative A would result in increased numbers of persons in the WRPA over a longer period of time, which might increase opportunities for vandalism of cultural resources. Specific probable direct or indirect impacts from Alternative A have not been identified, but impacts are likely to be minor and long term.

4.12.4 Alternative B (233 wells) – Direct and Indirect Impacts

Alternative B is likely to have potential direct and indirect impacts similar in kind to those of the Proposed Action and Alternative A. The potential for direct impacts will be relatively lower under Alternative B than under the Proposed Action or Alternative A, because of the lower number of wells and associated facilities. Alternative B would result in a smaller number of persons in the WRPA during well field development and operation, which might result in fewer opportunities for vandalism of cultural resources than would occur under the Proposed Action or Alternative A. Specific probable direct or indirect impacts from Alternative B have not been identified, but impacts to cultural resources are likely to be minor.

4.12.5 Alternative C (No Action-100 wells) – Direct and Indirect Impacts

Alternative C would consist of drilling of 100 new wells within the Pavillion area only, including wells on both private surface and minerals, as well as some wells on Tribal surface and minerals. The development would include initial disturbance of only 316.6 acres, which is a smaller area than would be disturbed under the Proposed Action or Alternatives A or B. Potential direct and indirect effects to cultural resources under Alternative C are likely to be consistent in kind with potential effects under the Proposed Action and Alternatives A and B, except that much of the private land within the Pavillion area is intensively farmed. Potential for undisturbed archaeological resources is therefore generally lower in the private lands than on other lands in the WRPA. Potential for direct or indirect impacts to cultural resources under Alternative C is therefore minor and long term.

4.12.6 Impacts Summary

Well field development within the WRPA has not resulted in reported impacts to significant cultural resources. Development under the Proposed Action and/or any of the alternatives would result in initial disturbance of no more than 2,817.7 acres, or about 3.06 percent of the WRPA. Cultural resource sites within the WRPA are typically small prehistoric lithic scatters that are often not eligible for the NRHP and can often be avoided during placement of well sites and ancillary facilities. Larger cultural resources include some prehistoric sites, typically on ridges, and the Wyoming Canal, and these cultural resources also can usually be avoided during site placement or by means of directional drilling. Potential direct impacts to any specific cultural resource have not been identified for the Proposed Action or Alternatives A, B, or C. The most likely indirect impact to cultural resources is increased vandalism to rock art sites. The potential for direct or indirect impacts to cultural resources under the Proposed Action or any of the Alternatives is likely to be minor and long term.

4.12.7 Additional Mitigation Measures

Measures to avoid or mitigate impacts to most cultural resources are listed in Chapter 2. Rock art is a rare and fragile type of cultural resource, and nearly any site containing rock art is likely to be eligible for nomination to the NRHP. Mitigation of potential direct or indirect impacts to rock art sites might include a systematic survey and recording of rock art within and adjacent to the proposed well development areas, and fencing of well locations and other development areas to restrict workers from entering areas that contain rock art. A Tribal elder also requested that wells and other facilities be sited away from the base of escarpments, or vertical rock faces, in order to avoid erosion or other damage to the escarpments and possible rock art and/or burials that could exist at those locations (R. Burnett, Joint Business Council, personal communication, October 7, 2003).

4.12.8 Residual Impacts

Destruction or damage to significant archaeological resources sites is permanent, and the cultural information contained in those sites is usually lost. Any impacts to cultural resources sites should be considered to be residual. However, development under the Proposed Action or any of the Alternatives is expected to have minor impacts to cultural resources.

4.13 SOCIOECONOMICS

4.13.1 Introduction

This section assesses potential effects of the Proposed Action and alternatives that were identified during the scoping process as well as potential effects that are standard elements of socioeconomic assessment. These include potential effects on:

- The local and regional economy including employment and income,
- Population and housing demand,
- Law enforcement and emergency response services,
- Tribal, state and local government revenues,
- Farm and ranching operations including potential fiscal impacts on the Midvale Irrigation District,
- Split estate lands and income from agricultural activities,
- The rural character of the area..

Additionally, a frequent issue raised during scoping was the concern that existing natural gas development has adversely affected property values in the WRPA and that proposed gas development would further affect property values. Section 102 (C) of NEPA requires federal agencies to evaluate the environmental impact of a Proposed Action and any adverse environmental effects. The U.S. Supreme Court ruled in *Metropolitan Edison Co. v. People Against Nuclear Energy,* 460 U.S. 766, 744 (1983) *(PANE)* that, to warrant consideration in an EIS, environmental effects must have a reasonably close causal relationship to changes in the physical environment. In determining a causal chain from gas development to an effect on property values, any change in the "character" of the Wind River Project Area and its perception are necessary links. Consistent with the Supreme Court's decision in *PANE*, these links lengthen the causal chain beyond the scope of NEPA. Since NEPA does not require analysis of the perception of any change in character of the WRPA or any potential impacts that the perception of such changes may have on property values, the potential impacts of the Proposed Action and alternatives on property values will not be considered in this EIS.

The socioeconomic assessment considers both direct and indirect impacts for three distinct but overlapping geographies within the WRPA:

- Wind River Indian Reservation
- Fremont County
- Midvale Irrigation District

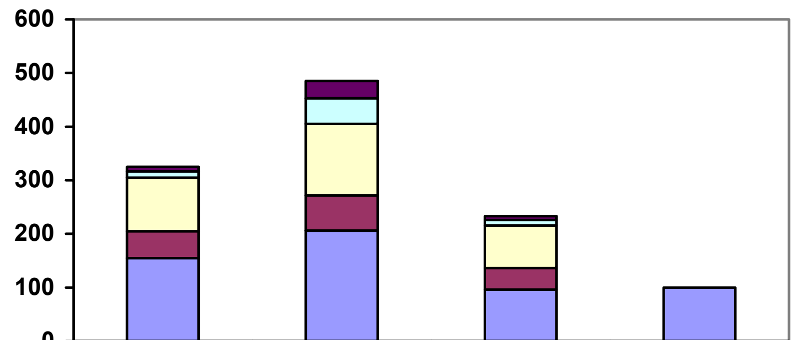
The appropriate geography is identified where specific impacts would affect only a specific jurisdiction.

4.13.1.1 Assumptions for the Socioeconomic Assessment

The level and pace of drilling, field development and the associated natural gas production are key determinants of the socioeconomic effects of the Proposed Action and alternatives. Each alternative analyzed for this assessment involves drilling a different number of wells and a different duration of the drilling phase in the fields that are involved. Well characteristics and the socioeconomic setting are different for each field, so the magnitude, intensity and duration of important socioeconomic impacts are tied to the amount and duration of drilling in a particular field.

This section examines the key individual assumptions: the total number of wells drilled, the duration of drilling, the peak year (highest annual number of wells drilled in the WRPA) and the number of wells drilled per year in each field. There is also a discussion of how the assumptions about the Proposed Action and alternatives compare to actual drilling that has occurred in the region in the recent past. Reference is made to these assumptions and to past drilling activity as a benchmark for comparing socioeconomic effects among the alternatives. Figure 4.13-1 displays the total number of wells associated with each alternative by field.

Figure 4.13-1 Total Wells Drilled, by Alternative, by Field



	Proposed Action	Alt. A	Alt. B	Alt. C
Coastal Extension	8	32	7	0
Sand Mesa So.	12	48	10	0
Sand Mesa	100	133	80	0
Muddy Ridge	50	66	40	0
Pavillion	155	206	96	100

Note: Drilling in the Sand Mesa South, Sand Mesa and Coastal Extension is contingent on the Operators achieving success rates and production sufficient to economically justify continued development.

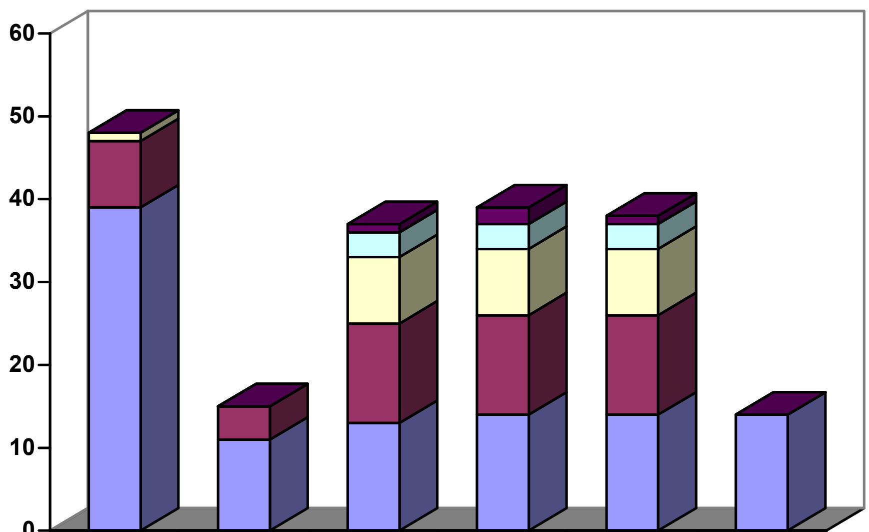
Table 4.13-1 presents proposed peak-year and average annual drilling activity for each of the four alternatives as compared to recent information on actual drilling activity that has occurred in the WRPA. Figure 4.13-2 displays this information by field.

Table 4.13-1. Wind River Project Area Recent and Proposed Drilling

	Actual Drilling 2001	Actual Drilling 2002	Proposed Action Peak Year/ Average Annual	Alt. A Peak Year/ Average Annual	Alt. B Peak Year/ Average Annual	Alt. C Peak Year/ Average Annual
Total Wells	**48**	**15**	**37 / 25**	**39 / 27**	**38 / 23**	**14 / 13**

During 2001, operators drilled a total of 48 wells in the WRPA. This is substantially higher than peak year drilling assumed under the Proposed Action and alternatives. Peak year drilling assumed under the Proposed Action and alternatives ranges from 37 to 39 wells per year for the three alternatives that include wells subject to federal approval and 14 per year for Alternative C – No Action, which includes wells that can be drilled regardless of federal actions. In 2002, the second year of recent activity in the WRPA, operators drilled 15 wells, or about 31 percent as many as in 2001.

Figure 4.13-2. Wind River Project Area: Recent and Proposed Peak Year Drilling by Alternative and Field



	2001	2002	Proposed Action Peak Year	Alt. A Peak Year	Alt. B Peak Year	Alt. C Peak Year
Coastal Extension	0	0	1	2	1	0
Sand Mesa So.	0	0	3	3	3	0
Sand Mesa	1	0	8	8	8	0
Muddy Ridge	8	4	12	12	12	0
Pavillion	39	11	13	14	14	14

Although the amount of average annual and peak-year drilling is similar for all action alternatives, the total number of wells to be drilled differs from one alternative to the next (325 for the Proposed Action, 485 for Alternative A, 233 for Alternative B and 100 for Alternative C – No Action). This causes the duration of the development phase to vary substantially by alternative, as shown in Figure 4.13-3.

Figure 4.13-3. Drilling and Field Development Duration by Alternative

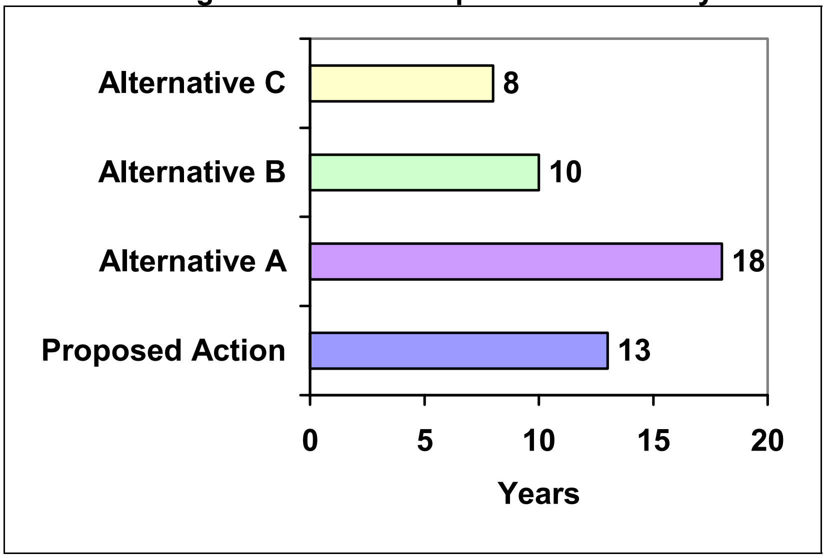
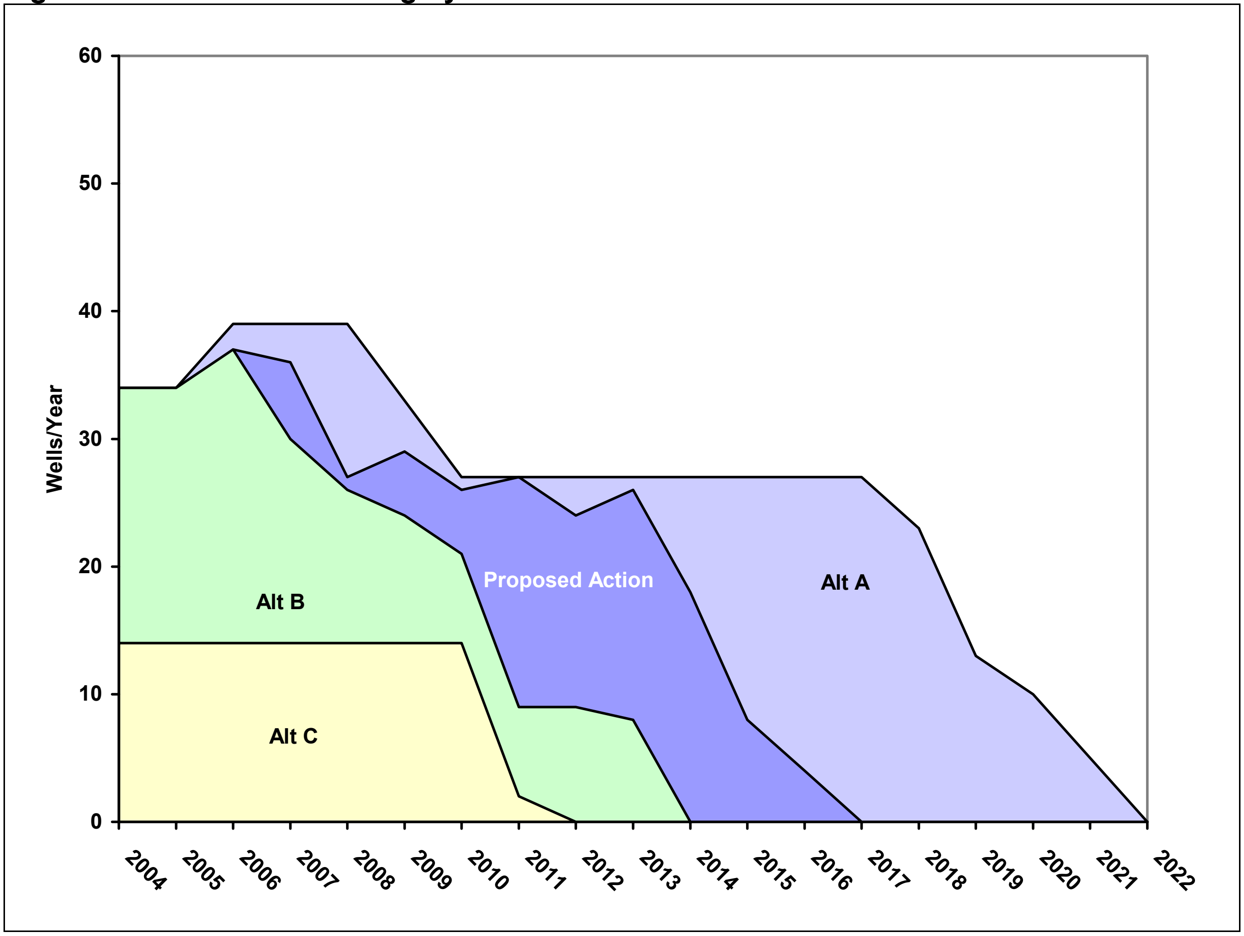


Figure 4.13-4 displays the annual drilling level for the development phase of each alternative. The figure illustrates how peak-year drilling levels are similar for the action alternatives and how they occur relatively early in the development phase. However, in the Proposed Action and Alternative A drilling levels extend for a longer time. In these two alternatives the extended drilling time is associated with drilling in the Pavillion Field, the Sand Mesa Field and, in the case of Alternative A, the Sand Mesa South and Coastal Extension Fields. A discussion follows of how drilling varies by alternative in each field within the WRPA

Figure 4.13-4. Annual Drilling by Alternative

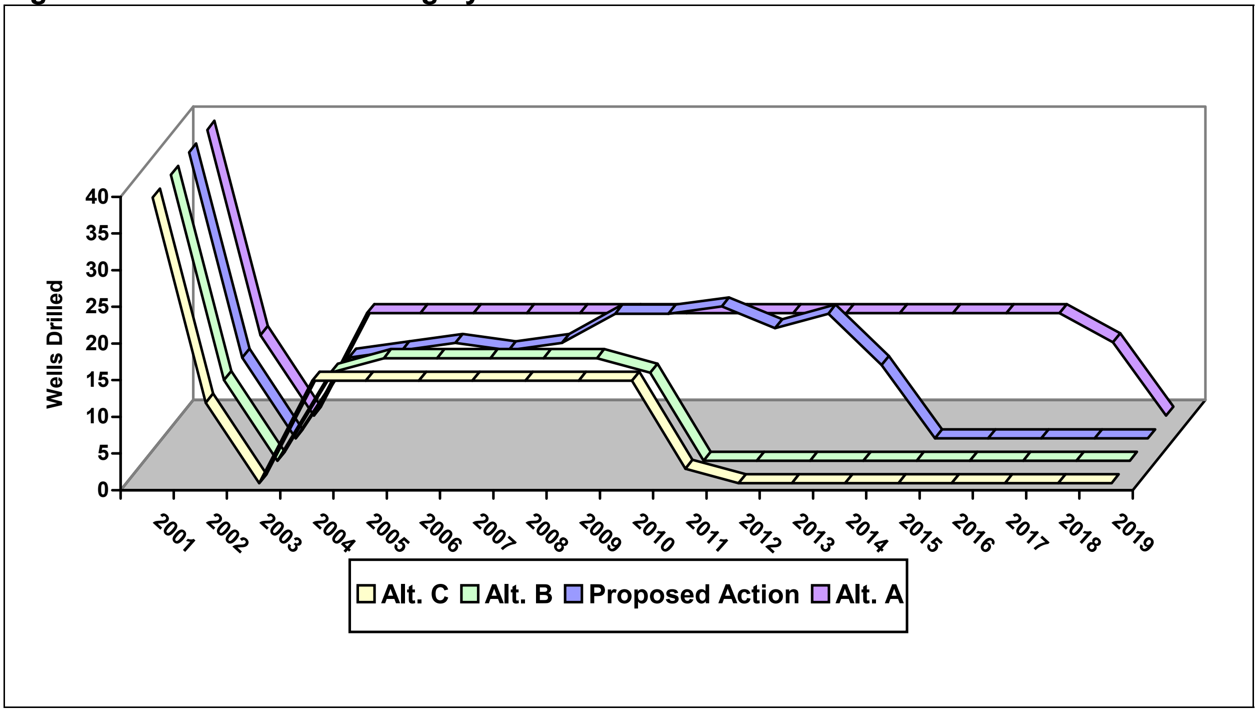


Pavillion Field

Recent drilling in the WRPA has been concentrated in the Pavillion field. During 2001, 39 out of 48 wells (81 percent of all wells drilled in the WRPA during that year) were drilled in the Pavillion field.

Figure 4.13-5 illustrates drilling in the Pavillion field for the Proposed Action and alternatives. Although Pavillion would experience more drilling than other fields under all alternatives, it would receive a substantially smaller percentage of the total drilling activity, except for Alternative C – No Action. Under the Proposed Action, 10 to 18 wells would be drilled annually in the Pavillion field, which is 26 percent and 46 percent respectively of the number of wells drilled in Pavillion during 2001. An annual average of 14 wells would be drilled in Pavillion under the Proposed Action, which is the same annual level of drilling for all alternatives including Alternative C – No Action, although the duration of drilling in Pavillion differs by alternative.

Figure 4.13-5. Pavillion Drilling by Alternative:

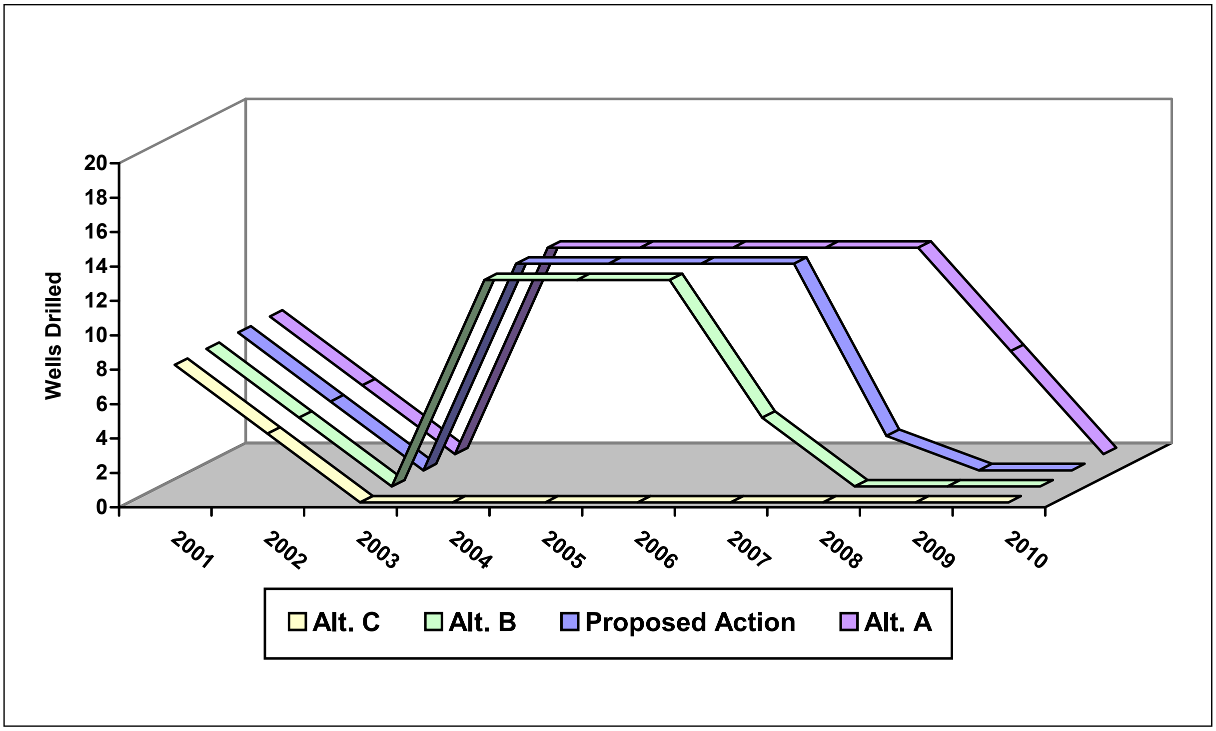


In the Pavillion field, a key difference among alternatives is the duration of drilling. Under the Proposed Action, a total of 155 wells would be drilled over 11 years in the Pavillion field, contrasted with 206 over 15 years for Alternative A, 96 over 7 years for Alternatives B and 100 over 8 years for Alternative C – No Action.

Muddy Ridge Field

In the Muddy Ridge field 8 wells were drilled in 2001 and 4 in 2002. Drilling would increase over these levels under every alternative but Alternative C – No Action. Under the other three alternatives, 12 wells would be drilled during most years; the key difference among the alternatives would be the duration of drilling. A total of 50 wells would be drilled in 5 years under the Proposed Action, 66 wells in six years under Alternative A, and 40 wells in four years under Alternative B.

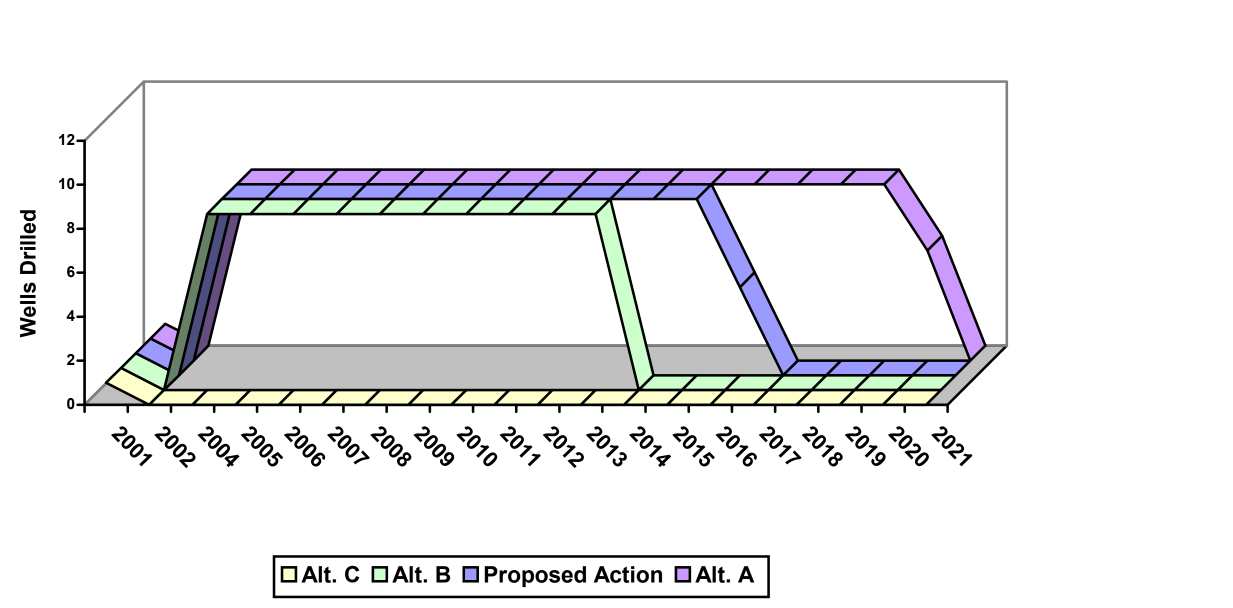
Figure 4.13-6. Muddy Ridge Drilling by Alternative



Sand Mesa Field

In the Sand Mesa field, one well was drilled in 2001 and none were drilled in 2002. Again, no drilling would occur in the Sand Mesa field under Alternative C – No Action, and the primary difference among the other three alternatives is the duration for drilling. Drilling would proceed at the rate of eight wells per year except for the final year under all three alternatives. A total of 100 wells would be drilled in 13 years under the Proposed Action, 133 wells would be drilled in 17 years under Alternative A and 80 wells would be drilled in 10 years under Alternative B. A 50 percent success rate for producing wells is assumed for all three alternatives.

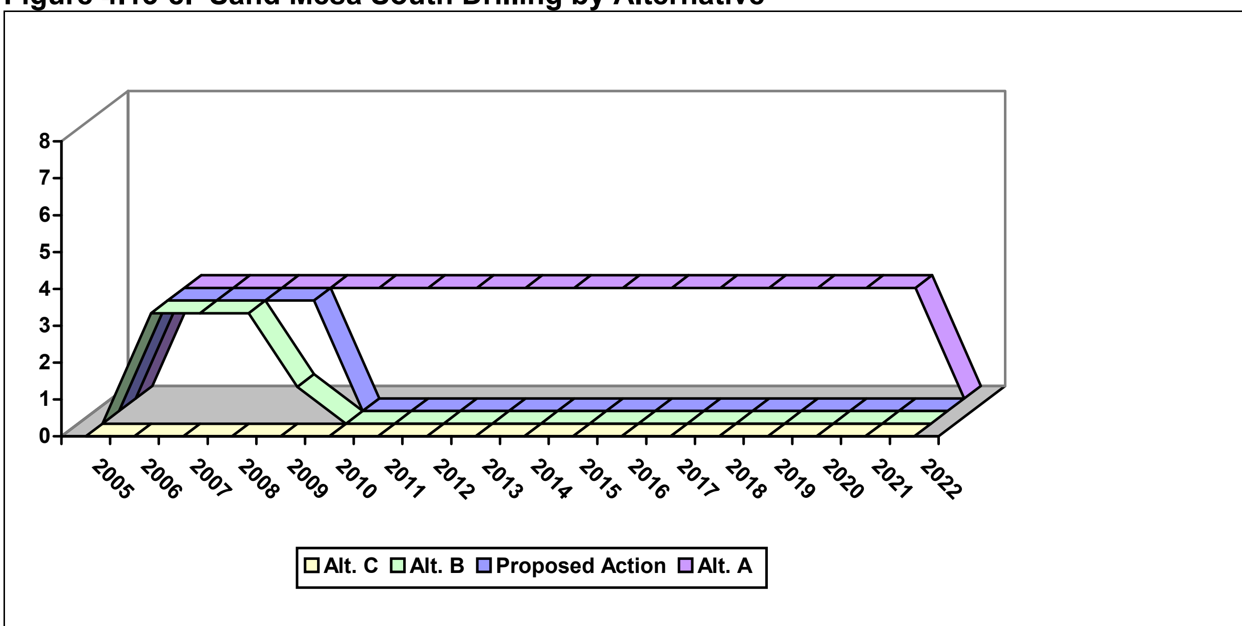
Figure 4.13-7. Sand Mesa Drilling by Alternative



Sand Mesa South Field

To date, no drilling has occurred in the Sand Mesa South field, and no drilling would occur under Alternative C (No Action). For the other alternatives, three wells would be the drilled per year except for the final year. Under the Proposed Action, a total of 12 wells would be drilled in four years. Under Alternative A, a total of 48 wells would be drilled in 16 years, and a total of 10 wells would be drilled in 4 years under Alternative B. A success rate of 50 percent is assumed for all drilling.

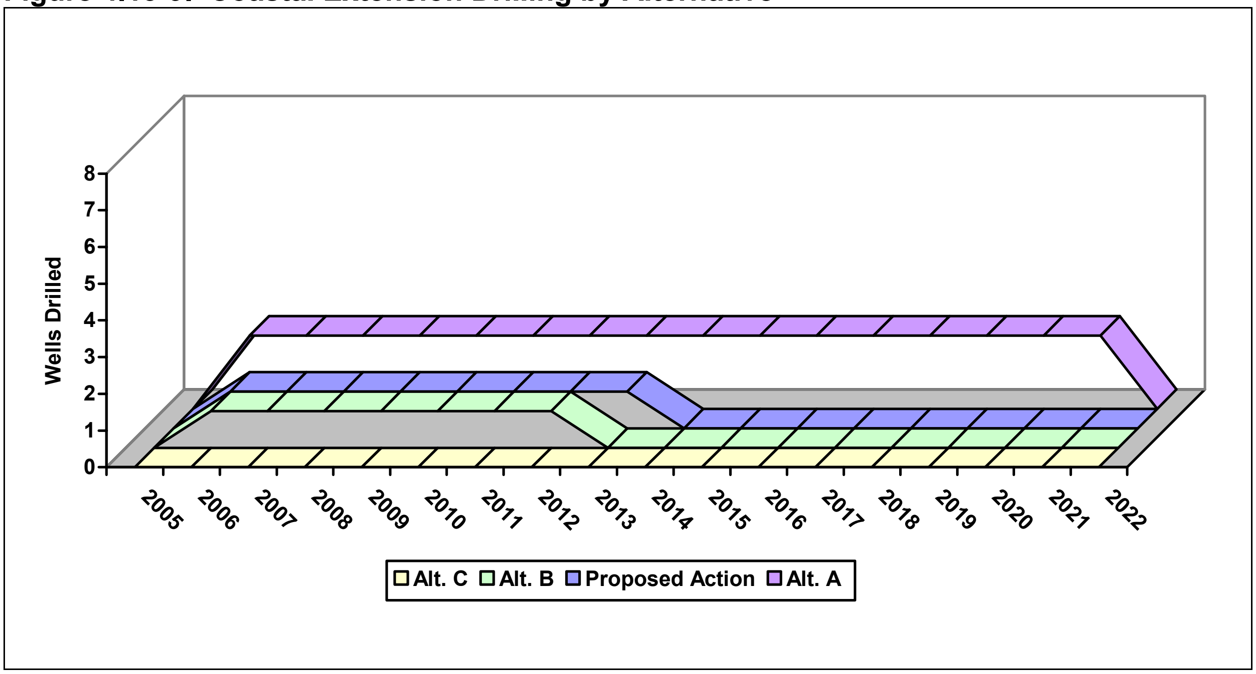
Figure 4.13-8. Sand Mesa South Drilling by Alternative



Coastal Extension Field

The Coastal Extension field is also an exploratory field, where an exploratory well has been drilled but no producing wells currently exist. Consequently, a 20 percent success rate is assumed. No drilling would occur in the Coastal Extension field under Alternative C – (No Action). Under the Proposed Action, a total of eight wells would be drilled in eight years. Under Alternative A, a total of 32 wells would be drilled in 16 years beginning in 2006. Under Alternative B, seven wells would be drilled in seven years.

Figure 4.13-9. Coastal Extension Drilling by Alternative



4.13.1.2 Economic and Fiscal Assessment Approach

Socioeconomic effects of the Proposed Action and alternatives would potentially occur because of drilling and field development activity and subsequently production of natural gas from wells within the WRPA. Production of natural gas from the fields in the WRPA requires sustained direct and indirect employment, capital investment and on-going operating expenditures by the natural gas industry and its suppliers.

The Operator's economic activity during field development and production would generate personal income in the region. In addition, personal income effects would result from 'per capita' distributions of royalty payments to members of the Eastern Shoshone and Northern Arapaho tribes. Personal income effects also would result from expenditures by the Tribes derived from royalty income, from expenditures by local governments and by quasi-governmental entities that derive fiscal revenue from taxes on natural gas development and production, and by expenditures by individuals and firms that derive income from private royalties. The size of projected socioeconomic impacts would vary over time as a function of the pace of development, the type and mix of wells drilled, future investments in gas field infrastructure, and the volume and value of future gas production, which is assumed to be constant at $3.25 per Mcf (Federal Index Based Value) at the wellhead for the entire analysis time frame.

The assessment that follows describes the socioeconomic effects in three, complementary ways. One describes the effects as estimated for three selected years: 2010, 2020 and 2030. A second estimates the employment effect of peak-year production for each alternative. The third estimates cumulative production, value of production, employment, personal income, economic output and selected fiscal measures over the period 2004 to 2032. Given the socioeconomic complexity of natural gas development, no single perspective fully describes an alternative. All three perspectives are useful in understanding the socioeconomic effects of the alternatives and assessing differences and trade-offs among them.

Economic and fiscal effects of Proposed Action and alternatives would be based on both infrastructure investment and natural gas production. A profile of projected annual production was developed based on the proposed drilling schedule, by field, and prototypical well production data provided by the BLM's Reservoir Management Group (RMG) and the Operators. Production estimates for all alternatives include estimates of production from existing wells in the Pavillion, Muddy Ridge and Sand Mesa fields. The data for the Pavillion and Muddy Ridge fields are derived from BLM RMG forecasts based on actual historical production data reported by the Wyoming Oil and Gas Conservation Commission (WOGCC), the IHS Energy/Dwight's Database, and professionally accepted gas production modeling software (PowerTools).[1] Production estimates for the Sand Mesa, Sand Mesa South and Coastal Extension fields were provided by the Operators and are based on exploration data and gas reservoir engineering estimates for a limited number of wells. Uncertainties inherent with the exploratory drilling into the latter fields are imbedded in the analysis by the lower success rates assumed for such wells.[2]

Infrastructure investment estimates provided by the operators, and production estimates as described above, were used as inputs for a regional economic modeling process using the IMPLAN economic modeling software. IMPLAN (impact Analysis for planning) is an input-output based model originally developed to assist the U.S. Forest Service in land resource management planning. Subsequently, the model and related software were transferred into the private sector, where it is the subject of ongoing refinement and enhancements to provide the analytical capacity to address a broader range of economic and impact planning issues. IMPLAN is widely recognized and accepted in regional economic and economic impact assessment circles.

4.13.2 Proposed Action (325 wells) – Direct and Indirect Impacts

4.13.2.1 Overview

Approval and implementation of the Proposed Action calls for the development of 325 new wells over a 13-year period. Of those, 205 wells would be in the established Pavillion and the Muddy Ridge fields. Wells in those fields are relatively shallow and have an assumed success rate of 100 percent. Another 120 wells are proposed for the Sand Mesa, Sand Mesa South and Coastal Extension fields. Those wells are considered exploratory, would be deeper, more costly and involve longer drilling schedules, and have a much lower probability

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1 Lee Almasy and Asghar Shariff, U.S. Bureau of Land Management, Wyoming State Office, Reservoir Management Group, Casper, WY.

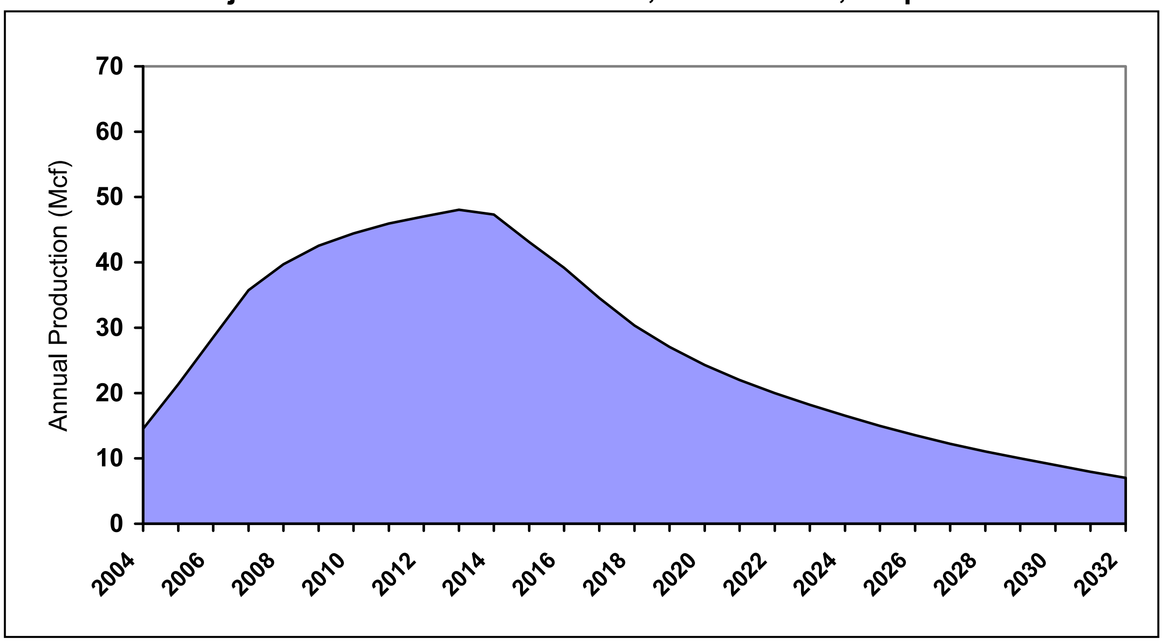
2 The production estimates developed for this analysis do not represent a full, detailed reservoir engineering analysis of potential development under each scenario. Rather, they reflect a series of simplified assumptions that allow an assessment and reasonable portrayal of the socioeconomic impacts associated with the alternative, and a characterization of the critical differences between the alternatives.

of success (50 percent for Sand Mesa and Sand Mesa South and 20 percent for Coastal Extension). The peak drilling activity would occur in 2006/2007, when 37 and 36 new wells, respectively, are proposed.

Typical well development costs (including gathering systems and production facilities) range from about $694,000 in the Pavillion field to nearly $4.1 million per well for the exploratory wells in Sand Mesa (TBI 2003). Approximately $681.2 million in future drilling expenditures would be made under the Proposed Action. An additional $54.2 million investment in gas field collection, processing and compression infrastructure would also be made by the Operators to support production and marketing of gas produced within the WRPA.[3]

Projected annual production from the WRPA under the Proposed Action is estimated at 14.5 million Mcf in 2004. Annual production would increase over time, peaking at 48.0 million Mcf in 2013. Although drilling of new wells would continue through 2016 under the Proposed Action, declines in production from existing and future new wells would more than offset the incremental gains in production beyond 2013. Consequently, annual production would begin to decline, with the declines continuing through the end of the year 2032 time horizon of this analysis as shown in Figure 4.13-10. An undetermined quantity of economically recoverable reserves would remain at that time; however, the field would be approaching the end of its economic viability based on an estimated threshold of 5 million Mcf.[4]

Figure 4.13-10. Projected Annual Gas Production, 2004 to 2032, Proposed Action

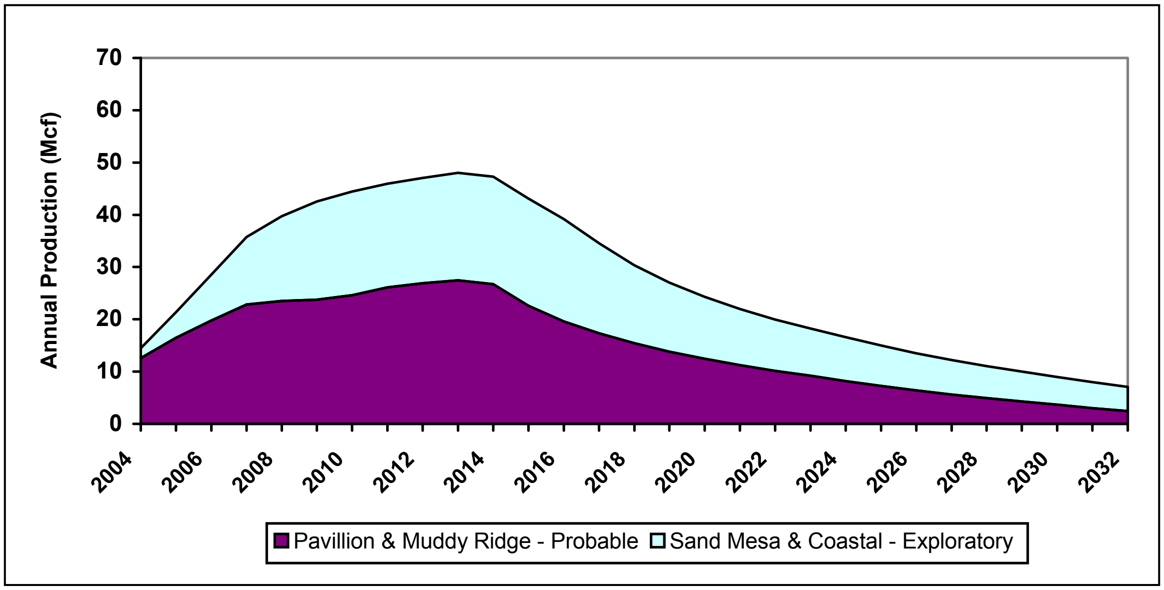


[3] All monetary sums are in constant 2003 dollars ($2003).

[4] The threshold for long-term economic viability is a function of the quantity and value of production and the cost of production, including the cost of maintaining and operating the field processing and compression infrastructure. This analysis relies on threshold of 5 million Mcf in annual production established by the Operator based on current economic conditions.

Total estimated production over the period 2004 to 2032 is 776.2 million Mcf. Of the total, 428.3 million Mcf (55 percent of the total) would be from the Pavillion and Muddy Ridge fields. The remaining 347.9 million Mcf is the combined production from the Sand Mesa, Sand Mesa South and Coastal Extension fields as shown in Figure 4.13-11. Changes in the assumed success and production rates of the exploratory wells would translate into an increase or a decrease in the net incremental production from those shown. Declines in future production would be of relatively greater local concern, as they would accelerate the point that the field becomes uneconomic.

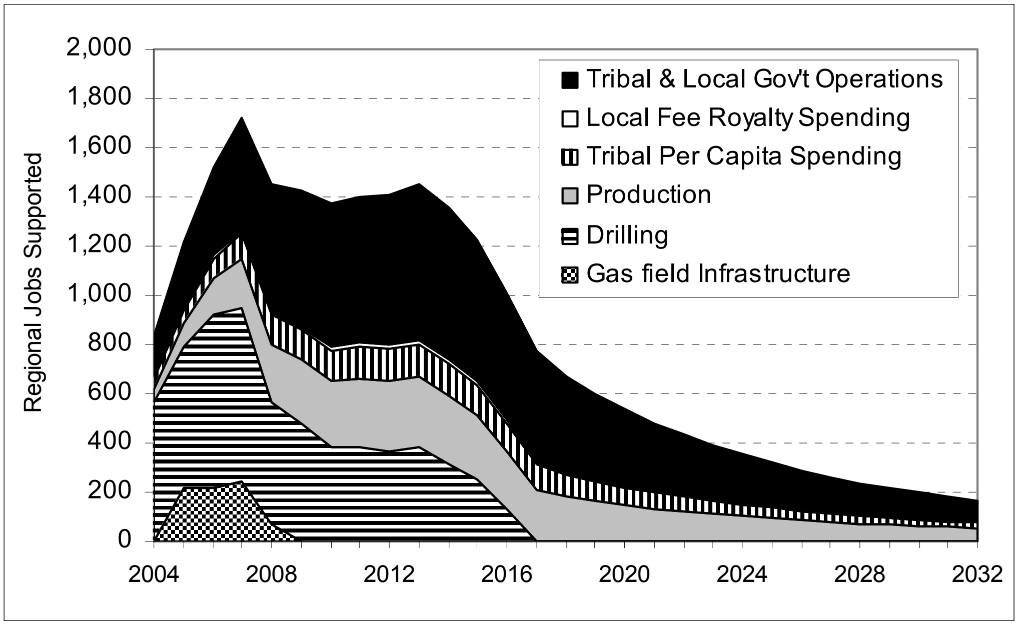
Figure 4.13-11 Projected Annual Production, By Field Grouping



Regional employment and businesses would be supported by the ongoing exploration, drilling, capital investment and production associated with the Proposed Action. The resulting economic stimulus encompasses not only the direct activity in the gas industry, but also the indirect and induced impacts on the region's finance, retail trade, services and other industries supported by the expenditures of the gas industry employees, Tribal members and fee mineral owners receiving royalties, and the wages and other expenditures made by the Tribal and local governmental agencies supported by taxes and other gas development related revenues.

The direct employment impacts are tied primarily to the drilling activity and the construction of new collection, processing and field compression infrastructure. Consequently, such employment would ramp up and peak early into the development timetable as displayed in Figure 4.13-12. The secondary employment impacts associated with the flows of severance and property taxes and royalty payments to governmental entities and individual households, which are more responsive the level of production, would lag the pace of drilling and construction.

Figure 4.13-12 Regional Employment Supported By the Proposed Action



4.13.2.2 Direct Economic Stimulus

As previously described, the drilling activity would occur over a 13-year period. The economic stimulus associated with the construction of the new gas field infrastructure would occur during a four-year period from 2005 to 2008. Together these investments yield a peak in direct activity and employment in 2007. Production would ramp-up quickly as the number of new Pavillion and Muddy Ridge wells increases, tapering off over time. Declining production would result in parallel declines in ongoing production expenditures and the value of production. The changes in selected production and expenditure parameters over time are presented in Table 4.13-2. For example, $48.5 million in estimated drilling expenditures are projected in 2010. However, with the completion of drilling in 2017, no such expenditures are anticipated in 2020 or 2030. Total annual gas production in 2010 is estimated at 44.4 million Mcf, declining to 24.3 million Mcf in 2020 and 9.0 million Mcf in 2030. Similarly, the total value of annual production is projected at $144.4 million in 2010, falling to $29.2 million by 2030. The Tribal share of future production increases over time, from 85 percent to 91 percent in 2030 because most of the new wells are on Tribal minerals.

Table 4.13-2. Expenditures and Production, 2010, 2020 and 2030, Proposed Action

	2010	2020	2030
Drilling Expenditures ($M)	$ 48.5	$ 0.0	$ 0.0
Annual Production Expenditures ($M)	$ 33.7	$ 18.4	$ 7.8
Annual Production (Millions of Mcf)	$ 44.4	$ 24.3	$ 9.0
Annual Value of Production ($M)	$144.4	$ 79.1	$ 29.2
Est. % from Tribal Minerals	85%	85%	91%

($M) – Millions of constant $2003.

Projected gas production would peak at 48.0 million Mcf in 2013 under the Proposed Action. Development of the Muddy Ridge field would have been completed previously, but a total of 26 new wells would be completed in the other four fields, at an estimated cost of $31.5 million. No major infrastructure investment is anticipated in that year. Table 4.13-3 summarizes these and other economic variables for the peak year.

Table 4.13-3. Project-Related Expenditures and Production, Peak Production - 2013, Proposed Action

	Peak Year – 2013
Gas Field Infrastructure Investments ($M)	$ 0.0
Drilling Expenditures ($M)	$ 48.5
Annual Production Expenditures ($M)	$ 35.6
Annual Production (Millions of Mcf)	48.0
Value of Production ($M)	$ 156.1
Est. Tribal Share of Production	83%

($M) – Millions of constant $2003

The Operators anticipate a total investment of $54.2 million in major gas field infrastructure over the 34-year time horizon from 2004 to 2032 (Table 4.13-4). Over the same period, more than $1.31 billion in drilling and production expenditures are projected in order to produce $2.5 billion in natural gas. The Tribal share of the cumulative production is estimated at 85 percent.

Table 4.13-4. Cumulative Project-Related Expenditures and Production, 2004 to 2032, Proposed Action

	Cumulative
Gas Field Infrastructure Investments ($M)	$ 54.2
Drilling Expenditures ($M)	$ 730.1
Production Expenditures ($M)	$ 578.0
Total Project Related Expenditures ($M)	$ 1,362.3
Total Production (Millions of Mcf)	776.2
Value of Production ($M)	$ 2,522.8
Est. Tribal Share of Production	85%

($M) – Millions of constant $2003.

4.13.2.3 Economic Impacts

Direct employment associated with the Proposed Action increases quickly in response to the simultaneous ramp up in drilling activity and infrastructure construction. At its peak in 2006/2007, drilling and construction would support an average of about 619 direct jobs. Another 320 secondary jobs would be supported by the direct jobs and associated expenditures. At its peak, the drilling and construction activity would directly and indirectly generate $33.7 million in total annual personal income.

The employment impacts are estimated on a place-of-work basis in Fremont County. Residents of other areas who commute to work on a daily or weekly basis would hold some of the jobs, particularly those in the gas fields. Furthermore, because the gas industry is already established in Fremont County, the employment impacts will to a large extent manifest themselves by sustaining current employment that otherwise would decline as other gas exploration and development activities run their course. At the same time, the economic activity supported by the Proposed Action would support additional employment elsewhere in Wyoming, both as a result of the flow of and eventual expenditure of state severance and sales and use taxes and non-local purchases by the Operators and their employees. The non-local economic benefits are not estimated as part of this analysis.

Following the completion of infrastructure construction, the total number of jobs associated with the ongoing drilling, including direct and secondary jobs, ranges from 497 in 2008 to 128 in 2016, the final year of scheduled drilling. Total personal income during that period ranges from $18.18 million to $4.68 million.

The secondary employment impacts associated with the flows of severance and property taxes and royalty payments to governmental entities and individual households, which are more responsive to the level of production, would lag the pace of drilling and construction. Consequently, the numbers of secondary jobs increase more slowly, climbing from an estimated 217 jobs in 2004, to a peak of 783 jobs in 2013. Thereafter, declining production would result in lower tax and royalty payments and hence, reduced per capita distributions to Tribal members and to fee mineral interest owners. In turn, the reductions in incomes would translate into less economic stimulus to the regional economy and fewer secondary jobs.

The pattern of an initial rise in employment, personal income and regional economic output, followed by protracted declines over time is evident in Tables 4.13-5 and 4.13-6. As shown, the total number of jobs supported by the Proposed Action, which peaks at 1,725 in 2007, declines to 1,372 jobs in 2010. Total employment increases to 1,449 jobs in 2013 when production peaks (Table 4.13-6) before beginning a long-term decline.

Table 4.13-5. Employment, Income and Output, 2010, 2020 and 2030, Proposed Action

	2010	2020	2030
Total Jobs Supported (Direct, Indirect & Induced)	1,372	535	198
Total Personal Income Generated ($M)	$ 58.6	$ 24.3	$ 9.2
Total Regional Economic Output Generated ($M)	$ 291.2	$ 135.9	$ 51.7

($M) – Millions of constant $2003

Total annual personal income associated with the Proposed Action mirrors the pattern of employment impacts. Project-related personal income climbs to $69.4 million in 2007, the final year of infrastructure development, declines to $58.6 million in 2010, and then increases to $61.8 million as production peaks in 2013. Personal income, which in this instance includes the per capita distributions of Tribal royalties to Tribal members, then tracks the downward trend in production. Project-related total personal income is projected at $24.35 million in 2020 and $9.2 million in 2030. The projected amount available for the annual per capita distribution to members of both Tribes peaks at $13.7 million in 2013 and the cumulative sum of such distributions would be $228.2 million over the entire time horizon.

Table 4.13-6. Employment, Income and Output, Peak Production Year, Proposed Action

	Peak Year – 2013
Total Jobs Supported (Direct, Indirect & Induced)	1,449
Total Personal Income Generated ($M)	$ 61.8
Total Regional Economic Output Generated ($M)	$ 309.9

($M) – Millions of constant $2003.

The contributions to regional economic output associated with the Proposed Action, a measure of the total value of goods and services produced within the regional economy, would peak at $309.9 million in the year 2013. Over time, the impact on regional output declines to $135.9 million in 2020 and $51.7 million in 2030.
The cumulative economic impacts associated with the Proposed Action over the period from 2004 to 2032 include nearly 23,500 job-years of employment, $1,007 million in personal income and over $5.0 billion in output (Table 4.13-7).

Table 4.13-7. Cumulative Economic Impacts, 2004 to 2032, Proposed Action

	Cumulative
Total Job-Years Supported (Direct, Indirect & Induced)	23,498
Total Personal Income Generated ($M)	$ 1,007.0
Total Regional Economic Output Generated ($M)	$ 5,004.6

($M) – Millions of constant $2003.

Under the Proposed Action, increases in regional economic output and employment would be considered positive, moderate and long term. Increases in personal income (including Tribal and private royalty income) would be considered positive, major and long term,

4.13.2.4 Fiscal Impacts

Severance taxes, royalties and other revenues generated by natural gas and other resource activity are important revenue sources for the Tribal and local governmental agencies in the region. The State of Wyoming also realizes substantial revenue from such development. Thus, the gas development and production associated with the Proposed Action represents a future revenue stream to the affected governments. Most of the public sector revenues are tied to the value of gas produced. Annual revenue accrual would closely mirror future production levels, increasing dramatically between 2004 and 2013, the year of peak production, before beginning a protracted decline.[5] Projected annual revenue accruals from selected sources in the three designated comparison years are summarized in Table 4.13-8 below.

For this assessment, the following royalty and tax rates have been assumed:

- Tribal royalties: 12.5 percent. Note that this is a standard federal royalty rate; Tribal royalties vary across the WRIR by lease. Actual royalty rates for individual leases are considered confidential by the Tribes.
- Fee royalties: 16 percent.
- Tribal severance taxes: 8.5 percent.
- Wyoming state severance taxes: 6 percent.
- Wyoming Oil and Gas Conservation charges: .0.8 mills of value at the well or 0.08 percent.

[5] Assumes a constant price of gas and constant tax and royalty rates over the entire time horizon. Furthermore, future revenues are reported in same year as projected production. In actuality, some time lags between production and receipt of the tax and royalty payments do occur. However, those lags are not material given the extended time horizon and level of detail of this assessment.

- Fremont County ad valorem property taxes (including state and local schools and other taxing entities): 76 mills or 7.6 percent.

Across the time spectrum, fees levied on oil and gas development to support the operation of the Wyoming Oil and Gas Conservation Commission consistently yield the least amount of revenue while Tribal severance tax and royalty payments and Fremont County ad valorem taxes have the highest values. For example, about $55,000 in WOGCC fees would accrue to the WOGCC in 2020. In that same year, a total of $5.11 million in Tribal severance payments and $8.40 million in Tribal royalty payments would accrue to the Tribes, with $6.41 million of ad valorem taxes accruing.[6] Royalty payments on fee mineral interests of $1.45 million and state severance taxes of $3.13 million are projected for that same year.

Table 4.13-8. Annual Tax and Royalty Payments, 2010, 2020 and 2030, Proposed Action

Revenue Type and Affected Entity/Group	2010	2020	2030
Wyoming Oil and Gas Conservation Comm. ($M)	$ 0.11	$ 0.06	$ 0.02
Wyoming State Severance Taxes ($M)	$ 6.26	$ 3.13	$ 1.09
Wyoming Sales and Use Tax ($M)	$ 1.35	$ 0.27	$ 0.10
Fremont County Ad Valorem Taxes ($M)	$ 13.82	$ 6.41	$ 1.94
Tribal Severance Taxes ($M)	$ 9.33	$ 5.11	$ 1.99
Tribal Royalty Payments ($M)	$ 15.35	$ 8.40	$ 3.31
Royalty Payments on Fee Production ($M)	$ 2.66	$ 1.45	$ 0.32

($M) – Millions of constant $2003.

A total of $50.87 million in tax and royalty payments would accrue from the peak production of 48.0 million Mcf in 2013; $1.06 per Mcf. Tribal receipts of severance taxes would total $9.83 million and Tribal royalties from the Proposed Action would total $16.12 million, 85 percent of the latter would be distributed to Tribal members in the form of per capita payments. Of the total $1.35 million collected in sales and use tax, $399,000 would accrue to Fremont County and its incorporated municipalities and $951,000 would accrue to the State. Another $13.82 million in ad valorem taxes would accrue to Fremont County, certain other taxing districts and state and local schools as shown on Table 4.13-9.

Table 4.13-9. Annual Tax and Royalty Payments, Peak Production Year - 2013, Proposed Action

Revenue Type and Affected Entity/Group	Peak Year – 2013
Wyoming Oil and Gas Conservation Commission ($M)	$ 0.11
Wyoming Severance Taxes ($M)	$ 6.26
Wyoming Sales and Use Tax ($M)	$ 1.38
Fremont County Ad Valorem Taxes ($M)	$ 13.82
Tribal Severance Taxes ($M)	$ 9.83
Tribal Royalty Payments ($M)	$ 16.12
Royalty Payments on Fee Production ($M)	$ 3.35

($M) – Millions of constant $2003.

[6] Ad valorem taxes would be distributed among Fremont County, Fremont County School District and a number of other local governmental entities. Detailed allocations were not prepared for this analysis.

Cumulative tax and royalty payments would total $809.33 million over the entire time period (see Table 4.13-10 and Figure 4.13-13 below).

Table 4.13-10. Cumulative Tax and Royalty Payments, 2004 to 2032, Proposed Action

Revenue Type and Affected Entity/Group	Cumulative
Wyoming Oil and Gas Conservation Comm. ($M)	$ 1.77
Wyoming Severance Taxes ($M)	$ 100.58
Wyoming Sales and Use Tax	$ 22.46
Fremont County Ad Valorem Taxes ($M)	$ 206.55
Tribal Severance Taxes ($M)	$ 163.13
Tribal Royalty Payments ($M)	$ 268.49
Royalty Payments on Fee Production ($M)	$ 46.35

($M) – Millions of constant $2003.

The total includes an estimated $163.13 million that would accrue to the Tribes in the form of severance taxes and $268.49 million in Tribal royalty payments. Again, 85 percent of Tribal royalties would be disbursed to Tribal members. Royalty payments on fee mineral interests are estimated at $46.4 million under the Proposed Action.

Figure 4.13-13 Cumulative Taxes and Royalties Generated, Proposed Action, 2004 – 2032 (millions of constant $2003)

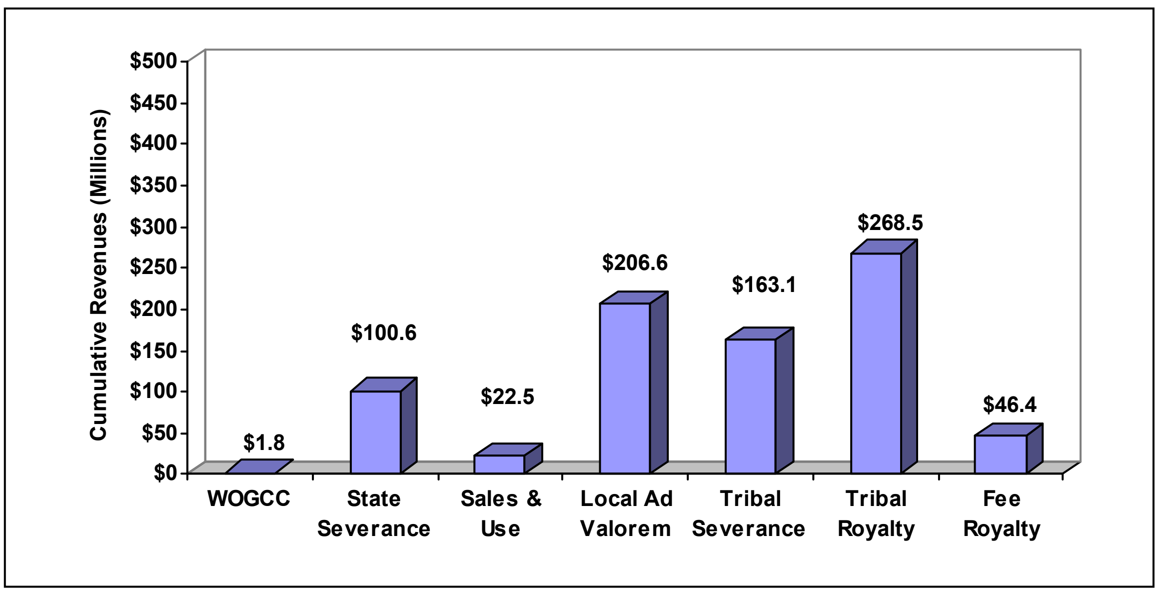
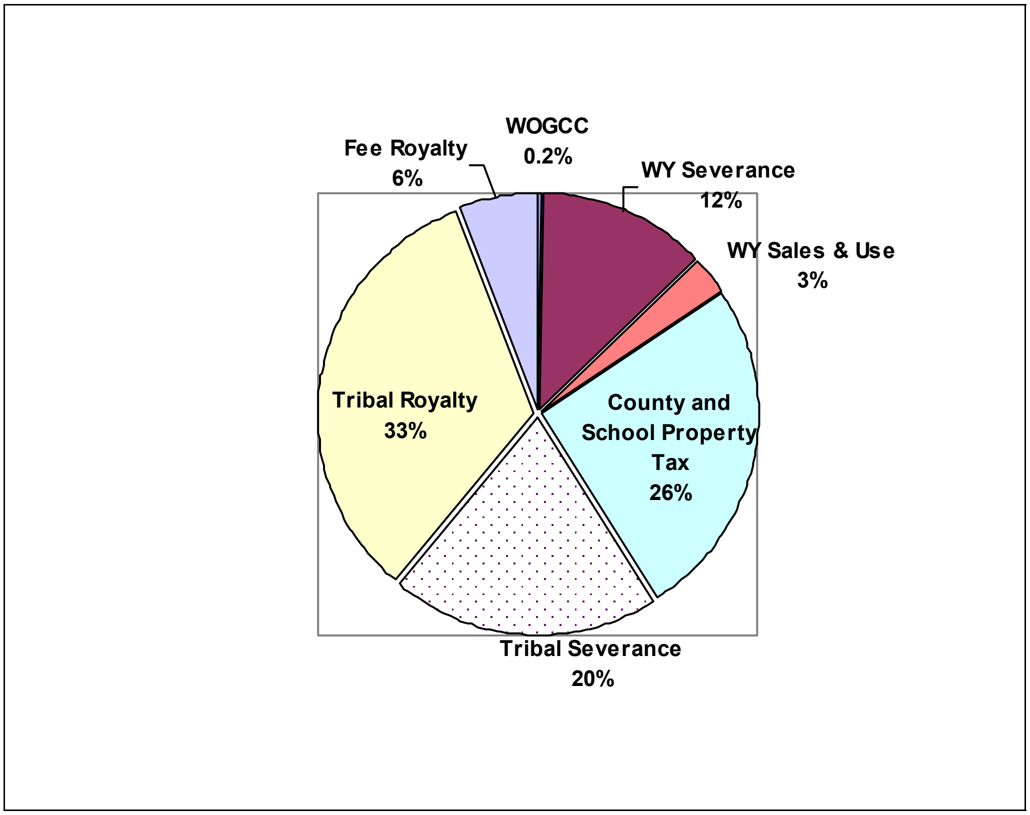


Figure 4.13-14 displays the percentage of total cumulative Proposed Action-related tax and royalty revenues that would be distributed to each entity.

Figure 4.13-14. Percentage Distribution of Cumulative Tax and Royalty Revenues: Proposed Action



Based on the estimates prepared for this assessment, the Eastern Shoshone and Northern Arapahoe Tribes would receive royalty payments equal to 33 percent of total cumulative tax and royalty revenues, Fremont County, its ad valorem property taxing entities and state and local schools would receive 26 percent, the WRIR Tribes would receive 20 percent of the total in severance tax payments, the State of Wyoming would receive 12 percent in severance tax payments, Wyoming, Fremont County and its incorporated municipalities would receive 3 percent in sales and use tax payments, fee mineral owners would receive 6 percent in royalty payments, and the Wyoming Oil and Gas Conservation Commission would receive 0.2 percent.

Wyoming State Severance Taxes

The Proposed Action – related $100.58 million in Wyoming State severance tax revenues on natural gas would be used to fund a variety of state and local entities including the Mineral Trust Fund, the Leaking Underground Storage Tank Fund, the Wyoming State General Fund, Water Development Funds, the Highway Fund, counties, county roads, cities and towns, capital construction and the State Budget Reserve Account.

Tribal Severance Tax and Royalty Revenues

Similar to the Wyoming State severance tax, the Proposed Action-related $163.13 million in Tribal severance tax revenues and $40.27 million of the tribal mineral royalty revenues fund the operations of the Eastern Shoshone and Northern Arapahoe Tribes, including medical services, basic transportation, housing, police protection, fire protection, solid waste disposal and a variety of human services.

Just as royalties on fee minerals accrue to their private owners, $228 million of Proposed Action-related Tribal Royalty revenues would accrue to enrolled members of the Eastern Shoshone and Northern Arapahoe tribes over the 28-year period. For some Tribal members, particularly the elderly, physically handicapped or unemployed, per capita payments derived from mineral income are a large part of their total income.

The Proposed Action - related increases in Tribal royalty and severance tax revenues would be considered positive, major and long-term.

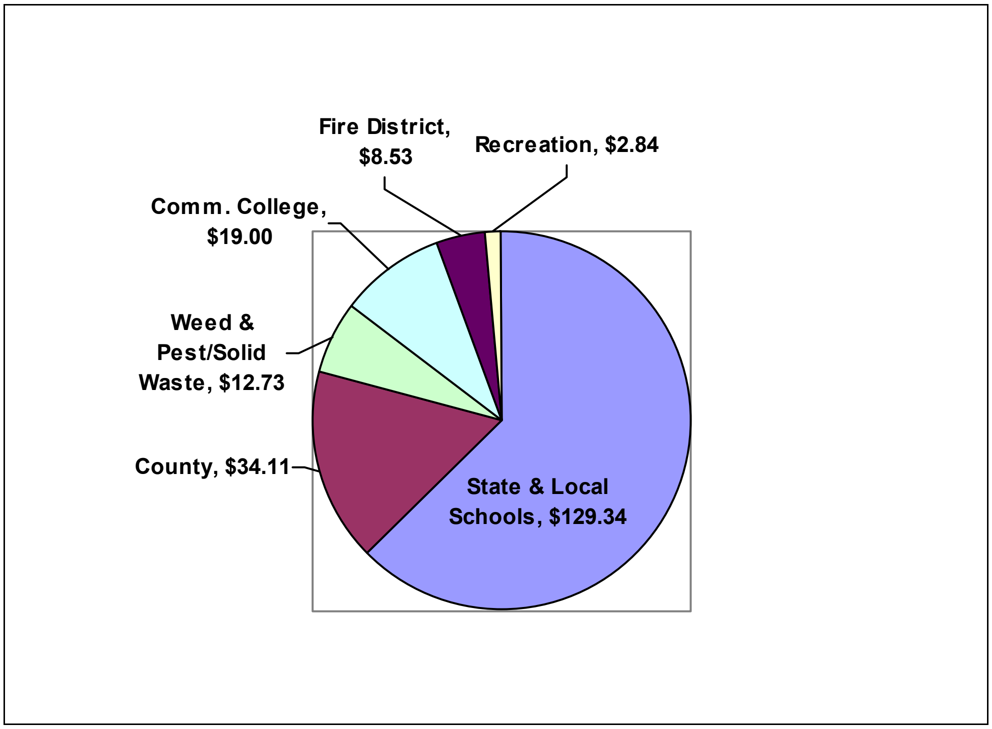
Fremont County Ad Valorem Property Tax Revenues

Fremont County ad valorem property tax revenues are distributed to a variety of taxing entities including state and local schools, the county (general fund, library, fair, recreation and museum) weed and pest and solid waste, fire districts and recreation districts. Figure 4.13-15 shows the distribution of estimated total cumulative Proposed Action-related ad valorem property tax revenues to relevant taxing entities.[7]

Proposed Action – related increases in ad valorem property tax revenues to Fremont County taxing entities would be considered positive, moderate and long term.

[7] Note that ad valorem property tax rates are set by state statute or by the Fremont County Commissioners and other school and special district officials based on the anticipated revenues and expenditures of the particular taxing entity, therefore tax rates and percentages would change over time.

Figure 4.13-15. Proposed Action Cumulative Ad Valorem Property Tax Distribution (millions of constant $2003)



4.13.2.5 Population

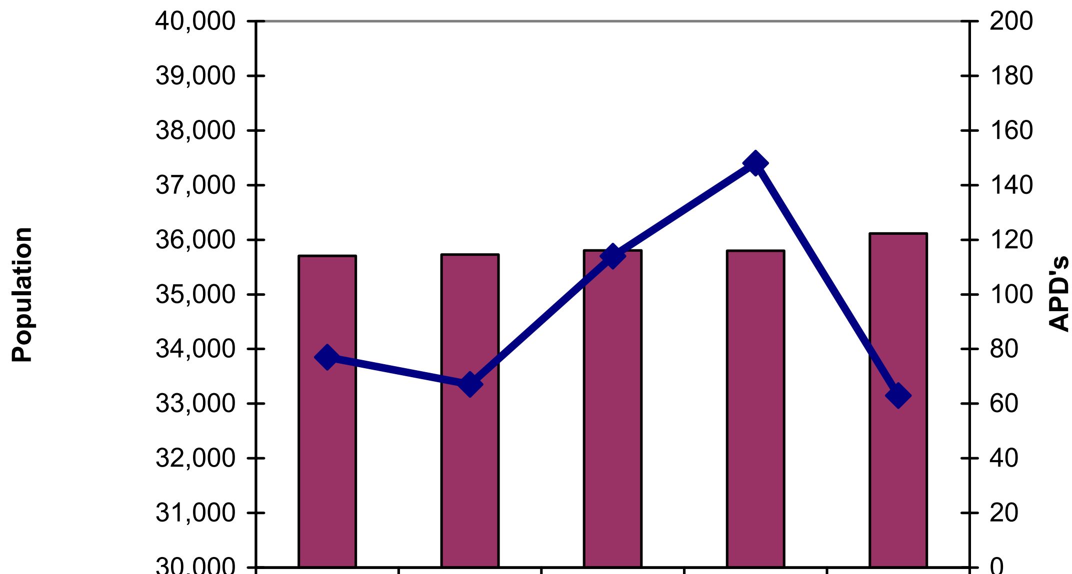
Population effects of the Proposed Action would be considered negligible to minor and long term. Fremont County has a relatively well-developed oil and gas service sector, which would provide many of the contractors and employees required for drilling, completion and field development. Other drilling and field development contractors are available in Casper, Thermopolis, Worland, Rock Springs and elsewhere in Wyoming. Regional contractors and employees would relocate to Fremont County for the duration of their task, staying in motels, recreational vehicle (RV) parks and other temporary accommodations. The duration of drilling and field development activity associated with the Proposed Action could encourage some contractor employees to relocate to Fremont County over time, but the effects on Fremont county population would likely be negligible.

The wells associated with the Proposed Action are likely to be drilled by regional drilling contractors located in Casper, Rock Springs or elsewhere in western Wyoming. Some supervisory, technical and key employees may accompany drill rigs to the area and stay in motels or RV parks during their workweek; however, most of the drilling crew would be hired locally. Tribal Employment Rights Ordinances or TERO (see Section 3.13.4.2) require that 50 percent of the workforce be hired from the Wind River Indian Reservation (WRIR), and recent drilling contractors have generally exceeded that requirement (Mansur, S. TBI, personal communication, November 5, 2003). Hiring of WRIR and other local employees would not result in population impacts, although the availability of local jobs could reduce out-migration from the WRIR and Fremont County. Operations employees and contractors associated with the Proposed Action would also be drawn primarily from the local or regional labor pool and pool of contractors.

As described in Section 4.13.2.3, the substantial increase in economic activity associated with the Proposed Action would support a correspondingly high level of indirect annual job equivalents (AJE). Many of these AJE's would be filled from the local labor pool or would be local employees who remain employed instead of losing their jobs, as economic activity from the Proposed action offsets anticipated declines in existing production in the WRPA or other oil and gas fields.

A comparison of recent population statistics to drilling activity seems to support this assessment. During 2001, a year in which oil and gas drilling in Fremont County reached historically high levels, county population remained relatively stable (see Figure 4.13-16). Even though drilling levels decreased substantially during the following year, 2002, population increased by about one percent. If drilling in the WRPA contributed to this growth, it was probably because effects to secondary employment typically lag drilling and field development employment by several months. Although increased economic activity from drilling in 2001 may have contributed to population growth in 2002, it appears that even at historically high levels of drilling the effect was minimal to Fremont County population.

Figure 4.13-16. Fremont County Population Contrasted with Applications for Permits to Drill: 1998 - 2002



	1998	1999	2000	2001	2002
Population	35,704	35,729	35,804	35,799	36,113
APD's	77	67	114	148	63

Sources: WDEA 2003; WOGCC 1998 – 2002.

Existing conditions and trends also would likely minimize the population impacts of the Proposed Action. As shown in Table 4.13-11, the Wyoming Division of Economic Analysis projects that Fremont County population will increase from the 2002 level of 36,113 to 37,370 in 2010, a total increase of 3.5 percent and an annual rate of less than one percent per year for the eight-year period.

Table 4.13-11. Fremont County Population Estimates and Projections: 2002 - 2010

2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change
36,110	36,280	36,410	36,540	36,710	36,910	37,090	37,220	37,370	3.5%

Source: WDEA 2003

At the projected level of 37,370 in 2010, Fremont County would still have a lower population than in 1980 by 1,622 persons, or about four percent. Given the modest rate of growth projected for the area and the substantial capacity in local and regional oil and gas service and construction companies, population effects of the Proposed Action would be negligible to minor and long term.

4.13.2.6 Housing

Under the Proposed Action housing demand would be primarily for temporary housing resources, such as motel rooms and RV spaces. Such demand is expected to be relatively limited because of the project's role in sustaining current employment as opposed to generating entirely net new opportunities. Fremont County has an ample supply of temporary housing resources. Therefore, the effects of the Proposed Action on local housing resources would be negligible and long - term.

Proposed Action – related sustained levels of employment and income may enable some local workers to purchase new housing. The resultant effects on local housing conditions would be gradual and represent a positive impact.

4.13.2.7 Law Enforcement and Emergency Response

Because population growth associated with the Proposed Action is anticipated to be negligible to minor, law enforcement and emergency response (ambulance and fire suppression) are two of a limited range of local government facilities and services that would be subject to impact. Potential effects also would occur to county road and bridge services, and these are discussed in Section 4.14 (Transportation).

Under the Proposed Action, four drilling rigs would be operating in separate areas of the WRPA at any one time (one in Pavillion, one in Muddy Ridge, one in Sand Mesa, and one alternating between Sand Mesa, Sand Mesa South and Coastal Extension). The industrial activity associated with drilling, completion and field development activities and the traffic associated with moving equipment, workers and materials to and from these sites are likely to result in increased demand for law enforcement and emergency response services.

Law Enforcement

The traffic and activity associated with Proposed Action-related drilling and field development would result in increased potential for demand for law enforcement services including traffic enforcement, accident response, trespass, industrial accidents and intervention in conflicts between Operator employees and contractors on the one hand and land owners and other users of land within the WRPA on the other. Although law enforcement demand associated with peak-year drilling (37 wells) under the Proposed Action would be less than that experienced during 2001 (48 wells), the demand would be distributed over more locations and over a wider geographic region.

It is anticipated that at least four rigs would be operating at any one time during most of the development phase, and completion and field development activities would be occurring concurrently at locations where drilling has been completed. The increased traffic and industrial activity at various locations on a relatively sustained basis (13 years) would require a more intensive level of law enforcement than is currently provided in the WRPA.

The Proposed Action is anticipated to result in minimal increased demand for BIA law enforcement, because of the small Tribal member population in the WRPA.

At present the Fremont County Sheriff's Department does not have the staff capacity to provide routine patrol services in the WRPA; calls are answered on a response basis, that is, an officer must travel to the emergency from Riverton or from the officer's location at the time of the call. An officer stationed in the WRPA may best be able to provide effective response to the demand associated with the Proposed Action; however, future staffing decisions would be based on actual demand, law enforcement priorities and available resources. Given current staffing levels, stationing an officer in the WRPA could require an additional deputy, vehicle and equipment. Costs to provide additional staff and equipment could be offset by Proposed Action-related revenues that would accrue to the Fremont County general fund, anticipated to total almost $24 million over the analysis period, and from county's share of Project-related sales and use tax.

Emergency Response

The sustained level of Proposed Action-related traffic and industrial activity has the potential to increase demand for emergency response services in the WRPA.

Fire Suppression

The Joint Tribal Programs Emergency Management Coordinator could experience increased demand for hazardous materials incident response and natural disaster response services under the Proposed Action. Based on historical experience within the WRPA, this demand is expected to be minimal. Individual hazardous materials and natural disaster incidents could require intensive periods of services, but typically these responses are relatively short in duration.

The Pavillion, Midvale and Riverton Fire Departments could all experience higher demand for emergency response services under the Proposed Action. Demand could include vehicle accidents, industrial accidents and natural gas fires. Additional training and specialized equipment may be needed to adequately prepare for the additional gas field development. Costs of the additional training and equipment could be offset by the estimated $9 million that would accrue to the Fremont County Fire District over the life of the Proposed Action, assuming a constant property tax rate of three mills.

Emergency Medical/Ambulance

As with fire suppression, emergency medical/ambulance services at Pavillion, Morton-Kinnear, Ft. Washakie and Riverton could experience increased demand for response to vehicular and industrial accidents. Additional training and equipment may be necessary to adequately prepare for the additional demand. The cost of additional ambulance response would be funded in part by patient billing. Additional costs of response and the cost of training and equipment could be offset by the Proposed Action's contributions to the county general fund, estimated to be about $29 million in ad valorem tax revenues and $3.8 million in sales and use tax revenues over the assessment period.

Based on the foregoing, the Proposed Action – related increases in demand for law enforcement and emergency response services would be considered minor and long – term.

4.13.2.8 Midvale Irrigation District (MID)

MID maintains and operates irrigation facilities which provide water to some of the land within the WRPA.

The Operators estimate that 72 of the total 155 wells in the Pavillion field associated with the Proposed Action would be drilled on irrigated land. It is not anticipated that wells will be drilled on irrigated land in any of the four other fields in the WRPA. As displayed in Table C-2, initial disturbance for each well on irrigated land in the Pavillion field is anticipated to average 2.8 acres/well. However, as is the recent practice, the Operators plan to drill on irrigated land during winter months, when the land is fallow, and to completely reclaim well access roads, pipelines and all but an approximately 64 square-foot area for each wellhead and a 9,375 square-foot area for production facilities (tanks, etc.) at each well, leaving total residual disturbance of 0.3 acres. Reclamation is intended to occur before the spring growing season. Based on these estimates, long-term disturbance of irrigated lands in the WRPA would total 21 acres although long-term irrigated land disturbance could be substantially less than this estimate, since the Operators intend to locate production facilities off of irrigated lands, where possible.

The BOR classifies land within the MID based on its agricultural use. The district may only assess a levy on irrigated land used for agricultural purposes, so natural gas, residential or other types of development that remove irrigable land from production has the potential to reduce district revenues if the land is reclassified by the BOR. Currently, the MID collects a levy of $15.00 per acre per year on irrigated land within the district. Therefore MID would lose an estimated $315 annually if the BOR reclassifies irrigated land taken out of agricultural production for the Proposed Action, consequently impacts of the Proposed Action on MID fiscal conditions and operations would be negligible and long-term, based on the assumptions used for this assessment. If wells are located on irrigated land in other fields, the amount of irrigated land and corresponding loss of revenue to the MID would increase, but would very likely remain negligible.

The Operators must obtain permits and approvals from the MID in order to construct roads, pipelines or other facilities across district canals, ditches or pipelines or use district rights-of-way or access roads. The permits are available at no cost, have an initial term of 25 years, and are renewable. However, they obligate the permit holder to meet specific engineering and design standards and pay for repairing any damages associated with their operations. These permits are also revocable.

4.13.2.9 Split Estate Issues

As described in Section 3.13.6.3, split estate exists when a different party owns the land surface than owns the minerals beneath the surface. Under the Proposed Action, the operators would drill an undetermined number of wells on split estate parcels in each of the fields. This would include parcels with private surface ownership above private minerals owned by another party or private surface ownership above minerals held in federal trust for the Tribes of the WRIR.

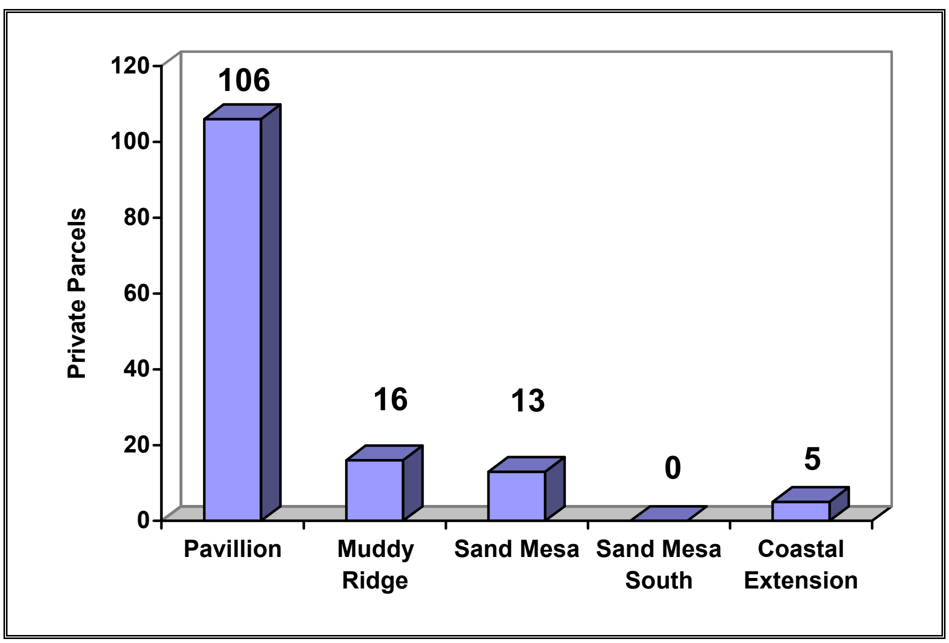
Operators often must occupy a portion of the surface to develop the gas beneath the surface. Where a surface owner also owns the minerals that are being drilled beneath the surface, the owner has presumably entered willingly into an agreement for gas development. But where the surface owner and the minerals owner are different, there is a potential for conflict over drilling. Intuitively, the more drilling that occurs on split estate properties, the greater the potential for problems. Table 4.13-12 displays the amount and percentage of private, tribal and federal (BOR) surface ownership in each of the five gas fields in the WRPA. Figure 4.13-15 displays the number of privately owned parcels in each field.

Table 4.13-12 Surface ownership of Gas Fields within the WRPA

Ownership	Pavillion		Muddy Ridge		Sand Mesa		Sand Mesa South		Coastal Extension	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
WRIR	0	0%	1,163	16%	925	9%	0	0%	3,237	63%
Private	9,826	83%	3,486	46%	4,369	46%	0	0%	1,838	35%
BOR or other federal	1,949	17%	2,876	38%	4,268	45%	3,774	100%	120	2%
Total	**11,775**	**100%**	**7,525**	**100%**	**9,562**	**100%**	**3,774**	**100%**	**5,195**	**100%**

There are a total of 140 private parcels within the five gas fields located in the WRPA, including 106 in the Pavillion field, 16 in the Muddy Ridge field, 13 in the Sand Mesa field and 5 in the Coastal Extension field (see Figure 4.13-17). There are no private parcels in the Sand Mesa South field.

Figure 4.13-17. Private Parcels Located within WRPA Gas Fields



Conflict over split estate may develop over the timing of drilling and field development, the location of wells and production facilities, disruption to agricultural activities, interaction between landowners and contractors, concerns about traffic, noise, safety and dust, and disagreement as to the sufficiency of payments associated with surface use agreements. Potential effects of gas development on agricultural operations include disruption of agricultural activities, damage to fields and crops and interference with farming practices such as cultivation patterns or the operation of mechanized irrigation systems. In recent years the Operators have developed measures to reduce disruption of agricultural activities. These measures are listed in detail in Sections 3.1.3.3 and 4.13.7. Typically, the Operators consult with the landowner on the location of a well to minimize interference with irrigation structures and cultivation patterns, within the limits of the drilling window imposed by the spacing order. Drilling on irrigated croplands typically would occur during the fallow late fall and winter seasons. Fill dirt is hauled in or purchased from the landowner, applied to access roads and well pads to minimize compaction and soil damage, and removed after completion. The well pad, access road and gathering system disturbance is reclaimed to an approximate 64 square foot area, the soil is prepared for cultivation, and production facilities are located at the edge of the property or along a road. These and other practices can, in most cases, minimize disruption to agricultural activities.

The potential for split estate impacts is greatest in the Pavillion field, because it is the most densely occupied of the five fields and has the greatest amount of private ownership of the surface. Of the 11,775 acres in the Pavillion field, 83 percent is comprised of 106 privately owned parcels of land. Under the Proposed Action, a total of 155 wells would be drilled (in addition to the existing wells) at an average rate of 14 wells per year for an 11-year period.

Of the 155 wells to be drilled in the Pavillion field under the Proposed Action, 72 wells, or 46 percent, would be drilled into privately owned minerals below the privately owned surface. A number of these wells may involve split estate, although it is not known how many. The potential for conflict also exists where private surface ownership overlies tribally owned minerals. This type of split estate would exist for 83 wells or 54 percent of wells drilled in the Pavillion field under the Proposed Action.

The Proposed Action assumes that 50 wells would be drilled in the Muddy Ridge field, where there are fewer private parcels and split estate conflicts have been less common. Depending on the location of the additional 16 wells, the potential for split estate conflicts could be substantially lower in the Muddy Ridge field.

Under the Proposed Action 8 wells would be drilled in the Coastal Extension field. It is assumed that one or two of these wells would be converted to producing wells. The relatively small amount of private land, the relatively few private parcels in the field (5), the characteristics of the target formations that allow directional drilling in some cases and the relatively wide spacing of wells, which allows more flexibility in surface location of wells, would all reduce the potential for split estate conflicts in the Coastal Extension field.

A total of 100 wells are assumed to be drilled in the Sand Mesa field under the Proposed Action, about 50 of which are anticipated to be converted to producing wells, under the assumptions used for this assessment. About 46 percent of the field is in private surface, divided into 16 parcels. There are fewer county roads within the field, which could require longer access roads to well pads and production facilities. On the other hand, the depth and characteristics of the target formations could allow directional drilling in some cases and the less dense spacing of wells would allow more flexibility in surface locations. Consequently the potential for split estate conflicts in the Sand Mesa field would be less than in the Pavillion Field, but likely higher than the other three fields.

There is no private surface in the Sand Mesa South field, so split estate conflicts would not occur in this field.

Based on the foregoing assessment and Operator - committed mitigation measures, the potential for Proposed Action-related split estate conflicts would me moderate and long term.

4.13.2.10 Gas Development, Agricultural Productivity and Income

The Proposed Action-related development of 325 additional wells and ancillary production facilities would initially disturb an estimated 1,982 acres; residual disturbance would total 422.6 acres. Most of this disturbance would be on dry land. It is anticipated that development on irrigated land would limited to the Pavillion field. An estimated 72 wells would be drilled on irrigated land used for crop production; consequently, landowner income for agricultural activities on these properties would be reduced. The mitigation measures identified in Section 4.13.7 are intended to minimize disruption to agricultural activities. Surface use agreement and reentry payments are intended to compensate landowners for income loss. These payments may offset all or a portion of agricultural income losses stemming from gas development, depending on the particulars of the situation. In some cases they may provide income in excess of losses, again depending on the particulars of the situation.

Wells drilled on irrigated land in the Pavillion field would require an estimated 2.8 acres of initial disturbance and about 0.3 acres of residual disturbance. Based on the 2002 average price of $360 /acre for alfalfa, the estimated loss in agricultural income associated with initial disturbance would be $1,008, which would be compensated by an initial surface use agreement payment of $6,000. Income losses from residual disturbance would be $108, which would be compensated with the annual surface use agreement payment of $1,500. Agricultural productivity and income could be affected on lands in addition to disturbed lands if cultivation patterns or mechanized irrigation systems are affected. However, mitigation measures and the recent Operator practice of drilling on irrigated lands during fallow seasons and reclaiming lands before crop seasons should minimize effects on adjacent lands.

Wells drilled on dry land in the Pavillion field would require 2.85 acres of initial disturbance and about 1.65 acres of residual disturbance. Grazing income on these lands averaged between $10.50 and $125/acre in 2002. Using the higher income amount, agricultural losses from initial disturbance would be $365 and residual losses would be $206, substantially less than initial and residual surface use agreement payments.

Assuming successful implementation of the Operator-committed mitigation measures summarized above and listed in detail in Sections 3.1.3.3 and 4.13.7, and assuming surface use agreement and reentry payments as described above, economic loss to agricultural operations associated with the Proposed Action are likely to be negligible and, in some cases, farmers and ranchers may experience increases in net income from properties with gas development. At the same time, based on scoping comments and the interviews conducted for this assessment, there are surface landowners who view gas development as an intrusion that is not adequately compensated by Operator-committed mitigation measures and surface damage payments.

4.13.2.11 Resource Extraction and Rural Character\

Although natural gas development has been occurring in the WRPA for almost 40 years, the pace of development has accelerated in recent years, accompanied by substantial increases in drilling and development activity, traffic and increases in wells and production facilities, mainly in the Pavillion and Muddy Ridge fields. Particularly during 2001, when 39 wells were drilled in the Pavillion field, the pace of change in rural character of the Pavillion area, from rural to mixed rural/resource extraction accelerated. Although development associated with the Proposed Action would proceed at a lower annual pace than the development that occurred in 2001, the development phase of the Proposed Action would last for 13 years and be more dispersed among the fields of the WRPA, with development in specific fields occurring from 13 years (Sand Mesa) to 4 years (Sand Mesa South). The development of a single well is a relatively short-term activity that lasts from two weeks to 90 days or more. But as a whole, additional development in each field would further change the character of affected areas from rural to a mixture of rural and resource extraction.

The change in rural character would be greatest in areas where drilling and field development is ongoing and would tend to diminish as development moved to other parts of the field. Change in land use and character would be most intense in the Pavillion Field because of the number of wells that would be drilled (155), the density of spacing and the relatively large number of private parcels in the area. As development activity subsides and reclamation occurs, particularly on irrigated lands, the Pavillion area would return to a more rural character. However, the increase in number of production facilities, the more prominent evidence of wells on dry land parcels and the constant level of production activity would still represent a change in the rural character of the area compared to current and historical conditions.

Gas development is less likely to impact the character of the Muddy Ridge Field. The impact of change in the Muddy Ridge Fields would be less because there are fewer private parcels (16), many wells would be located on Reservation or BOR surface instead of private surface, fewer wells (50) would be drilled and much of the intensively developed part of the field is separated by terrain from private land and from major thoroughfares.

In the Coastal Extension field, gas development and production may also change the character of rural lands, but the impact is likely to be much less than in the other fields in the WRPA. There are very few private parcels (5) and fewer wells would be drilled (8, with only 2 of these assumed to be converted to producing wells), and the field is also distant from major thoroughfares and residences.

The Sand Mesa Field has relatively few private parcels (13), but it would receive a fairly high level of development (100 wells). Currently, the Sand Mesa Field is relatively undeveloped, and the contrast of 100 drill sites, 50 of which are assumed to result in producing wells with associated production facilities, would be relatively high.

There is no private land within the Sand Mesa South field and only 12 wells would be drilled under the Proposed Action, six of which would be converted to producing wells. Therefore the change in rural character would be less evident,

Based on the level of development and the associated physical and environmental change, the impact of the Proposed Action on the rural character of lands in the WRPA is likely to be moderate and long term.

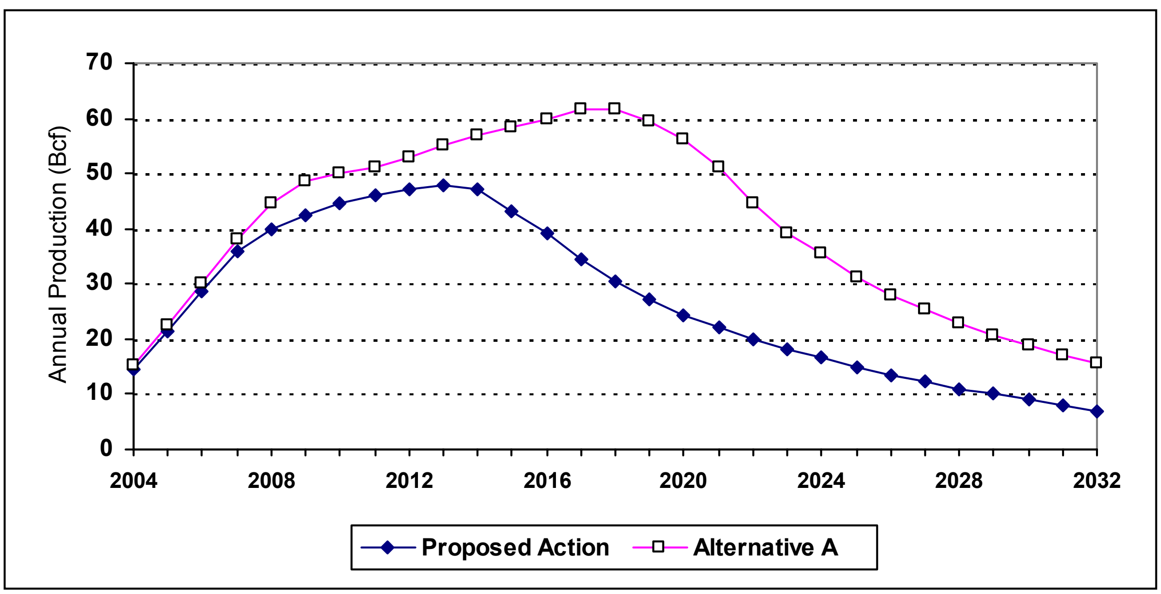
4.13.3 Alternative A (485 wells)

4.13.3.1 Overview

Under Alternative A the Operators would drill 485 new wells over 18 years. Of those, 272 wells would be in the well-defined Pavillion and Muddy Ridge fields. Another 213 wells would be in the more exploratory Sand Mesa, Sand Mesa South and Coastal Extension fields. The peak of drilling activity would occur from 2006 to 2008, when 39 new wells would be drilled each year. Approximately $1.2 billion in future drilling expenditures would be made under Alternative A. An additional $54.2 million investment in gas field collection, processing and compression infrastructure would be made to support production and marketing of gas produced within the WRPA.[8] Completion of new wells would trigger increased future natural gas production. Annual production was projected using prototypical well production data consistent with that for the Proposed Action.[9]

Under Alternative A, projected annual gas production from the WRPA would be 15.1 million Mcf in 2004. Annual production would increase to a peak of 61.8 million Mcf in 2018. Although drilling would continue through 2021 under the Alternative A, declines in production from existing and future wells would more than offset the incremental production gains beyond 2018. Consequently, annual production would begin declining, with the declines continuing through 2032, the end of analysis's time horizon as shown in Figure 4.13-18. An undetermined quantity of economically recoverable reserves would remain, such that production would continue beyond that time. At the end of that period, the field would still be economically viable, with annual production in excess of 15.4 million Mcf.[10]

Figure 4.13-18. Projected Annual Gas Production, 2004 to 2032, Alternative A

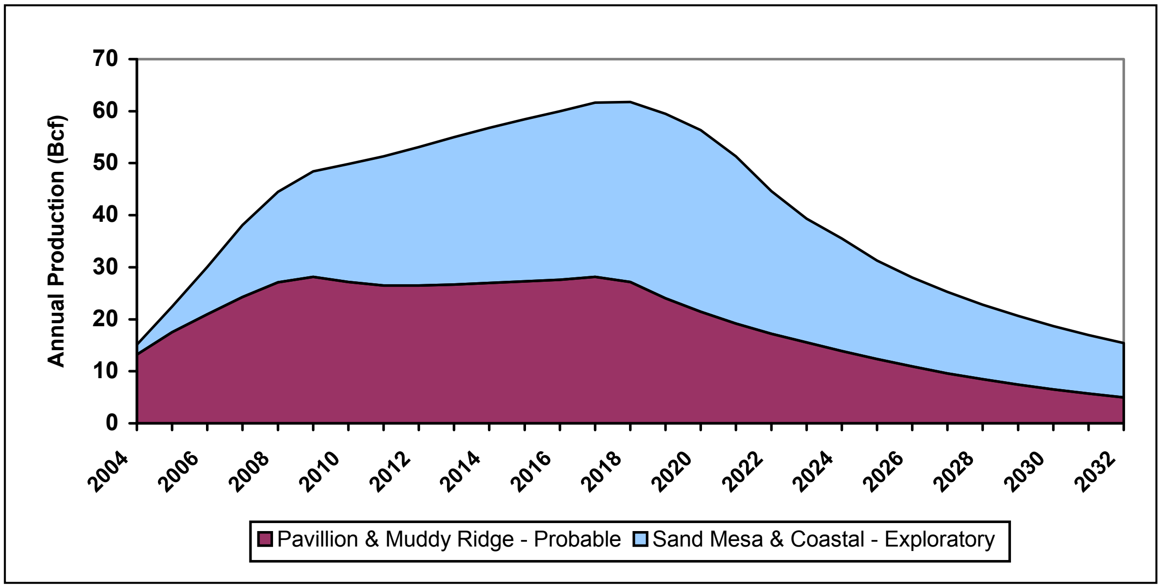


[8] All monetary sums are in constant 2003 dollars ($2003).

[9] The production estimates developed for this analysis do not represent a detailed reservoir engineering analysis. Rather, they reflect a series of simplified assumptions that allow a reasonable portrayal of the socioeconomic impacts associated with the alternative <u>and</u> characterization of the differences between the alternatives.

Total estimated production over the period 2004 to 2032 is 1,172.2 million Mcf. Of the total, 552.3 million Mcf (47 percent of the total) would be from the Pavillion and Muddy Ridge fields, about 124 million Mcf higher than with the Proposed Action. The combined production from the Sand Mesa, Sand Mesa South and Coastal Extension fields is estimated at 619.9 million Mcf (see Figure 4.13-19). Relative to the Proposed Action, Alternative A yields higher peak production, the peak occurring about 5 years later, but with a larger share of the projected production associated with the deeper, more speculative formations.

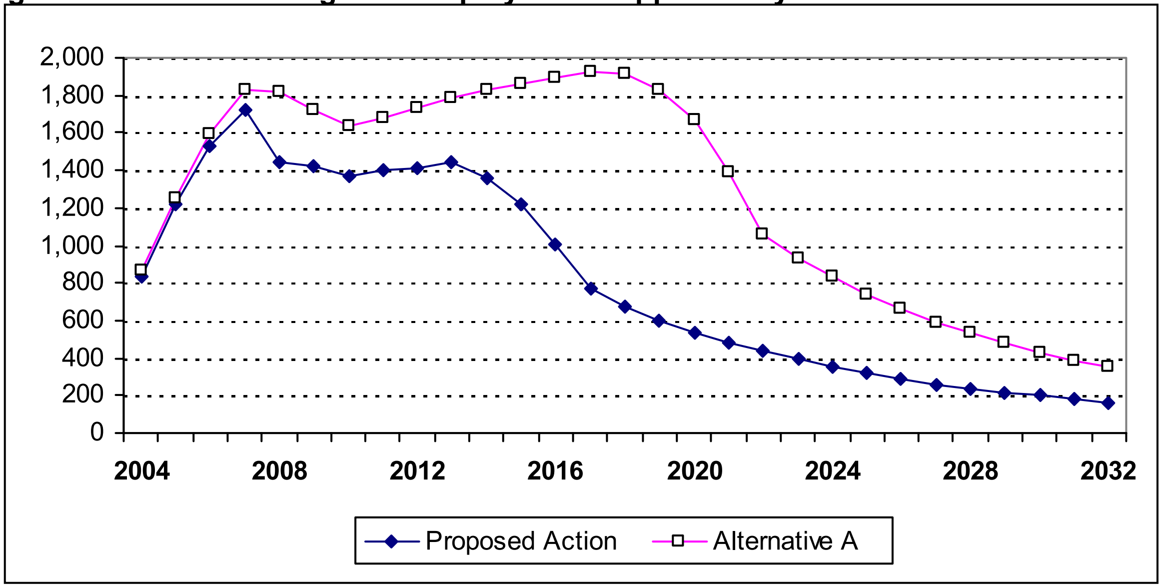
Figure 4.13-19. Projected Annual Production, By Field Grouping, Alternative A



Regional employment and businesses would be supported directly and indirectly by ongoing exploration and production associated with the Alternative A, as well as the expenditures of gas industry employees, Tribal members and fee mineral owners receiving royalties, and the activities of Tribal and local governmental agencies supported by gas development-related revenues. The direct employment impacts are tied to the drilling activity, the construction of new infrastructure and production. The deeper wells in the Sand Mesa, Sand Mesa South and Coastal Extension require more labor and take longer to complete. Consequently, the direct employment is sustained for a longer time than under the Proposed Action. Similarly, the secondary impacts associated with the flows of severance and property taxes and royalty payments, which are more responsive to the level of production, would increase over time until production peaks in 2018, and then would begin a period of continuous decline.

[10] The threshold for long-term economic viability is 5 million Mcf in annual production.

Figure 4.13-20. Total Regional Employment Supported By Alternative A



4.13.3.2 Direct Economic Stimulus

As described previously, the drilling activity would occur over 18 years under Alternative A. The economic stimulus associated with the construction of the new gas field infrastructure would occur between 2005 and 2008. Together these activities would support 649 direct jobs in 2007. Production would ramp-up quickly as the number of new Pavillion and Muddy Ridge wells increases, supporting 102 additional direct jobs that same year. After peaking at 751 jobs in 2007, direct employment would decline in 2008 and 2009, then remain consistently above 450 jobs through 2018. Declining production thereafter would result in parallel declines in production expenditures, value of production and regional economic stimulus – (see Table 4.13-13).

Table 4.13-13. Expenditures and Production, 2010, 2020 and 2030, Alternative A

	2010	2020	2030
Drilling Expenditures ($M)	$ 62.7	$ 40.7	$ 0.0
Annual Production Expenditures ($M)	$ 41.2	$ 53.5	$ 18.0
Annual Production (Millions of Mcf)	49.9	56.4	18.7
Annual Value of Production ($M)	$ 162.1	$ 183.2	$ 60.8
Est. Tribal Share of Production	87%	88%	91%

($M) – Millions of constant $2003.

For example, $62.7 million in drilling expenditures are projected in 2010, with $40.7 million anticipated in 2020. With the completion of drilling scheduled in 2021, no drilling expenditures are projected in 2030. Total annual gas production in 2010 is estimated at 49.9 million Mcf, climbing to 56.4 million Mcf in 2020 but then declining to 18.7 million Mcf in 2030. Similarly, total gas production valued at $162.1 is projected in 2010, climbing to $183.2 million in 2020 before falling to $60.8 million by 2030. The Tribal share of production increases over time, from about 66 percent at present to 91 percent in 2030 because most new wells are on Tribal minerals.\

Projected gas production would peak at 61.8 million Mcf in 2018 under Alternative A, 13.8 million Mcf per year higher and five years later than the peak under the Proposed Action.

Peak annual drilling and production expenditures are also higher and the value of gas produced peaks at over $200 million. No additional major infrastructure investment beyond that proposed for the Proposed Action is anticipated for Alternative A. Table 4.13-14 summarizes these and other economic variables for the peak year.

Table 4.13-14. Project-Related Expenditures and Production, Peak Production, Alternative A

	Alternative A (2018)	Proposed Action (2013)	Differences
Gas Field Infrastructure Investments ($M)	$ 0.0	$ 0.0	-0-
Drilling Expenditures ($M)	$ 59.9	$ 48.5	+$ 11.4
Annual Production Expenditures ($M)	$ 56.0	$ 35.6	+$ 20.4
Annual Production (Millions of Mcf)	61.8	48.0	+$ 13.8
Value of Production ($M)	$ 200.7	$ 156.1	$ 44.60
Est. Tribal Share of Production	86%	83%	+ 3%

($M) – Millions of constant $2003.

Over the entire time horizon of this analysis, more than $2.26 billion in drilling and production expenditures are projected under Alternative A to produce $3.8 billion in natural gas. That total is more than $900 million higher than under the Proposed Action and occurs over a much longer time horizon. Consequently, Alternative A provides a more sustained direct economic stimulus to the regional economy when compared to the Proposed Action. The Tribal share of the cumulative production would be 93 percent, compared to 85 percent under the Proposed Action.

Table 4.13-15. Cumulative Project-Related Expenditures and Production, 2004 to 2032, Alternative A

	Alternative A	Proposed Action	Differences
Gas Field Infrastructure Investments ($M)	$ 54.2	$ 54.2	- 0 -
Drilling Expenditures ($M)	$ 1,187.1	$ 730.1	+$ 457.0
Production Expenditures ($M)	$ 1,021.7	$ 578.0	+$ 443.7
Total Project Related Expenditures ($M)	$ 2,263.0	$ 1,362.3	+$ 900.7
Total Production (Millions of Mcf)	1,172.2	776.2	+ 396.0
Value of Production ($M)*	$ 3,809.6	$ 2,522.8	+$ 1,286.8
Est. Tribal Share of Production	93%	85%	+ 8%

($M) – Millions of constant $2003.

4.13.3.3 Economic Impacts

Direct employment associated with Alternative A would increase quickly in response to the simultaneous ramp up in drilling, infrastructure construction and production. In 2007, Alternative A would support 751 direct jobs. Another 463 secondary jobs would be supported by the direct jobs and associated expenditures. At its peak, gas exploration and production activity would generate $46.8 million in personal income. Following completion of infrastructure construction, the number of jobs associated with ongoing drilling and production, including direct and secondary jobs, ranges from 1,091 in 2008 to 557 in 2021, the final year of scheduled drilling. The associated personal income during that period ranges from $43.3 million in 2008 to $25.5 million in 2021.

The induced impacts associated with the flows of taxes and royalty payments to governmental entities and individual households, are more responsive to the level of production, and thereby lag behind the pace of drilling. Consequently, the numbers of secondary jobs increase more slowly, climbing from 225 jobs in 2004, to a peak of 993 jobs in 2018. Thereafter, declining production results in lower tax and royalty payments and hence, reduced per capita distributions to Tribal members and income to fee mineral interest owners. Those reductions would translate into less economic stimulus to the regional economy and fewer secondary jobs.

The pattern of an initial rise in employment, personal income and regional economic output, followed by protracted declines over time is evident in Figure 4.13-20 and Table 4.13-16. As shown, the total number of jobs supported by Alternative A, climbs to 1,684 jobs in 2010. The total employment impact continues to increase, peaking at 1,924 jobs in 2017, after which long-term decline would occur (Figure 4.13-20).

Table 4.13-16. Employment, Income and Output, 2010, 2020 and 2030, Alternative A

	2010	2020	2030
Total Jobs Supported (Direct, Indirect & Induced)	1,638	1,664	430
Total Personal Income Generated ($M)	$ 69.8	$ 72.9	$ 20.1
Regional Economic Output ($M)	$ 340.7	$ 371.4	$ 111.2

($M) – Millions of constant $2003.

The impacts on personal income and regional economic output associated with Alternative A mirror the pattern of employment impacts. Project-related personal income would be $69.8 million in 2010, peaking at $83.0 in 2017, and then tracking the downward trend of production. Projected personal income would be $72.9 million in 2020 and $20.1 million in 2030. The annual amount for the per capita distribution to Tribal members peaks at $18.4 million in 2018. The cumulative sum of such distributions would be $353.4 million over the entire period.

Peak gas production of 61.8 Mcf would occur in 2018 under Alternative A. The corresponding employment impact of 1,911 jobs is almost 32 percent higher than the 1,449 jobs at peak production under the Proposed Action. Personal income generated by Alternative A is projected at $82.8.1 million in 2018; $21.0 million higher than under the Proposed Action (see Table 4.13-17). The $82.8 million sum is equivalent to 10.3 percent of the total personal income of Fremont County residents in the year 2000.

Table 4.13-17. Employment, Income and Output, Peak Production, Alternative A

	Alternative A (2018)	Proposed Action (2013)	Differences
Total Jobs Supported	1,911	1,449	+ 462
Total Personal Income Generated ($M)	$ 82.8	$ 61.8	+ $ 21.0
Regional Economic Output Generated ($M)	$ 414.8	$ 309.9	+ $104.9

($M) – Millions of constant $2003.

The contributions to regional economic output associated with the Alternative A, a measure of the total value of goods and services produced within the regional economy, would peak at $414.8 million in 2018, $104.9 million (34 percent) above the peak impact under the Proposed Action.

The cumulative economic impacts from 2004 to 2032 for Alternative A include more than 37.200 job-years of employment, $1.76 billion in personal income and over $7.9 billion in total economic output (Table 4.13-18). The employment and income impacts are each more than 58 percent above the comparable impacts under the Proposed Action. Alternative A would have a 57 percent greater impact on regional output than is projected for the Proposed Action.

Table 4.13-18. Cumulative Employment, Income and Output, 2004 to 2032, Alternative A

	Alternative A	Proposed Action	Differences
Total Job-Years Supported	37,223	23,498	+ 13,725
Total Personal Income Generated ($M)	$ 1,599.4	$ 1,007.0	+ $ 592.4
Regional Economic Output Generated ($M)	$ 7,895.9	$ 5,004.6	+ $2,891.3

($M) – Millions of constant $2003.

Alternative A increases in regional economic output and employment would be considered positive, moderate and long-term. Alternative A – related increases in personal income (including Tribal and private royalty income) would be considered, positive, major and long-term.

4.13.3.4 Fiscal Impacts

Annual revenue accrual associated with Alternative A would mirror future production levels, increasing dramatically between 2004 and 2018, the year of peak production, before beginning a protracted decline.[11] Projected annual revenue accruals from selected sources in the three designated comparison years are summarized in Table 4.13-19 below.

About $130,000 in WOGCC fees would accrue to the WOGCC in 2020 under Alternative A. That same year, $12.25 million in Tribal severance taxes and $20.25 million in Tribal royalty payments would accrue to the Tribes, with $15.13 million of ad valorem taxes accruing to affected local governments in Fremont County.[12] Royalty payments of $2.40 million on fee minerals and state severance taxes of $6.57 million are also projected.

[11] Assumes a constant gas price and constant tax and royalty rates. Future revenues are reported in same year as projected production.
[12] Ad valorem taxes would be distributed among Fremont County, Fremont County School District and a number of other local governmental entities. Detailed allocations were not prepared for this analysis.

Table 4.13-19. Annual Tax and Royalty Payments, 2010, 2020 and 2030, Alternative A

Revenue Type and Affected Entity/Group	2010	2020	2030
Wyoming Oil and Gas Conservation Comm. ($M)	$ 0.11	$ 0.13	$ 0.04
Wyoming State Severance Taxes ($M)	$ 6.20	$ 6.57	$ 2.15
Wyoming Sales and Use Tax ($M)	$ 1.69	$ 1.42	$ 0.23
Fremont County Ad Valorem Taxes ($M)	$ 13.89	$ 15.13	$ 4.15
Tribal Severance Taxes ($M)	$ 10.69	$ 2.25	$ 4.17
Tribal Royalty Payments ($M)	$ 17.65	$ 20.25	$ 6.91
Royalty Payments on Fee Production ($M)	$ 2.49	$ 2.40	$ 0.62

($M) – Millions of constant $2003.

A total of $63.81 million in tax and royalty payments would accrue from the peak production of 61.8 million Mcf in 2018; $1.03 per Mcf. Tribal receipts of a total of $13.2 million in severance taxes and $21.7 million in royalties would accrue from Alternative A. Of the total $1.81 million collected in sales and use tax, $533,000 would accrue to Fremont County and its incorporated municipalities and $1,274,000 would accrue to the State. Another $16.53 million in ad valorem taxes would accrue to local governments and school districts in Fremont County (see Table 4.13-20).

Table 4.13-20 Tax and Royalty Payments, Peak Production Year, Alternative A

Revenue Type and Affected Entity/Group	Alternative A (2018)	Proposed Action (2013)	Differences
WOGCC ($M)	$ 0.14	$ 0.11	+ $ 0.03
Wyoming Severance Taxes ($M)	$ 7.38	$ 6.26	+ $ 1.12
Wyoming Sales and Use Tax ($M)	$ 1.81	$ 0.82	+ $ 0.99
Fremont County Ad Valorem Taxes ($M)	$ 16.53	$ 13.82	+ $ 2.71
Tribal Severance Taxes ($M)	$ 13.15	$ 9.83	+ $ 3.32
Tribal Royalty Payments ($M)	$ 21.69	$ 16.12	+ $ 5.57
Royalty Payments on Fee Production ($M)	$ 3.14	$ 3.35	- $ 0.21

($M) – Millions of constant $2003.

Cumulative tax and royalty payments would total $1,220.39 million over the entire time period (see Table 4.13-21 below). That total is $411.06 million higher than that for the Proposed Action.

Table 4.13-21 Cumulative Tax and Royalty Payments, 2004 to 2032, Alternative A

Revenue Type and Affected Entity/Group	Alternative A	Proposed Action	Differences
WOGCC ($M)	$ 2.67	$ 1.77	$0.90
Wyoming Severance Taxes ($M)	$ 142.33	$ 100.58	$41.75
Wyoming Sales and Use Tax ($M)	$ 36.00	$ 22.46	$13.54
Fremont County Ad Valorem Taxes ($M)	$ 314.93	$ 206.55	$108.38
Tribal Severance Taxes ($M)	$ 251.82	$ 163.13	$88.69
Tribal Royalty Payments ($M)	$ 415.71	$ 268.49	$147.22
Royalty Payments on Fee Production ($M)	$ 56.93	$ 46.35	$10.58

($M) – Millions of constant $2003.

The total includes an estimated $251.82 million in additional severance taxes and $415.71 million in royalty payments that would accrue to the Tribes. Royalty payments of $10.58 million more than under the Proposed Action would accrue to owners of fee mineral interests in the WRPA, raising the total to $56.93 million. Tax and royalty revenues for

Alternative A and the Proposed Action are shown in Figure 4.13-21. Figure 4.13-22 displays the percentage of cumulative Alternative A-related tax and royalty revenues that would be distributed to each entity.

Figure 4.13-21. Cumulative Taxes and Royalties Generated, Alternative A, 2004 – 2032 (millions of constant $2003)

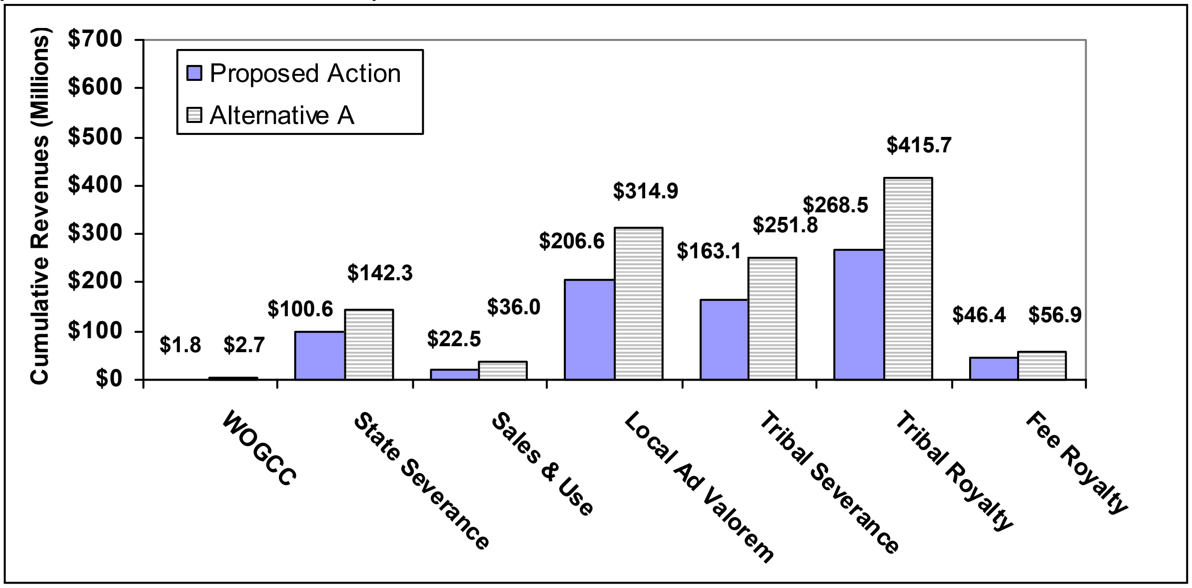
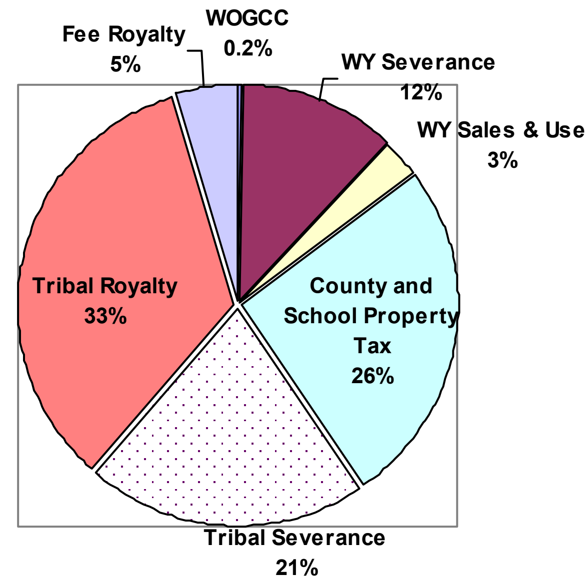


Figure 4.13-22. Percentage Distribution of Cumulative Tax and Royalty Revenues: Alternative A



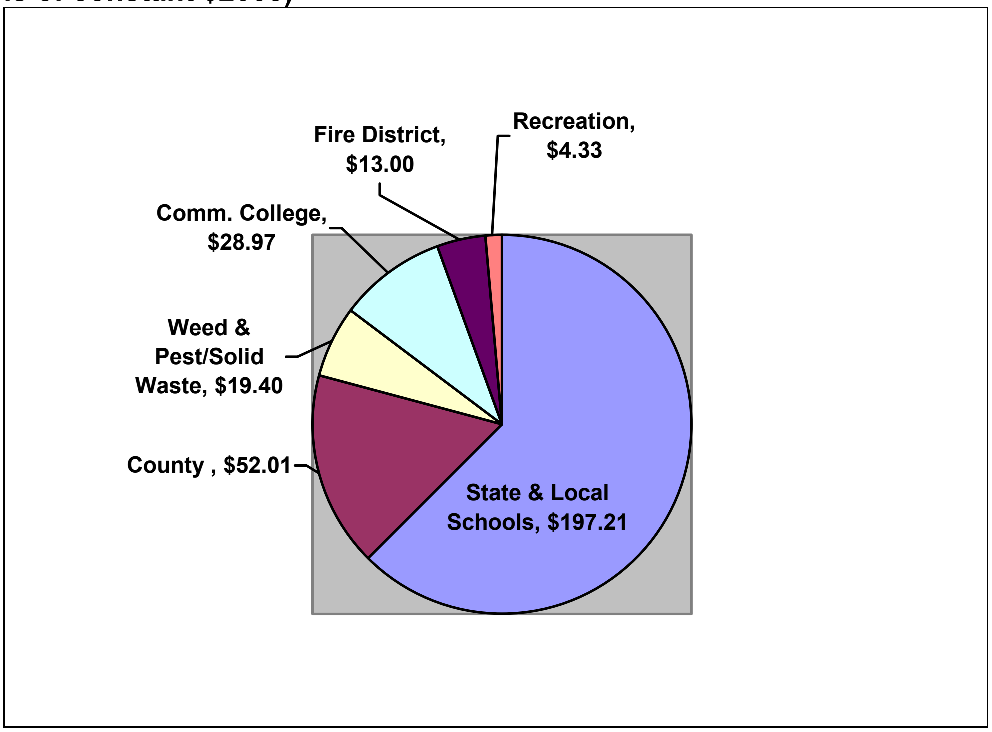
Based on the estimates prepared for this assessment, the Eastern Shoshone and Northern Arapahoe Tribes would receive royalty payments equal to 33 percent of total cumulative tax and royalty revenues associated with Alternative A, Fremont County, its ad valorem property taxing entities and state and local schools would receive 26 percent, the WRIR Tribes would receive 21 percent in severance tax payments, the State of Wyoming would receive 12 percent in severance tax payments, Wyoming, Fremont County and its incorporated municipalities would receive 3 percent in sales and use tax payments, fee mineral owners would receive 5 percent in royalty payments, and the Wyoming Oil and Gas Conservation Commission would receive 0.2 percent.

Alternative A increases in Tribal royalty and severance tax revenues would be considered positive, major and long term. Alternative A – related increases in Fremont County ad valorem taxes would be considered positive, moderate and long term.

Fremont County Ad Valorem Property Tax Revenues

Figure 4.13-23 shows the distribution of estimated total cumulative Alternative A-related ad valorem property tax revenues to relevant taxing entities.[13]

Figure 4.13-23. Alternative A Cumulative Ad Valorem Property Tax Distribution (millions of constant $2003)



4.13.3.5 Population

As previously noted, the analysis of population effects focuses on the consequences of peak employment experienced during drilling and field development, plus the effect of sustained employment during the drilling and field development phase, which lasts different lengths of time under each alternative. From this perspective, Alternative A would be similar to the Proposed Action in the early years of the assessment period during the peak of drilling and field development employment (which would occur at a similar point in the assessment period). However, Alternative A would generate substantially higher levels of employment over a longer period of time, as discussed in Section, 4.13.3.1 and shown in Figures 4.13-2 and 4.13-4.

Consequently, population effects associated with Alternative A drilling and field development would likely be minor and long term, just slightly higher than the effects of the Proposed Action. Despite more years of higher employment associated with infrastructure development that would generate higher levels of indirect employment, new jobs would likely be filled by a combination of local workers who are unemployed or under-employed and by existing employees who would retain jobs that otherwise might be lost as production

[13] Note that ad valorem property tax rates are set by state statute or by the Fremont County Commissioners and other school and special district officials based on the anticipated revenues and expenditures of the particular taxing entity, therefore tax rates and percentages would change over time.

from other oil and gas fields decrease. It is also likely that unemployed residents of the WRIR would reenter the labor pool as employment opportunities increased, providing yet another source of local workers to take jobs and discourage in-migration.

4.13.3.6 Housing

As with the Proposed Action, the large majority of housing demand associated with Alternative A would likely be for temporary housing resources, though demand for more permanent housing may be somewhat greater under Alternative A than under the Proposed Action. This may be the case because the longer duration of the drilling and field development phase could result in more contract employees purchasing houses, seeking apartments or locating mobile homes in existing mobile home parks, instead of using temporary housing. Notwithstanding this, the existing supply of local housing resources would likely still be adequate to accommodate somewhat higher level of this type of demand associated with Alternative A. Consequently, the effects of Alternative A on area housing conditions are likely to be negligible to minor and long term.

It is possible that the longer-term increases in employment and income would encourage more local workers to purchase housing under Alternative A, again, these effects would occur over time and be seen as positive.

4.13.3.7 Law Enforcement and Emergency Response

Demand for law enforcement and emergency response services associated with the Proposed Alternative A would be similar to the Proposed Action, because peak and annual drilling and field development would be similar under both alternatives. Under both alternatives four rigs would be operating full time in the WRPA, and the annual level of infrastructure development would be similar. Any differences in impact would occur because the drilling and field development phase would last for 18 years under Alternative A compared to 13 years for the Proposed Action. The effect of this difference would be that the increased potential for traffic and industrial accidents, plus the associated demand for emergency and law enforcement services, would likewise last an additional five years.

At the same time, natural gas production-related revenues accruing to the county general fund would increase to about $45 million over the analysis period under Alternative A. Revenues accruing to the Fremont County Fire District alone would total almost $14 million. These revenues could be used to defray the expense of providing additional law enforcement and emergency response services over the longer period. Alternative A – related effects on law enforcement and emergency response services would be considered minor and long term.

4.13.3.8 Midvale Irrigation District

The Operators estimate that 92 of the total 206 Pavillion field wells associated with Alternative A would be drilled on irrigated land. It is not anticipated that wells would be drilled on irrigated land in any of the four other fields in the WRPA. Assuming implementation of Operator commitments to reclaim all access roads, pipeline cuts and reclaim the well pad to a 64 square foot area by the first growing season, a total of 28 irrigated acres would be removed from production over the life of Alternative A, resulting in an annual loss of $420 in assessment revenues for the MID. This amount could be reduced if production facilities were located off irrigated ground. Based on the forgoing, Alternative A would result in negligible, but long term impact to MID fiscal conditions and operations

4.13.3. 9 Split Estate Issues

As noted previously the more drilling on split estate lands, the higher the potential for conflict between surface owners and the Operators (see Section 4.13.2.9). By increasing the number of wells by 49 percent over the Proposed Action, Alternative A would correspondingly increase the potential for split estate conflicts.

Drilling in the Pavillion field, where most split estate parcels are located, would increase by 33 percent (51 wells) over the Proposed Action. As noted in Section 4.13.2.9, the Pavillion field has the highest amount of private land and the largest number of private parcels of the five fields. It is also the most densely occupied and most intensively used for agricultural and residential purposes. Consequently, the increase in drilling in the Pavillion field would likely generate additional conflicts over split estate issues. As with the Proposed Action, successful implementation of the Operator committed mitigation measures would reduce but not eliminate split estate conflicts.

Drilling in the Muddy Ridge field, where there are fewer private parcels and where split estate conflicts have been less common as a result, would also increase by 33 percent or 16 wells under Alternative A. Depending on the location of the additional 16 wells, the potential for split estate issues in the Muddy Ridge field would increase under Alternative A but would remain much lower than in the Pavillion field.

Drilling activity would increase fourfold in the Coastal Extension field (from 8 to 32 wells). Wells that go into production would be a fraction of wells drilled: it is assumed that 6 or 7 wells in the Coastal Extension field would be converted to producing wells. Even with the substantial increase in drilling under Alternative A compared to the Proposed Action, the potential for split-estate conflict would be limited by the relatively few private parcels in this field (5) and the greater flexibility to select acceptable locations for wells on the surface.

Drilling in the Sand Mesa field would increase by one third, or 33 wells, for a total of 133 wells drilled; about 66 of these are assumed to be converted to producing wells. About 46 percent of the field is in private surface ownership, and private ownership is divided among 16 parcels. With fewer existing county roads within the Sand Mesa field, longer access roads may be needed to access well pads and production facilities. On the other hand, conditions in the Sand Mesa field could allow directional drilling in some cases because of the depth and characteristics of the target formations, and there may be more flexibility in the selection of surface locations for wells, given the less dense spacing of wells in the field. On balance, the potential for split estate conflicts in the Sand Mesa field under Alternative A would be less than in the Pavillion field but higher than the other three fields.

The absence of private land in the Sand Mesa South field would preclude split estate effects.

Based on the foregoing, split estate conflicts under Alternative A would likely be moderate and long term.

4.13.3.10 Gas Development, Agricultural Productivity and Income

Per well disturbance on irrigated lands and per well surface use agreement and reentry payments would be the same for Alternative A as for the Proposed Action, Consequently, assuming successful implementation of the Operator-committed mitigation measures listed in detail in Sections 3.1.3.3 and 4.13.7, economic loss to agricultural operations associated with the Proposed Action are likely to be negligible and, in some cases, farmers and ranchers may receive increases in net income from properties with gas development.

4.13.3.11 Industrialization and Rural Character

By increasing the number of wells drilled in the WRPA by 49 percent over the Proposed Action, Alternative A would further accelerate the change in rural character (from rural to mixed rural and resource extraction) in the five gas development areas of the WRPA. The longer drilling schedule and the higher number of wells and production facilities that stay in place for the life of project would increase the level and pace of change and extend the length of time that effects of gas development would alter the rural character of the area. These effects would be highest in the Pavillion field, which would see drilling increase by about a third under Alternative A compared to the Proposed Action. The impacts of Alternative A activities on the rural character of lands within the WRPA are likely to be moderate and long term.

4.13.4 Alternative B (233 wells)

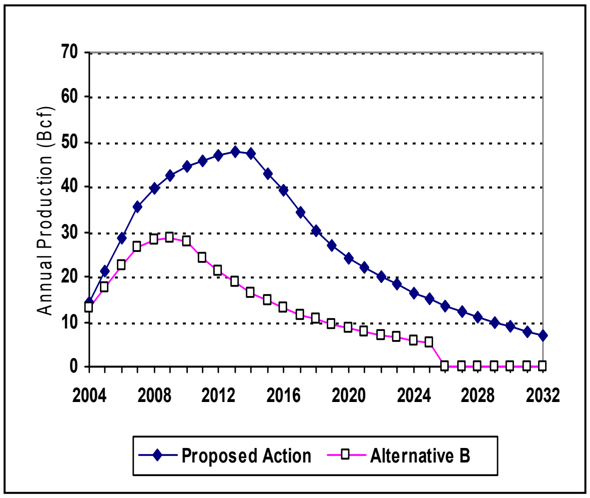
4.13.4.1 Overview

Alternative B calls for the development of 233 new wells over 10 years. Of those, 136 wells would be in the Pavillion and the Muddy Ridge fields and 97 wells would be in deeper Sand Mesa, Sand Mesa South and Coastal Extension fields. The peak of drilling activity would occur from 2006 when 38 new wells would be drilled. Approximately $568.7 million in future drilling expenditures would be made under Alternative B. The investment in gas field collection, processing and compression infrastructure would be the same as under the Proposed Action.[14] Annual production was projected using prototypical well production data consistent with that for the Proposed Action.[15]

Under Alternative B, projected annual gas production from the WRPA would be 13.2 million Mcf in 2004. Annual production would increase to a peak of 28.5 million Mcf in 2009. Although drilling would continue through 2013 under the Alternative B, declines in production from existing and future wells would more than offset the incremental production gains beyond 2009. Consequently, annual production declines continually from 2010 through 2025 – (see Figure 4.13-24). However, the annual production falls below the 5.0 million Mcf economic viability threshold in 2026 such that the remaining reserves, both proven and probable, would likely be abandoned.

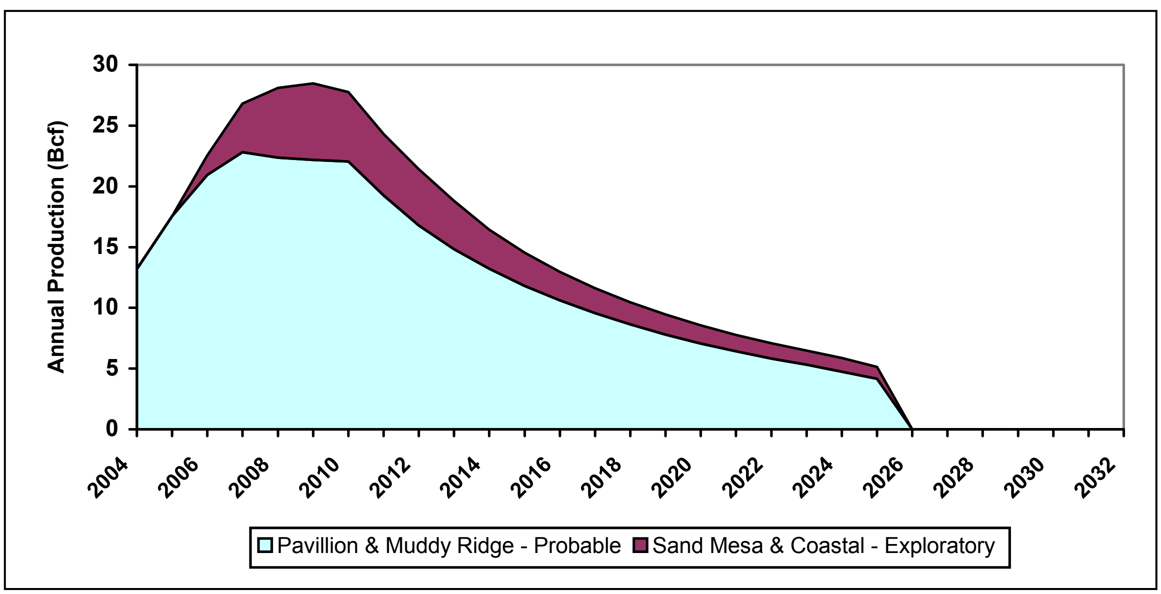
[14] All monetary sums are in constant 2003 dollars ($2003).
[15] The production estimates for this analysis do not represent detailed reservoir engineering analysis. Rather, they reflect simplified assumptions that permit a reasonable portrayal of the socioeconomic impacts associated with the alternative and characterization of the differences between the alternatives.

Figure 4.13-24. Projected Annual Gas Production, 2004 to 2032, Alternative B



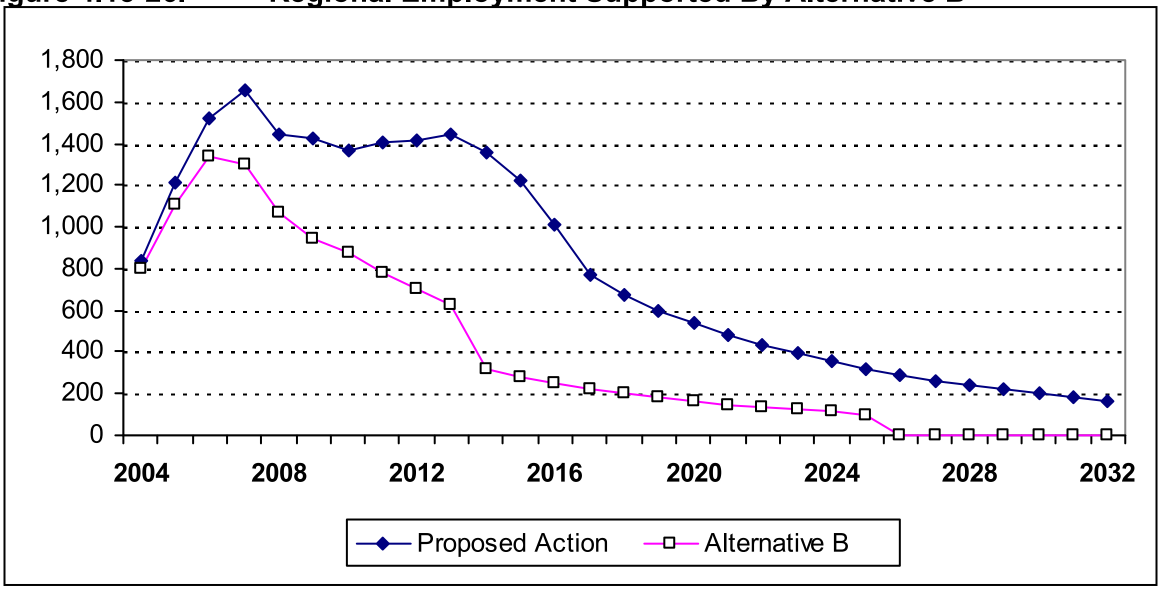
Total estimated production over the period 2004 to 2026 is 345.4 million Mcf, 430.8 Mcf (56 percent) less than under the Proposed Action. Of the total production, 287.1 million Mcf (83 percent) would be from the Pavillion and Muddy Ridge fields. The combined production from the Sand Mesa, Sand Mesa South and Coastal Extension fields is estimated at 58.3 million Mcf (see Figure 4.13-25). Relative to the Proposed Action, Alternative B yields substantially lower total and peak production, with a larger share of production from the Pavillion and Muddy Ridge fields.

Figure 4.13-25. Projected Annual Production, By Field Grouping, Alternative B



Alternative B involves slightly faster development of the Pavillion and Muddy Ridge wells, but fewer of the deeper Sand Mesa, Sand Mesa South and Coastal Extension wells that require more labor and take longer to complete. Consequently, the initial direct employment increases generally track those under the Proposed Action, but then decline more sharply, as shown in Figure 4.13-26. Similarly, the secondary impacts associated with the flows of taxes and royalty payments, which are responsive the level of production, would increase until production peaks in 2009, then begin a period of continuous decline until production is suspended in 2025 after falling below the threshold of economic viability.

Figure 4.13-26. Regional Employment Supported By Alternative B



4.13.4.2 Direct Economic Stimulus

As described previously, the drilling activity would occur over 10 years under Alternative B. The economic stimulus associated with the construction of the new gas field infrastructure would occur between 2005 and 2008. Together these activities would support 609 direct jobs in 2006. Production would increase as the new Pavillion and Muddy Ridge wells come on-line, supporting 39 additional direct jobs that same year. After peaking at 648 jobs in 2006, direct employment would decline steadily to 206 jobs by 2013, the final year of scheduled drilling, after which it drops below 40 jobs until production is discontinued. Declining production would trigger parallel declines in related factors across the three selected years – (see Table 4.13-22).

Table 4.13-22. Expenditures and Production, 2010, 2020 and 2030, Alternative B

	2010	2020	2030
Drilling Expenditures ($M)	$ 43.6	$ 0.0	$ 0.0
Annual Production Expenditures ($M)	$ 17.1	$ 5.1	$ 0.0
Annual Production (Millions of Mcf)	27.8	8.6	0.0
Annual Value of Production ($M)*	$ 90.2	$ 27.8	$ 0.0
Est. Tribal Share of Production	77%	78%	0%

($M) – Millions of constant $2003.

Drilling expenditures totaling $43.6 million are projected in 2010. However, with the completion of drilling scheduled in 2013, no drilling expenditures are projected in 2020 or 2030. Annual gas production in 2010 is estimated at 27.8 million Mcf, declining by nearly 70 percent to 8.6 million Mcf in 2020 and falling below the 5.0 million Mcf threshold in 2026. Similarly, the value of gas produced declines from $90.2 million in 2010 to $27.8 million in

2020 before production ceases in 2026. The Tribal share of production increases over time, from about 66 percent at present to 78 percent in 2030, because most new wells are on Tribal minerals.

Projected gas production would peak at 28.5 million Mcf in 2009 under Alternative B, 13.8 million Mcf per year higher and five years later than the peak under the Proposed Action. Peak annual drilling and production expenditures are also higher and the value of gas produced peaks at over $200 million. No additional major infrastructure investment beyond that proposed for the Proposed Action is anticipated for Alternative B. Table 4.13-23 summarizes these and other economic variables for the peak year.

Table 4.13-23. Project-Related Expenditures and Production, Peak Production, Alternative B

	Alternative B (2009)	Proposed Action (2013)	Differences
Gas Field Infrastructure Investments ($M)	$ 0.0	$ 0.0	-0-
Drilling Expenditures ($M)	$ 50.5	$ 48.5	+$ 2.0
Annual Production Expenditures ($M)	$ 17.7	$ 35.6	($ 17.9)
Annual Production (Millions of Mcf)	28.5	48.0	(19.5)
Value of Production ($M)	$ 92.6	$ 156.1	($ 63.50)
Est. Tribal Share of Production	79%	83%	(4%)

($M) – Millions of constant $2003.

Over the full time horizon of this analysis, more than $826.6 million in drilling and production expenditures are projected under Alternative B to produce $1.1 billion in natural gas. That total expenditures amount is more than $535 million less than under the Proposed Action, but it occurs over a shorter time horizon – (see Table 4.13-24). Consequently, when compared to the Proposed Action, Alternative B provides substantially less economic stimulus to the regional economy during the defined time horizon. The Tribal share of cumulative production would be 83 percent, compared to 85 percent under the Proposed Action.

Table 4.13-24. Cumulative Project-Related Expenditures and Production, 2004 to 2032, Alternative B

	Alternative B	Proposed Action	Differences
Gas Field Infrastructure Investments ($M)	$ 54.2	$ 54.2	- 0 -
Drilling Expenditures ($M)	$ 568.7	$ 730.1	($ 161.4)
Production Expenditures ($M)	$ 203.7	$ 578.0	($ 374.3)
Total Project Related Expenditures ($M)	$ 826.6	$ 1,362.3	($ 535.7)
Total Production (Millions of Mcf)	345.5	776.2	(430.7)
Value of Production ($M)	$ 1,122.4	$ 2,522.8	($1,400.4)
Est. Tribal Share of Production	83%	85%	(2%)

($M) – Millions of constant $2003.

4.13.4.3 Economic Impacts

Direct employment associated with Alternative B increases quickly in response to the simultaneous start of drilling, infrastructure construction and production. In 2006, 648 direct jobs would be supported by Alternative B, with 367 secondary jobs supported by the direct jobs and associated expenditures. That year, the exploration, construction and production activity and linked secondary activities, would generate personal income totaling $37.8 million.

Following completion of infrastructure construction, the numbers of jobs supported by ongoing drilling and production declines from 909 in 2007 to 206 in 2013. The associated personal income during that period ranges from $34.3 million in 2007 to $14.3 million in 2013.

As in the other alternatives, the induced impacts associated with the flows of taxes and royalty payments to governmental entities and individual households, lag behind the pace of drilling. Consequently, the numbers of secondary jobs increase more slowly, peaking at 448 jobs in 2009. Declining production thereafter results in lower tax and royalty payments until production ceases in 2026. In turn, the reductions in incomes would translate into less economic stimulus to the regional economy and fewer secondary jobs.

The pattern of an initial rise in jobs, personal income and economic output, followed by protracted declines is evident in 25 and Table 4.13-26. As shown, Alternative B would support 873 jobs and total personal income of $37.3 million in 2010. The economic impacts decline to 160 jobs and $7.8 million in income by 2020. Alternative B would contribute $183.6 million in regional economic output in 2010, but only $44.6 million by 2020. The total sum available for the per capita distributions to Tribal members peaks at $7.8 million in 2008.

Table 4.13-25. Employment, Income and Output, 2010, 2020 and 2030, Alternative B

	2010	2020	2030
Total Jobs Supported (Direct, Indirect & Induced)	873	160	0
Total Personal Income Generated ($M)	$ 37.3	$ 7.8	$ 0.0
Regional Economic Output ($M)	$ 183.6	$ 44.6	$ 0.0

($M) – Millions of constant $2003.

Peak production, in terms of the volume of natural gas produced, would be 28.5 Mcf in 2009 under Alternative B. The projected employment impact of 944 jobs is 505 fewer (35%) than the 1,449 jobs at peak production under the Proposed Action. The peak personal income generated by Alternative B is projected at $40.1 million in 2009, $21.7 million less than that in the peak year under the Proposed Action (see Table 4.13-26). The $40.1 million in income is equivalent to 5.0 percent of the total personal income of Fremont County residents in the year 2000.

Table 4.13-26. Employment, Income and Output, Peak Production, Alternative B

	Alternative B (2009)	Proposed Action (2013)	Differences
Total Jobs Supported	944	1,449	(505)
Total Personal Income Generated ($M)	$ 40.1	$ 61.8	($ 21.7)
Regional Economic Output Generated ($M)	$ 193.7	$ 309.9	($ 116.2)

($M) – Millions of constant $2003.

The contributions to regional economic output associated with the Alternative B at peak production, a measure of the total value of goods and services produced within the regional economy, would be $193.7 million in 2009, $116.2 million less than the peak impact under the Proposed Action.

The cumulative economic impacts from 2004 to 2032 for Alternative B include nearly 11,800 job-years of employment, $494.4 million in personal income and over $2.3 billion in total economic output (Table 4.13-27). The employment and income impacts are each more than 50 percent less than the corresponding impacts under the Proposed Action. Alternative B would have an 54 percent lesser impact on regional output than is projected for the Proposed Action.

Table 4.13-27. Cumulative Employment, Income and Output, 2004 to 2032, Alternative B

	Alternative B	Proposed Action	Differences
Total Job-Years Supported	11,752	23,498	(11,746)
Total Personal Income Generated ($M)	$ 494.4	$ 1,007.0	($ 512.6)
Regional Economic Output Generated ($M)	$ 2,338.5	$ 5,004.6	($ 2,666.1)

($M) – Millions of constant $2003.

Based on the foregoing assessment, Alternative B would result in positive, moderate, long term effects on regional economic output, and employment conditions, and positive, major, long term impacts on personal income (including Tribal and private royalty income).

4.13.4.4 Fiscal Impacts

Taxes, royalties and other revenues generated by natural gas activity are important revenue sources for Tribes, local governmental agencies in the region and the state. The gas development and production associated with Alternative B represents a potential revenue stream to the affected governments. Most of the public sector revenues are tied to the value of gas produced. Annual revenue accrual would mirror future production levels, increasing dramatically between 2004 and 2018, the year of peak production, before beginning a protracted decline.[16] Projected annual revenue accruals from selected sources in the three designated comparison years are summarized in Table 4.13-28 below.

Across the time horizon, fees levied on oil and gas development to support operations of the WOGCC consistently yield the least revenue while Tribal severance tax and royalty payments and Fremont County ad valorem taxes have the highest values. For example, about $19,500 in WOGCC fees would accrue to the WOGCC in 2020. That same year, $4.37 million in Tribal severance and royalty payments would accrue to the Tribes, with $1.85 million of ad valorem taxes accruing to affected local governments in Fremont County.[17] Royalty payments of $0.81 million on fee minerals and state severance taxes of $1.20 million are also projected.

[16] Assumes a constant gas price and constant tax and royalty rates. Future revenues are reported in same year as projected production.
[17] Ad valorem taxes would be distributed among Fremont County, Fremont County School District and a number of other local governmental entities. Detailed allocations were not prepared for this analysis.

Table 4.13-28. Annual Tax and Royalty Payments, 2010, 2020 and 2030, Alternative B

Revenue Type and Affected Entity/Group	2010	2020	2030
Wyoming Oil and Gas Conservation Comm. ($M)	$ 0.06	$ 0.02	$ 0.00
Wyoming State Severance Taxes ($M)	$ 3.86	$ 1.20	$ 0.00
Wyoming Sales and Use Tax ($M)	$ 1.03	$ 0.08	$ 0.00
Fremont County Ad Valorem Taxes ($M)	$ 6.00	$ 1.85	$ 0.00
Tribal Severance Taxes ($M)	$ 5.37	$ 1.66	$ 0.00
Tribal Royalty Payments ($M)	$ 8.74	$ 2.71	$ 0.00
Royalty Payments on Fee Production ($M)	$ 2.63	$ 0.81	$ 0.00

($M) – Millions of constant $2003.

A total of $28.57 million in tax and royalty payments would accrue from the peak production of 28.5 million Mcf in 2009; about $1.00 per Mcf. Tribal receipts of severance taxes on that production would be $5.60 million and Tribal Royalties revenues from the Alternative B would total $9.14 million, 85 percent of which would be distributed to Tribal members in the form of per capita payments. Of the total $1.16 million collected in sales and use tax, $342,000 would accrue to Fremont County and its incorporated municipalities and $818,000 would accrue to the State. Another $6.15 million in ad valorem taxes would accrue to local governments and school districts in Fremont County and the state school foundation fund (see Table 4.13-29).

Table 4.13-29. Tax and Royalty Payments, Peak Production Year, Alternative B

Revenue Type and Affected Entity/Group	Alternative B (2009)	Proposed Action (2013)	Differences
WOGCC ($M)	$ 0.06	$ 0.11	($ 0.05)
Wyoming Severance Taxes ($M)	$ 3.94	$ 6.26	($ 2.32)
Wyoming Sales and Use Tax ($M)	$ 1.16	$ 0.76	($ 0.17)
Fremont County Ad Valorem Taxes ($M)	$ 6.15	$ 13.82	($ 7.67)
Tribal Severance Taxes ($M)	$ 5.60	$ 9.83	($ 4.23)
Tribal Royalty Payments ($M)	$ 9.14	$ 16.12	($ 6.98)
Royalty Payments on Fee Production ($M)	$ 2.52	$ 3.35	($ 0.83)

($M) – Millions of constant $2003.

Cumulative tax and royalty payments would total $344.38 million over the entire time period – (see Table 4.13-30 below). That total is $464.95 million (57 percent) less than that for the Proposed Action.

Table 4.13-30. Cumulative Tax and Royalty Payments, 2004 to 2032, Alternative B

Revenue Type and Affected Entity/Group	Alternative B	Proposed Action	Differences
WOGCC ($M)	$ 0.78	$ 1.77	($ 0.99)
Wyoming Severance Taxes ($M)	$ 48.53	$ 100.58	($ 52.05)
Wyoming Sales and Use Tax ($M)	$ 14.30	$ 22.46	($ 8.16)
Fremont County Ad Valorem Taxes ($M)	$ 71.53	$ 206.55	($ 135.02)
Tribal Severance Taxes ($M)	$ 67.44	$ 163.13	($ 95.69)
Tribal Royalty Payments ($M)	$ 110.00	$ 268.49	($ 158.49)
Royalty Payments on Fee Production ($M)	$ 31.80	$ 46.35	($ 14.55)

($M) – Millions of constant $2003.

Under Alternative B, an estimated $67.4 million in additional severance taxes and $110.0 in royalty payments would accrue to the Tribes. Again, 85 percent of royalty payments would be disbursed to Tribal members. Additional royalty payments of $31.8 million would accrue to owners of fee mineral interests in the WRPA. Tax and royalty revenues for Alternative B and the Proposed Action are shown in Figure 4.13-27.

Figure 4.13-27. Cumulative Taxes and Royalties Generated, Alternative B, 2004 – 2032 (millions of constant $2003)

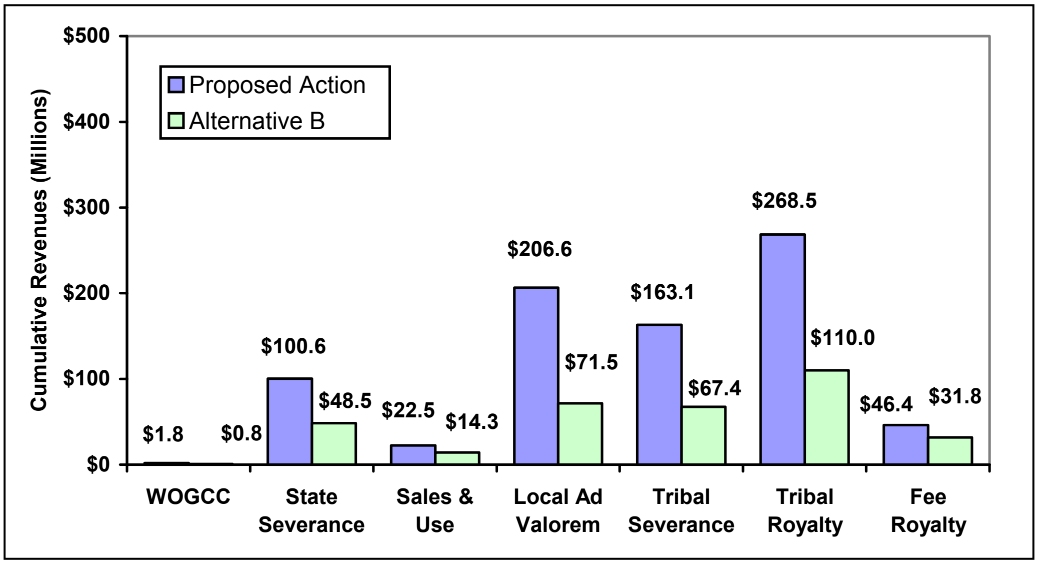
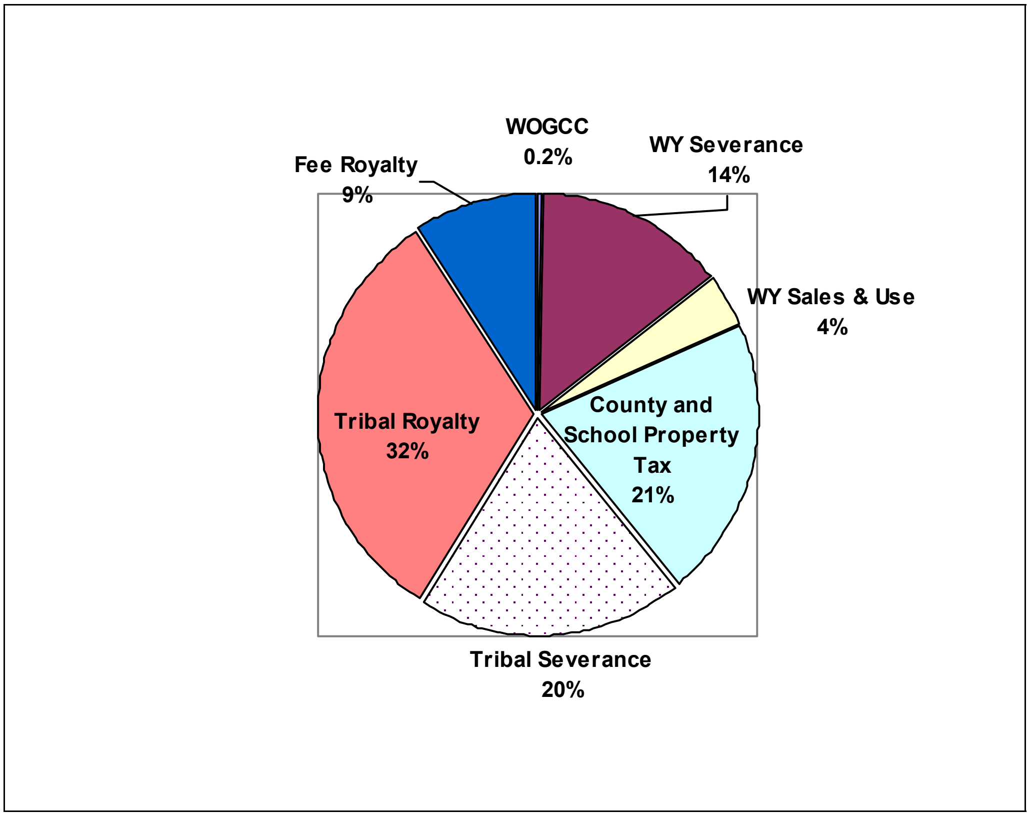


Figure 4.13-28 displays the percentage of cumulative Alternative B-related tax and royalty revenues that would be distributed to each entity.

Figure 4.13.28. Percentage Distribution of Cumulative Tax and Royalty Revenues: Alternative B



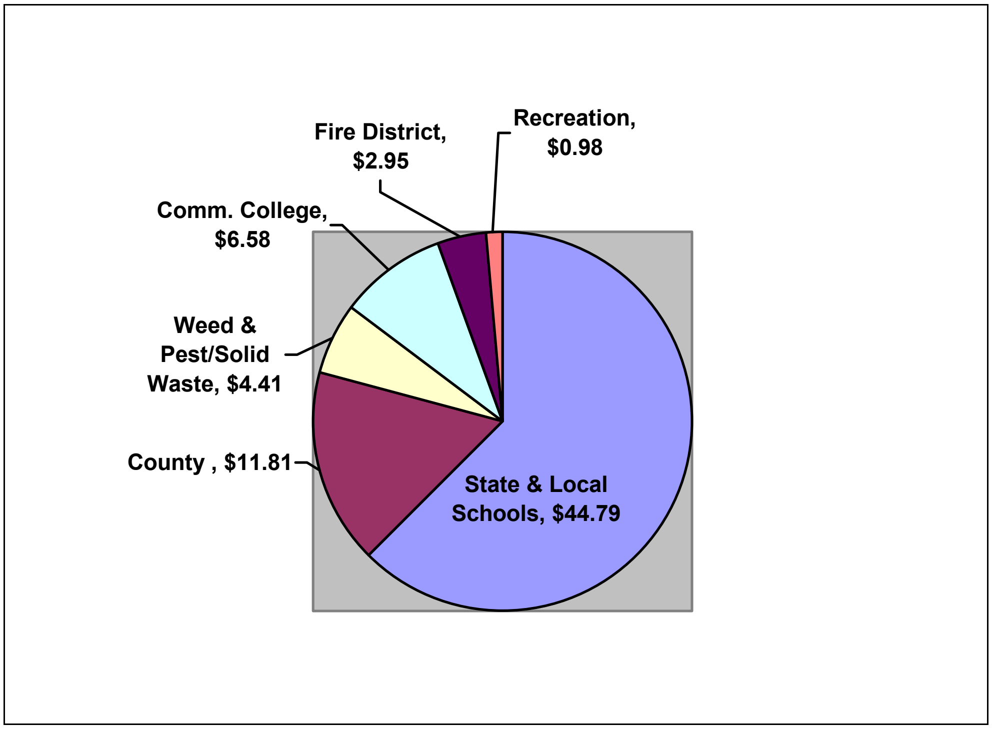
Based on the estimates prepared for this assessment, the Eastern Shoshone and Northern Arapahoe Tribes would receive royalty payments equal to 32 percent of total cumulative tax and royalty revenues associated with Alternative B. Fremont County, its ad valorem property taxing entities and local schools would receive 21 percent, the WRIR Tribes would receive 20 percent in severance tax payments, the State of Wyoming would receive 14 per cent in severance tax payments, Wyoming, Fremont County and its incorporated municipalities would receive 4 percent in sales and use tax payments, fee mineral owners would receive 9 percent in royalty payments, and the Wyoming Oil and Gas Conservation Commission would receive 0.2 percent.

The impacts of Alternative B – related royalty and severance tax revenues to the Eastern Shoshone and Northern Arapahoe Tribes would be positive, moderate and long term. The impacts of Alternative – B related property tax revenues to Fremont County taxing entities would be positive, minor and long term.

Fremont County Ad Valorem Property Tax Revenues

Figure 4.13-29 shows the distribution of estimated total cumulative Alternative B-related ad valorem property tax revenues to relevant taxing entities. [18]

Figure 4.13-29. Alternative B Cumulative Ad Valorem Property Tax Distribution (millions of constant $2003)



4.13.4.5 Population

The population effects of Alternative B are anticipated to be negligible for several reasons. The number of wells drilled each year under Alternative B would be slightly higher than under the Proposed Action for the first three years; however, the number of rigs operating would be the same, so population effects would be similar under the two alternatives. Most jobs would be filled by local workers and contractors, and non-resident contractors would be less likely to relocate to Fremont County, given the fewer number of wells and shorter development phase under Alternative B (10 years) as compared to the Proposed Action (13 years).

Given the lower level of development and production, indirect employment would also be substantially lower under Alternative B. Thus it would be even more likely that both direct and indirect jobs would be filled from the local unemployed labor pool or by currently employed workers who otherwise would have been laid off as production diminishes in other

[18] Note that ad valorem property tax rates are set by state statute or by the Fremont County Commissioners and other school and special district officials based on the anticipated revenues and expenditures of the particular taxing entity, therefore tax rates and percentages would change over time.

oil and gas fields. As a result, the impacts of Alternative B activities on area population conditions would be negligible to minor and long term.

4.13.4.6 Housing

Demand for housing under Alternative B would be similar to the Proposed Action, but for shorter duration. Additional demand for housing would be primarily for temporary housing resources. Existing resources in Fremont County would adequately accommodate this type of demand. Given the lower level and shorter duration of employment associated with Alternative B, fewer employees would be likely to purchase housing. Consequently, the impacts of Alternative B on local housing conditions would be negligible and long term.

4.13.4.7 Law Enforcement and Emergency Response

Under Alternative B, demand for law enforcement and emergency response services would be similar to the Proposed Action through 2007. After that, the lower level of field development and production activity under Alternative B would result in a lower potential for traffic and industrial accidents. Alternative B production-related revenues to the Fremont County general fund and fire fund would also be 66 percent lower than the Proposed Action, totaling about $9.5 million and $3 million respectively over the analysis period. Therefore, the impacts of Alternative B activities on law enforcement and emergency response services would be minor and long term.

4.13.4.8 Midvale Irrigation District

The Operators estimate that 34 of the total 96 wells in the Pavillion field under Alternative B would be drilled on irrigated land. It is not anticipated that wells would be drilled on irrigated land in any of the four other fields under Alternative B. Assuming implementation of Operator commitments to reclaim all access roads, pipeline cuts and reclaim the well pad to a 64 square foot area by the first growing season, a total of 10 irrigated acres would be removed from production over the life of Alternative B, resulting in an annual loss of $150 in assessment revenues for the MID, if the BOR were to reclassify land. This amount could be reduced if production facilities were located off of irrigated ground. Consequently, the impacts of Alternative B on the revenues and operations of the MID would be negligible and long term.

4.13.4. 9 Split Estate Issues

Under Alternative B, the number of wells drilled in the WRPA would decrease by 28 percent compared to the Proposed Action, which would decrease the potential for split estate conflicts.

Drilling in the Pavillion field, where most split estate parcels are located, would decrease by 38 percent (96 wells under Alternative B compared to 155 under the Proposed Action). The decrease in drilling in the Pavillion field would likely result in fewer split estate conflicts as compared with the Proposed Action. As with other alternatives, successful implementation of the Operator committed mitigation measures would further reduce split estate conflicts but probably not eliminate them entirely.

Drilling in the Muddy Ridge field, where there are fewer private parcels and split estate conflicts have been less common in the past, would decrease by 20 percent (40 wells would be drilled under Alternative B compared to 50 for the Proposed Action). Therefore the potential for split estate issues in the Muddy Ridge field would be lower under Alternative B.

Drilling in the Coastal Extension field would decrease by one well, from eight to seven, with one or two becoming producers. With relatively few private parcels (5) and given the greater flexibility to locate wells on the surface that would come from the anticipated lower density drilling program, the potential for split estate conflicts in the Coastal extension field would be lower under Alternative B compared to the Proposed Action.

Drilling in the Sand Mesa field would decrease by 20 percent or 20 wells, compared to the Proposed Action. A total of about 80 wells would be drilled in the Sand Mesa field, about 40 of which would be producing wells, under the assumptions used for this assessment. About 46 percent of the field is in private surface, divided into 16 parcels. Therefore, the potential for split estate conflicts in the Sand Mesa field would decrease somewhat under Alternative B compared to the Proposed Action.

As with other alternatives, the absence of private surface in the Sand Mesa South field would preclude split estate conflicts.

Based on the foregoing assessment and Operator – committed mitigation measures the potential for Alternative B – related split estate conflicts is likely to be moderate and long term.

4.13.4.10 Gas Development, Agricultural Productivity and Income

Per well disturbance on irrigated lands and per well surface use agreement and reentry payments would be the same for Alternative B as for the Proposed Action, Consequently, assuming successful implementation of the Operator-committed mitigation measures listed in detail in Sections 3.1.3.3 and 4.13.7, economic loss to agricultural operations associated with the Proposed Action are likely to be negligible and, in some cases, farmers and ranchers may receive increases in net income from properties with gas development.

4.13.4.11 Industrialization and Rural Character

Although drilling in the WRPA would decrease by 28 percent under Alternative B compared to the Proposed Action, the pace of drilling would be similar in the first four years of development, so the change in rural character would be similar during the early period of the project. Over time, the fewer wells drilled and the shorter duration of drilling would result in less noticeable overall change in rural character of the area.

Drilling in the Pavillion field would be lower by 38 percent under Alternative B as compared to the Proposed Action, but the pace of drilling would be the same as the average pace of drilling under the Proposed Action for the entire seven-year duration of Alternative B. Consequently, the change in rural character would be similar during that seven-year period in areas associated with the Pavillion field. Once development ends under Alternative B, impacts to rural character would diminish quicker. Because fewer wells would be drilled and the end of production and eventual reclamation would occur sooner, the return to a more rural character would occur sooner under Alternative B compared to the Proposed Action, however, the change in rural character of lands within the WRPA would still be considered moderate and long term.

4.13.5 Alternative C - No Action (100 wells)

4.13.5.1 Overview

Alternative C, the No Action alternative, calls for the development of 100 additional wells over eight years, all in the Pavillion field. Wells in the Pavillion field are relatively shallow and have a very high probability of being productive. Alternative C assumes a constant pace of drilling, 14 wells/year between 2004 and 2010, with the final 2 wells drilled in 2011. Approximately $69.4 million in drilling expenditures would be made under Alternative C. An additional $13.1 million investment would be made in gas field infrastructure to support production and marketing of gas produced from the WRPA.[19] Completion of the new wells would stimulate increased gas production. Annual production was projected consistent with the approach used for the Proposed Action.[20]

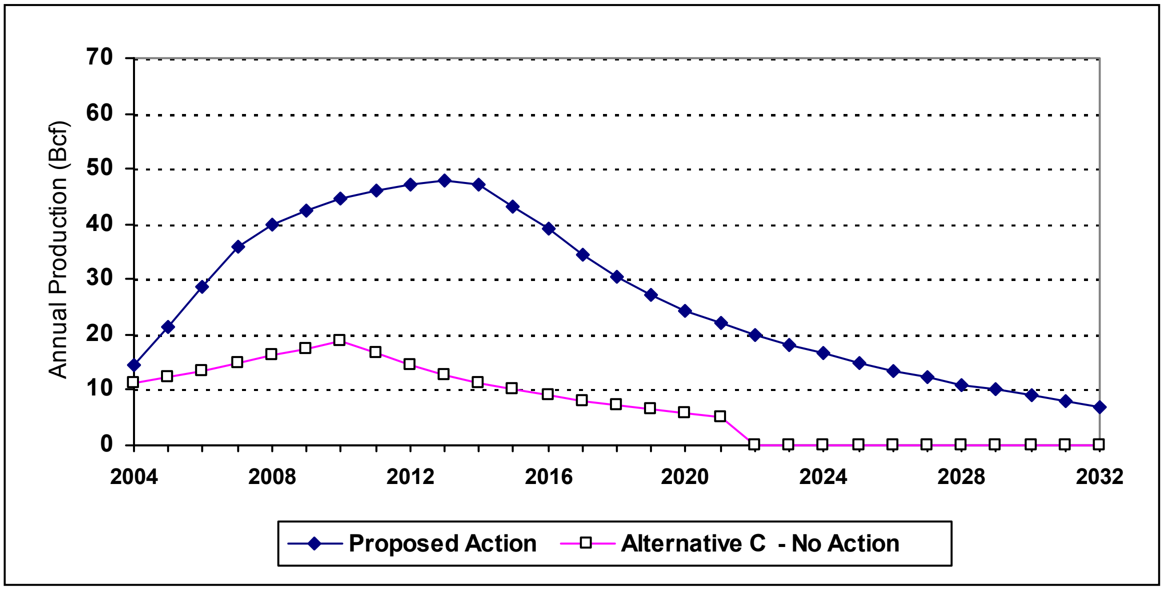
Under Alternative C – (No Action), projected annual gas production from the WRPA would be 11.4 million Mcf in 2004. Production would increase to a peak of 18.7 million Mcf in 2010. Although drilling would continue into 2011 under Alternative C – (No Action), the decline of production from existing and future wells would more than offset the incremental production gains beyond 2010. By 2021, annual production would fall off to the point that continued production would no longer be economically feasible – (see Figure 4.13-30).[21] An undetermined quantity of potentially recoverable reserves would remain but would likely be abandoned.

[19] All monetary sums are in constant 2003 dollars ($2003).

[20] The production estimates developed for this analysis do not represent a detailed reservoir engineering analysis. Rather, they reflect a series of simplified assumptions that allow a reasonable portrayal of the socioeconomic impacts associated with the alternative and characterization of the differences between the alternatives.

[21] The threshold for long-term economic viability is 5 million Mcf in annual production.

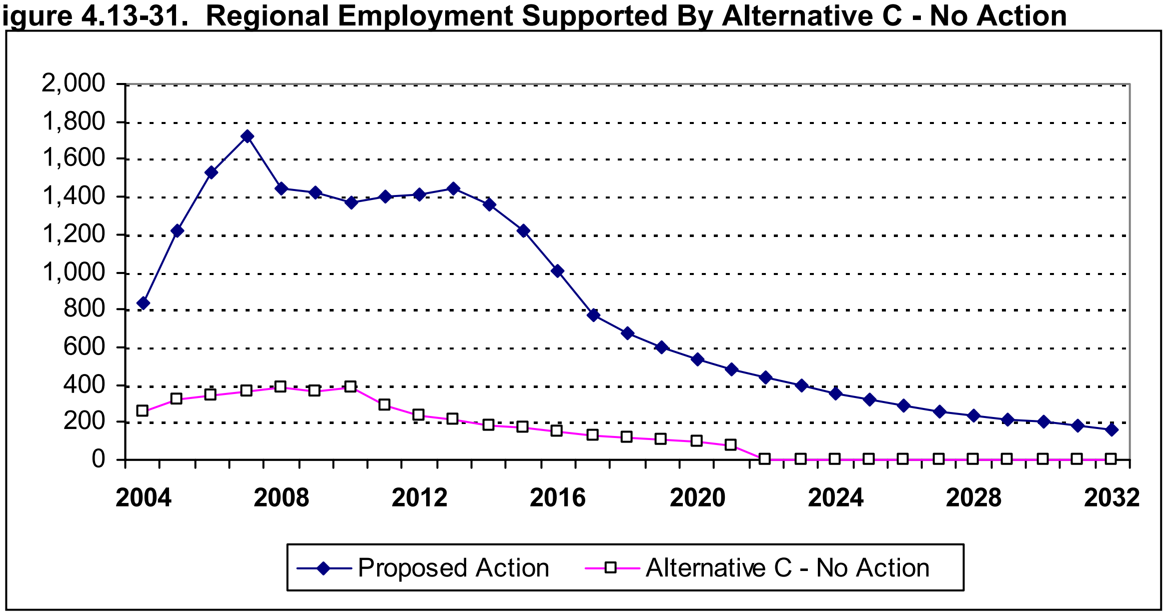
Figure 4.13-30. Projected Gas Production, 2004 to 2032, Alternative C - No Action



Total estimated production over the period 2004 to 2021 is 210.5 million Mcf, entirely from the Pavillion and Muddy Ridge fields. Relative to the Proposed Action, Alternative C – (No Action) yields total production that would be 73 percent below the Proposed Action through 2032.

The implications of the lower production under the No Action alternative extend to the support provided for regional employment and businesses. Consequently, the peak total employment of 378 jobs occurs in 2008, and then declines steadily as production falls through 2021 – (see Figure 4.13-31).

Figure 4.13-31. Regional Employment Supported By Alternative C - No Action



4.13.5.2 Direct Economic Stimulus

Drilling activity would occur over 8 years under Alternative C – (No Action). Together with anticipated infrastructure construction, that activity would support 82 direct jobs in 2007/2008. Increases in production from the Pavillion and Muddy Ridge wells would support another 18 direct jobs that same year. After peaking at 389 jobs in 2008, direct employment would decline steadily until production ceases in 2021. Declining production would result in parallel declines in production expenditures, value of gas produced and economic stimulus (see Table 4.13-31).

Table 4.13-31. Expenditures and Production, 2010, 2020 and 2030, Alternative C - No Action

	2010	2020	2030
Drilling Expenditures ($M)	$ 9.7	$ 0.0	$ 0.0
Annual Production Expenditures ($M)	$ 6.2	$ 1.9	$ 0.0
Annual Production (Millions of Mcf)	18.7	5.7	$ 0.0
Annual Value of Production ($M)	$ 60.8	$ 18.5	$ 0.0
Est. Tribal Share of Production	66%	66%	0%

($M) – Millions of constant $2003.

As shown above, only $9.7 million in drilling expenditures are projected in 2010, with no additional drilling expenditures after 2011. Total annual gas production in 2010 is estimated at 18.7 million Mcf, but begins declining thereafter such that only 5.7 million Mcf are produced in 2020. Similarly, year 2010 gas production is valued at $60.8 million, falling to $18.5 million by 2020. The Tribal share of production would remain relatively constant at 66 percent – approximately the same as the existing allocation

Projected gas production peaks at 18.7 million Mcf in 2010 under Alternative C, 29.3 million Mcf (61 percent) lower and three years earlier than the peak under the Proposed Action. Peak annual drilling and production expenditures are also lower and the value of gas produced peaks at $60.8 million. Infrastructure investment would also be lower than proposed for the Proposed Action. Table 4.13-32 summarizes these and other economic variables for the peak year.

Table 4.13-32. Project-Related Expenditures and Production, Peak Production Year, Alternative C - No Action

	Alternative C (2010)	Proposed Action (2013)	Differences
Gas Field Infrastructure Investments ($M)	$ 0.0	$ 0.0	-0-
Drilling Expenditures ($M)	$ 6.3	$ 48.5	($ 42.2)
Annual Production Expenditures ($M)	$ 6.2	$ 35.6	($ 29.4)
Annual Production (Millions of Mcf)	18.7	48.0	(29.3)
Value of Production ($M)*	$ 60.8	$ 156.1	(95.3)
Est. Tribal Share of Production	66%	83%	(17%)

($M) – Millions of constant $2003.

Over the entire time horizon of this analysis, almost $152 million in drilling and production expenditures are projected under Alternative C, resulting in the production of $684 million in natural gas. That total is more than $1.8 billion less than under the Proposed Action – (see Table 4.13-33). Consequently, Alternative C provides a substantially lower economic stimulus to the regional economy when compared to the Proposed Action. The Tribal share of the cumulative production would be 66 percent, compared to 85 percent under the Proposed Action.

Table 4.13-33. Cumulative Project-Related Expenditures and Production, 2004 to 2032, Alternative C - No Action

	Alternative C - No Action	Proposed Action	Differences
Gas Field Infrastructure Investments ($M)	$ 13.1	$ 54.2	($ 41.1)
Drilling Expenditures ($M)	$ 69.4	$ 730.1	($ 660.7)
Production Expenditures ($M)	$ 69.3	$ 578.0	($ 508.7)
Total Project Related Expenditures ($M)	$ 151.8	$ 1,362.3	($1,210.5)
Total Production (Millions of Mcf)	206.2	776.2	(570.0)
Value of Production ($M)	$ 684.0	$ 2,522.8	($1,838.6)
Est. Tribal Share of Production	66%	85%	(19%)

($M) – Millions of constant $2003.

4.13.5.3 Economic Impacts

The employment impacts associated with Alternative C grow modestly from 262 jobs in 2004 to a peak of 389 jobs in 2008. The peak number of jobs includes 102 direct jobs, 64 secondary jobs supported by the drilling and production activity, and 212 jobs supported by the flows of taxes and royalty payments. At its peak, the exploration and production activity would generate $6.5 million in personal income. Another $10.1 million in personal income would be generated in that year by the tax and royalty payments associated with Alternative C. Beyond 2008, employment, income and regional output supported by Alternative C all decline. The pattern of an initial rise in employment, personal income and regional economic output, followed by protracted declines over time is evident in Table 4.13-34 and Table 4.13-35. As shown, the number of jobs supported by Alternative C is 384 in 2010; falling to 91 in 2020 and effectively disappearing after production ceases in 2021. Project-related personal income likewise declines from $17.0 million in 2010 to $4.3 million in 2020.

Table 4.13-34. Employment, Income and Output, 2010, 2020 and 2030, Alternative C - No Action

	2010	2020	2030
Total Jobs Supported (Direct, Indirect & Induced)	384	91	0
Total Personal Income Generated ($M)	$ 17.0	$ 4.3	$ 0.0
Regional Economic Output ($M)	$ 96.2	$ 26.7	$ 0.0

($M) – Millions of constant $2003.

Peak gas production of 18.7 Mcf would occur in 2010 under Alternative C – (No Action). The projected employment impact of 384 jobs is 1,065 jobs fewer than that during the peak production year under the Proposed Action. The peak personal income generated by Alternative C – (No Action) is $17.0 million in 2010, $44.8 million less than during the peak production under the Proposed Action (see Table 4.13-35). The $17.0 million sum is equivalent to a 2.1 percent increase over the total personal income of Fremont County residents in the year 2000.

Table 4.13-35. Employment, Income and Output, Peak Production, Alternative C - No Action

	Alternative C - No Action (2010)	Proposed Action (2013)	Differences
Total Jobs Supported	3843	1,449	(1,065)
Total Personal Income Generated ($M)	$ 17.0	$ 61.8	($ 44.8)
Regional Economic Output Generated ($M)	$ 96.2	$ 309.9	($ 213.7)

($M) – Millions of constant $2003.

The contributions to regional economic output associated with the Alternative C would peak at $96.2 million in 2010, $213.7 (69 percent) below the peak impact under the Proposed Action.

The cumulative economic impacts for Alternative C, which cover the period from 2004 to 2021 when further production becomes uneconomical, include nearly 4,200 job-years of employment, $186 million in personal income and $1.06 billion in total economic output, as shown in Table 4.13-36). These are about 80 to 82 percent less than the comparable impacts under the Proposed Action.

Table 4.13-36. Cumulative Employment, Income and Output, 2004 to 2032, Alternative C - No Action

	Alternative C - No Action	Proposed Action	Differences
Total Job-Years Supported	4,189	23,498	(19,309)
Total Personal Income Generated ($M)	$ 186.2	$ 1,007.0	($ 855.0)
Regional Economic Output Generated ($M)	$ 1,059.0	$ 5,004.6	($ 3,945.6)

($M) – Millions of constant $2003.

The changes in employment and income under the No Action would have little impact on local labor market conditions. Consequently, Alternative C - related impacts on regional economic output, employment and personal income would be considered positive, minor and long term.

4.13.5.4 Fiscal Impacts

The gas development and production associated with Alternative C represents a potential revenue stream to the affected governments. Annual public sector revenue accrual, most of which is tied to the value of gas produced, would mirror future production levels. Thus, modest increases would occur between 2004 and 2010, the year of peak production, before beginning their protracted decline.[22] Projected annual revenue accruals from selected sources in the three designated comparison years are summarized in Table 14.13-37

Across the time horizon, fees levied on oil and gas development to support operations of the WOGCC consistently yield the least amount of revenue while Tribal severance tax and royalty payments and Fremont County ad valorem taxes have the highest values. For example, about $42,200 in WOGCC fees would accrue to the WOGCC in 2010. That same year, $8.09 million in Tribal severance and royalty payments would accrue to the Tribes, with $4.41 million of ad valorem taxes accruing to affected local governments in Fremont

[22] Assumes a constant gas price and constant tax and royalty rates. Future revenues are reported in same year as projected production.

County.[23] Royalty payments of $3.01 million on fee minerals and state severance taxes of $2.98 million are also projected.

Table 4.13-37. Annual Tax and Royalty Payments, 2010, 2020 and 2030, Alternative C - No Action

Revenue Type and Affected Entity/Group	2010	2020	2030
Wyoming Oil and Gas Conservation Comm. ($M)	$ 0.04	$ 0.01	$ 0.0
Wyoming State Severance Taxes ($M)	$ 2.98	$ 0.91	$ 0.0
Wyoming Sales and Use Tax ($M)	$ 0.31	$ 0.04	$ 0.0
Fremont County Ad Valorem Taxes ($M)	$ 4.41	$ 1.23	$ 0.0
Tribal Severance Taxes ($M)	$ 3.11	$ 0.95	$ 0.0
Tribal Royalty Payments ($M)	$ 4.98	$ 1.52	$ 0.0
Royalty Payments on Fee Production ($M)	$ 3.01	$ 0.91	$ 0.0

($M) – Millions of constant $2003.

A total of $18.84 million in tax and royalty payments would accrue from the peak production of 18.7 million Mcf in 2010; about $1.01 per Mcf. Tribal receipts of severance taxes on that production would total $3.11 million and their receipts of royalties from Alternative C would total $4.98 million that year, 85 percent of which would be distributed to Tribal members in the form of per capita payments (see Table 4.13-38). Compared to the Proposed Action, Alternative C would generate substantially lower peak tax and royalties.

Table 4.13-38. Tax and Royalty Payments, Peak Production Year, Alternative C - No Action

Revenue Type and Affected Entity/Group	Alternative C - No Action (2010)	Proposed Action (2013)	Differences
WOGCC ($M)	$ 0.04	$ 0.11	($ 0.07)
Wyoming Severance Taxes ($M)	$ 2.98	$ 6.26	($ 3.28)
Wyoming Sales and Use Tax ($M)	$ 0.31	$ 0.82	($ 0.51)
Fremont County Ad Valorem Taxes ($M)	$ 4.41	$ 13.82	($ 9.41)
Tribal Severance Taxes ($M)	$ 3.11	$ 9.83	($ 6.72)
Tribal Royalty Payments ($M)	$ 4.98	$ 16.12	($ 11.14)
Royalty Payments on Fee Production ($M)	$ 3.01	$ 3.35	($ 0.34)

($M) – Millions of constant $2003.

Cumulative tax and royalty payments would total $211.42 million over the entire time period – (see Table 4.13-39). That total is $597.9 million (74 percent) lower than the $809.33 million for the Proposed Action.

[23] Ad valorem taxes would be distributed among Fremont County, Fremont County School District and a number of other local governmental entities. Detailed allocations were not prepared for this analysis.

Table 4.13-39. Cumulative Tax and Royalty Payments, 2004 to 2032, Alternative C - No Action

Revenue Type and Affected Entity/Group	Alternative C - No Action	Proposed Action	Differences
WOGCC ($M)	$ 0.47	$ 1.77	($ 1.30)
Wyoming Severance Taxes ($M)	$ 33.49	$ 100.58	($ 67.09)
Wyoming Sales and Use Tax ($M)	$ 3.04	$ 22.46	($ 19.42)
Fremont County Ad Valorem Taxes ($M)	$ 49.24	$ 206.55	($ 157.31)
Tribal Severance Taxes ($M)	$ 35.33	$ 163.13	($ 127.80)
Tribal Royalty Payments ($M)	$ 56.64	$ 268.49	($ 211.85)
Royalty Payments on Fee Production ($M)	$ 33.21	$ 46.35	($ 13.14)

($M) – Millions of constant $2003.

The total cumulative tax and royalty payments for Alternative C includes an estimated $92.0 million in additional severance taxes and royalty payments that would accrue to the Tribes, with 85 percent of the royalty receipts earmarked for disbursement to Tribal members. Additional royalty payments of $33.21 million would accrue to owners of fee mineral interests in the WRPA. Tax and royalty revenues for Alternative C –(No Action) and the Proposed Action are shown in Figure 4.13-32.

Figure 4.13-32. Cumulative Taxes and Royalties Generated, Alternative C - No Action, 2004 – 2032 (millions of constant $2003)

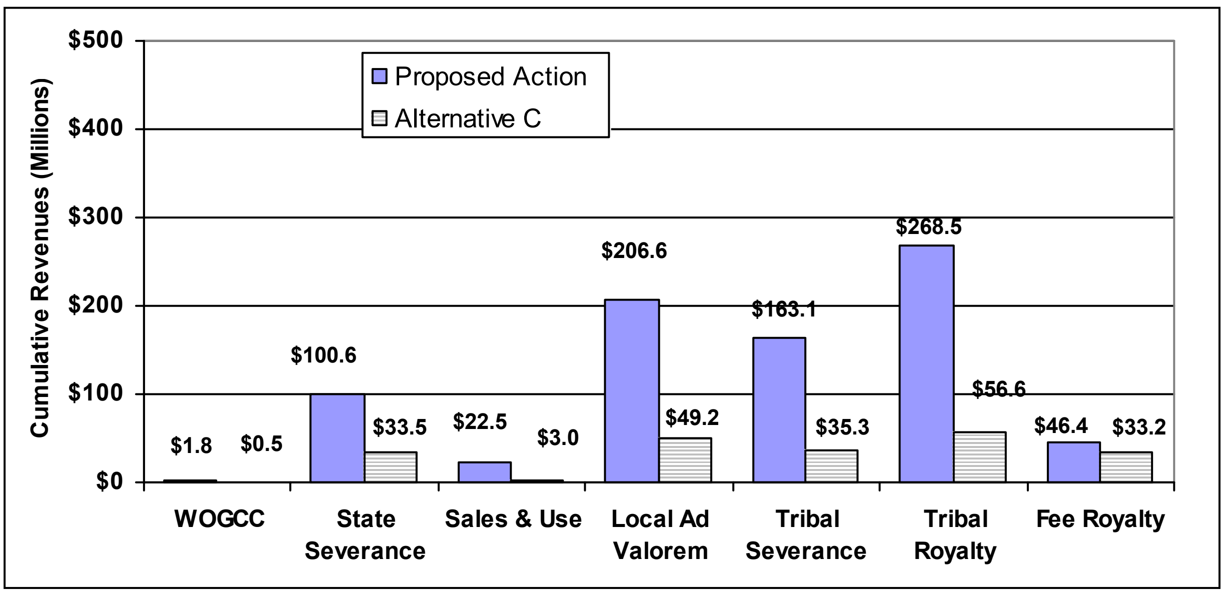
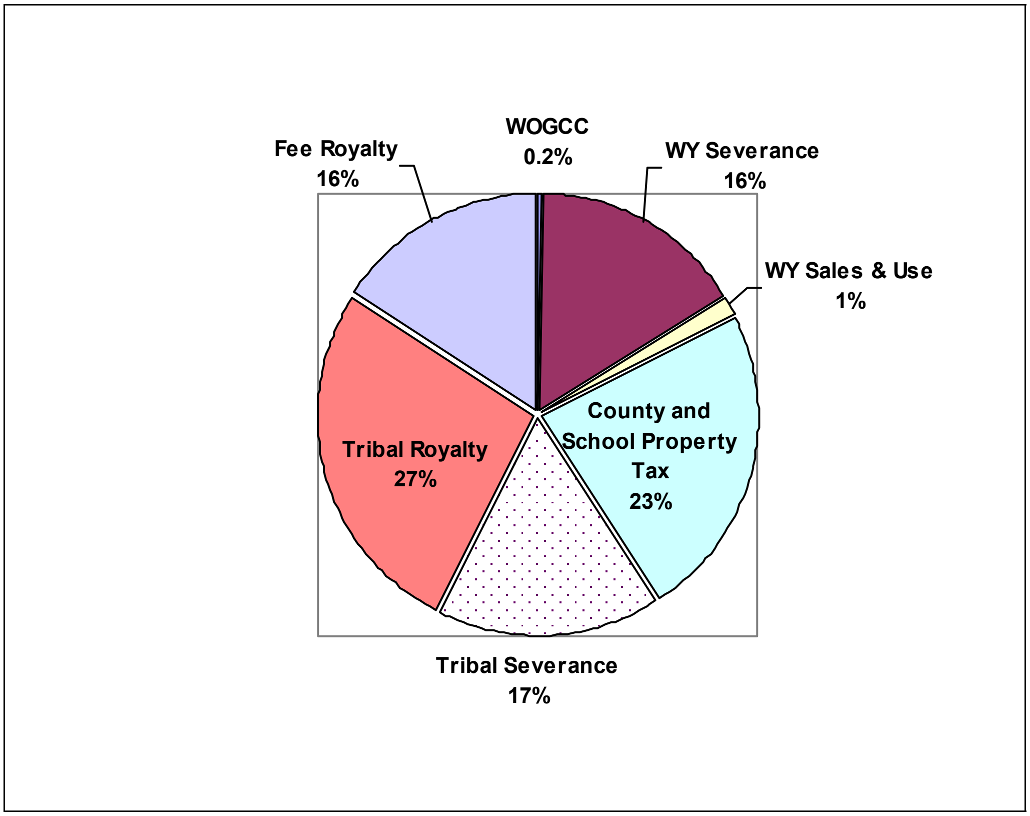


Figure 4.13-33 displays the percentage of cumulative Alternative C- No Action tax and royalty revenues that would be distributed to each entity.

Figure 4.13-33. Percentage Distribution of Cumulative Tax and Royalty Revenues: Alternative C – No Action



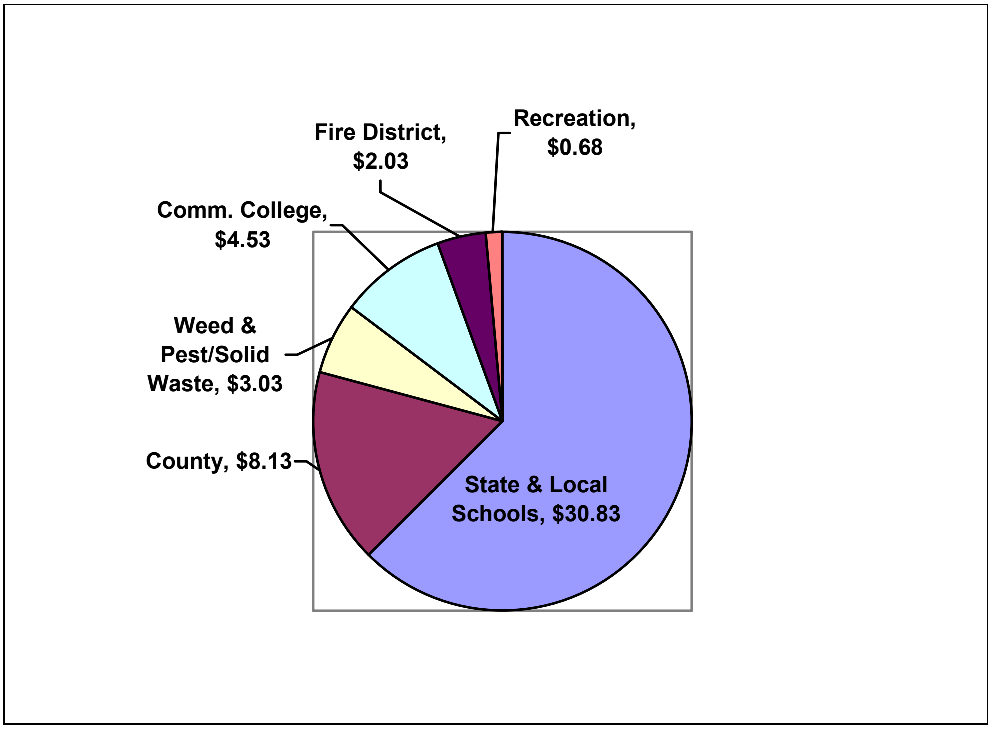
Based on the estimates prepared for this assessment, the Eastern Shoshone and Northern Arapahoe Tribes would receive royalty payments equal to 27 percent of total cumulative tax and royalty revenues associated with Alternative C (No Action), Fremont County, its ad valorem property taxing entities and schools would receive 23 percent, the WRIR Tribes would receive 17 percent in severance tax payments, the State of Wyoming would receive 16 per cent in severance tax payments, Wyoming, Fremont County and its incorporated municipalities would receive 1 percent in sales and use tax payments, fee mineral owners would receive 16 percent in royalty payments, and the Wyoming Oil and Gas Conservation Commission would receive 0.2 percent.

The Alternative C – related royalty and severance tax revenue to the Eastern Shoshone and Northern Arapaho tribes would be positive, minor and long term. The effects of Alternative C – related property tax revenue to Fremont County taxing entities would be positive, minor and long term.

Fremont County Ad Valorem Property Tax Revenues

Figure 4.13-34 shows the distribution of estimated total cumulative Alternative C (No Action) ad valorem property tax revenues to relevant taxing entities.[24]

Figure 4.13-34. Alternative C – No Action Cumulative Ad Valorem Property Tax Distribution (millions of constant $2003)



4.13.5.5 Population

The population effects of Alternative C would be negligible. Under Alternative C, one rig would drill 14 wells per year in just the Pavillion field. Workforce needs for this level of drilling and infrastructure development would be accommodated by the existing Fremont County and regional oil and gas service industry, which would fill out crews from the pool of unemployed and under-employed workers in the county. Currently employed secondary workers could lose jobs due to declining production in Muddy Ridge and other existing fields, which could trigger out-migration if other employment opportunities were unavailable. The impacts of Alternative C – related activities on area population conditions would be negligible and long term.

4.13.5.6 Housing

Housing demand associated with Alternative C would be negligible, long term and easily accommodated by existing temporary housing resources.

[24] Note that ad valorem property tax rates are set by state statute or by the Fremont County Commissioners and other school and special district officials based on the anticipated revenues and expenditures of the particular taxing entity, therefore tax rates and percentages would change over time.

4.13.5.7 Law Enforcement and Emergency Response

The potential demand for emergency response and law enforcement services would be substantially lower under Alternative C than under the Proposed Action. Drilling and field development would take place only in the Pavillion field (instead of in all five fields targeted under the Proposed Action and other alternatives) and drilling would proceed at a much slower pace under Alternative C (14 wells per year) as compared to the Proposed Action (an average of 25 wells per year and a peak of 37 wells).

As a result, it is unlikely that a resident Sheriff's deputy would be warranted under Alternative C, and the potential for ambulance calls would be greatly reduced. Of course, production related revenues to the county general fund and fire district would also be substantially less under Alternative C, totaling about $6.2 million and $1.9 million, respectively, over the life of the project, or about 21 percent of the revenues associated with the Proposed Action. Consequently, the impacts of Alternative C – related activities on law enforcement and emergency response services would be negligible and long term.

4.13.5.8 Midvale Irrigation District

The Operators estimate that 64 of the total 100 Pavillion field wells associated with Alternative C would be drilled on irrigated land. Assuming implementation of Operator commitments to reclaim all access roads, pipeline cuts and reclaim the well pad to a 64 square foot area by the first growing season, a total of 19 irrigated acres would be removed from production over the life of Alternative C, resulting in an annual loss of $285 in assessment revenues for the MID, if the BOR were to reclassify land. This amount could be reduced if production facilities were located off of irrigated ground. Impacts of Alternative C – related development on MID revenues and operations would be negligible and long term.

4.13.5.9 Split Estate Issues

Drilling in the Pavillion field, where most split estate parcels are located, would decrease by 35 percent under Alternative C (a total of 100 wells) compared to 155 under the Proposed Action. Less drilling in the Pavillion field would likely result in fewer split estate conflicts than with the Proposed Action. The potential for Alternative C – related split estate conflicts would be moderate and long term, because of the level of development that would occur in the Pavillion field, where much of the surface is privately owned. As with other alternatives, successful implementation of Operator-committed mitigation measures would further reduce but probably not eliminate split-estate conflicts.

Under Alternative C, split estate issues would not be a concern in the other four fields of the WRPA where no wells would be drilled.

4.13.5.10 Gas Development, Agricultural Productivity and Income

Per well disturbance on irrigated lands and per well surface use agreement and reentry payments would be the same for Alternative C as for the Proposed Action, Consequently, assuming successful implementation of the Operator-committed mitigation measures listed in detail in Sections 3.1.3.3 and 4.13.7, economic loss to agricultural operations associated with the Proposed Action are likely to be negligible and, in some cases, farmers and ranchers may receive increases in net income from properties with gas development.

4.13.5.11 Industrialization and Rural Character

Drilling in the Pavillion field would be reduced by 35 percent under Alternative C as compared to the Proposed Action, but the pace of drilling would be the same as the average pace of drilling under the Proposed Action for the entire seven-year duration of Alternative C. Consequently, impacts to rural character would be similar in the Pavillion field during that seven-year period. Once development ends under Alternative C, the impacts would diminish quicker, gas production would end earlier and eventual reclamation would occur sooner because fewer wells would be drilled. Therefore, the Pavillion field would ultimately return to a more rural character sooner under Alternative C than under the Proposed Action. However, the change in rural character associated with Alternative C would be considered moderate and long term, but the impact would be limited to the Pavillion field.

4.13.6 Impacts Summary

The economic impacts of the Proposed Action and alternatives would be positive for the WRIR, for Fremont County. Fremont County and the surrounding region have a well-developed oil and gas service industry. Regional employment and businesses would be supported by the ongoing exploration, drilling, capital investment and production associated with the development.

Cumulative economic effects would encompass not only the direct activity in the gas industry, but also the indirect and induced impacts to the region's finance, retail trade, services and other industries that would potentially capture a range of expenditures spun off by direct activity in the gas industry. These expenditures include those of gas industry employees, of Tribal members and fee mineral owners receiving royalties, and of the Tribal and local governmental agencies and their employees supported by taxes and other revenues related to gas development. Of course, the magnitude of the economic effects would be tied to the level of development and would vary by alternative. Table 4.13-40 displays estimates of the cumulative economic impacts projected for each of the four alternatives.

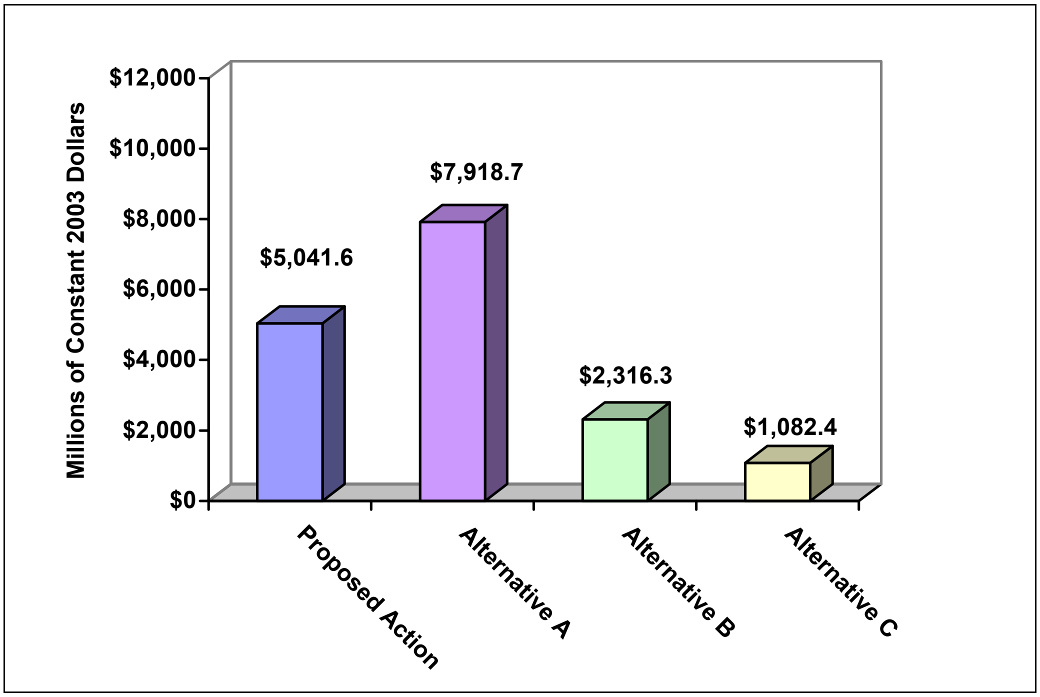
Table 4.13-40. Cumulative Economic Impacts by Alternative, 2004 to 2032

	Proposed Action	Alternative A	Alternative B	Alternative C
Total Job-Years Supported (Direct, Indirect & Induced)	22,205	34,872	11,279	4,071
Total Personal Income Generated ($M)	$1,114.1	$1,729.7	$546.9	$225.0
Total Regional Economic Output Generated ($M)	$5,041.6	$7,918.7	$2,361.3	$1,082.4

($M) – Millions of constant $2003.

As shown in Table 4.13-40, cumulative economic effects over the 28-year analysis period would total an estimated 22,205 job-years, $1.1 billion in total personal income and $5 billion in total regional economic output for the Proposed Action. Cumulative economic effects could range from a high of 34,872 job-years, $1.7 billion in total personal income and $7.9 billion in total regional economic output for Alternative A to a low of 4,071 in total job-years, $225 million in total personal income and $1 billion in total regional economic output for Alternative C-No Action.

Figure 4.13-35. Cumulative Total Regional Economic Output by Alternative, 2004 to 2032



The fiscal impacts of gas development would also be positive. Severance taxes, royalties and ad valorem taxes all would generate substantial revenues to a number of entities either in the public sector or specifically representing Tribal interests. Table 4.13.41 shows the estimated cumulative total tax and royalty revenues for each alternative.

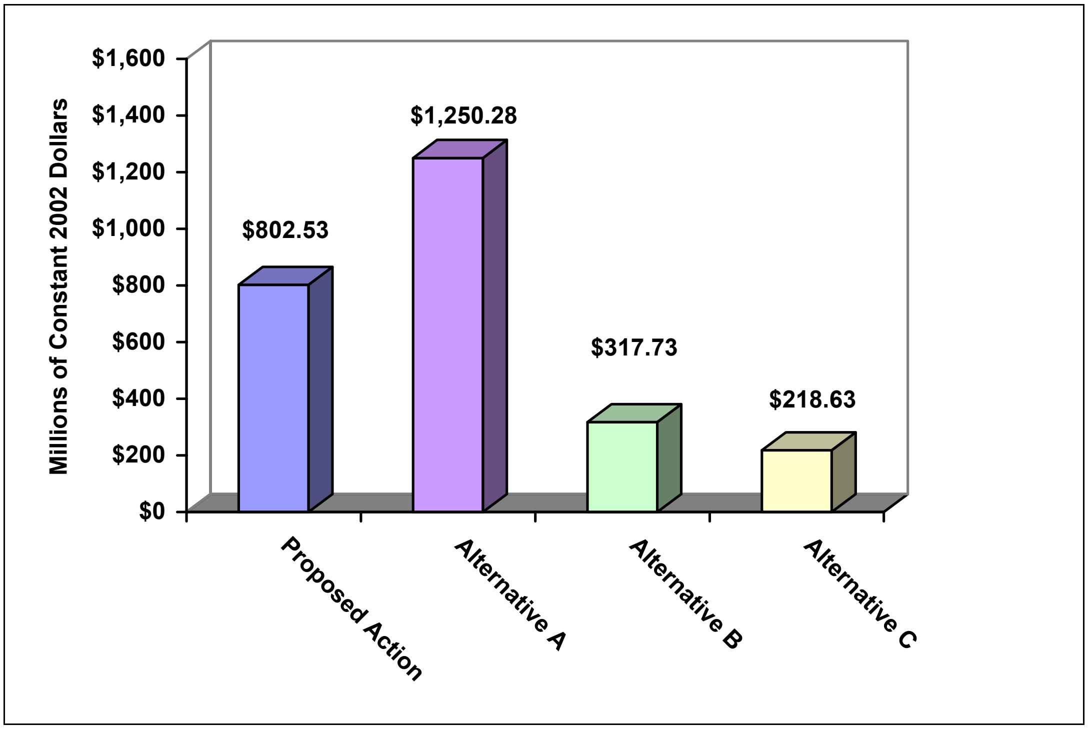
Table 4.13-41. Cumulative Tax and Royalty Payments by Alternative, 2004 to 2032

	Proposed Action	Alternative A	Alternative B	Alternative C
Wyoming Oil and Gas Conservation Comm. ($M)	$ 1.77	$ 2.69	$0.78	$.0.47
Wyoming Severance Taxes ($M)	$116.38	$143.92	$48.21	$36.67
Wyoming Sales and Use Tax	$ 13.09	$ 17.04	$ 5.91	$ 1.99
Fremont County Ad Valorem Taxes ($M)	$227.70	$349,97	$74.13	$48.59
Tribal Severance Taxes ($M)	$132.41	$194.57	$57.60	$32.54
Tribal Royalty Payments	$264.83	$389.13	$115.20	$65.16
Royalty Payments on Fee Production ($M)	$ 46.35	$56.93	$15.90	$33.21
TOTAL	**$802.53**	**$1,250.28**	**$317.73**	**$218.63**

($M) – Millions of constant $2003.

As shown in Figure 4.13-36, total cumulative tax and royalty income over the 28 year analysis period is estimated to be $802.5 million for the Proposed Action and would range from a high of $1.25 billion for Alternative A to a low if $218.6 million for Alternative C.

Figure 4.13-36. Cumulative Total Taxes and Royalties Generated by Alternative, 2004 - 2032



Under all alternatives, the private owners of lands that overlay minerals held in trust for the Eastern Shoshone and Northern Arapaho tribes or owned by other private interests (split estate lands) could experience economic loss associated with the removal of land from agricultural production, disruption of agricultural activity, damage to fields and crops and interference with farming practices such as cultivation patterns and the operation of mechanized irrigation systems.

In recent years the Operators have instituted practices and measures to avoid and mitigate such losses (see Section 4.12.7). The Operators also make initial and annual surface damage payments to private owners and make additional payments when they must re-enter previously reclaimed fields. The mitigation measures and damage payments are intended to reduce disruption of agricultural operations and compensate private surface owners for economic loss associated with natural gas development. Assuming successful implementation of the Operator-committed mitigation measures and receipt of surface use payments, economic loss to agricultural operations associated with all alternatives are likely to be negligible and, in some cases, farmers and ranchers may receive increases in net income from properties with gas development.

According to scoping comments and the interviews conducted for this assessment, some surface owners consider these payments adequate. Others believe they adequately cover economic loss but perhaps do not adequately cover the "nuisance factor" of development or the potential negative effects on property values. Still other owners of split estate lands have disputed the adequacy of surface damage payments on all counts.

The additional gas development associated with each alternative would further change the character of lands within the WRPA, from rural agricultural toward mixed agriculture and natural resource extraction, the latter being a type of low density industrial land use. The potential change in rural character varies from field to field for each alternative.

Population effects of all alternatives are anticipated to be minor. The well-developed regional oil and gas service industry and the local labor pool would provide most of the contractors and employees needed for gas development activities. Indirect jobs stimulated secondarily by gas development within the WRPA would also be filled from the local labor pool or by local employees who remain employed instead of losing their jobs, as economic activity from the Proposed action offsets anticipated declines in existing production in the WRPA or other oil and gas fields.

Housing demand associated with all alternatives would be minor. Most housing demand would be for temporary housing accommodations to serve non-local contract employees during their work week. The duration of development under some alternatives may encourage non-local contract employees to seek longer term housing in Fremont County, but existing resources would likely accommodate this demand.

Because population growth associated with the Proposed Action is anticipated to be negligible to minor, law enforcement and emergency response (emergency medical/ambulance and fire suppression) are two of a limited range of local government facilities and services that would be subject to impact. Potential effects also would occur to county road and bridge services, and these are discussed in Section 4.14.

The potential for increased demand for law enforcement and emergency response services would be associated with all alternatives, and would be dependent on the magnitude of development, traffic and industrial activity associated with the alternative. Increased demand could result in the need for increased training and specialized equipment in the case of emergency response services and for an equipped sheriff's deputy to be located within or near the WRPA during the development phase. This effect would occur under all alternatives, except Alternative C – (No Action), which has no development outside of the Pavillion field.

The substantial production-related ad valorem tax revenues that would accrue to the Fremont County general fund and to the county fire district under all alternatives would offset the cost of potential increases in these services.

4.13.7 Additional Mitigation Measures

While the impact avoidance and mitigation measures for irrigated land, described in Section 3.13.6.3 and listed again below would be negotiated between the Operators and private land owners rather than federally mandated, they would reduce split estate conflicts and to a lesser extent diminish the change in rural character of the area:

- Perform work on irrigated land during fallow seasons.
- Conduct regular meetings with surface owners and other residents of each field to describe upcoming drilling and development plans, discuss issues and receive landowner input.

- Haul fill dirt (or purchase from surface owner) for pad construction and removing the fill after drilling/completion.
- Completely reclaim the access road and reclaim the well pad to an approximately 8 foot x 8 foot disturbed area.
- Contain drill cuttings in tubs and dispose of the cuttings offsite.
- Stockpile topsoil in accordance with landowner preferences.
- Locate tank batteries and other facilities along property boundaries and roads, in accordance with landowner preferences.
- Use existing flowline rights-of-way when possible.
- Supply gated pipe to landowners to facilitate ongoing irrigation during the surface disturbance, drilling and completion phases of development.
- Remove reserve pit spoils.
- Locate well pads away from hillsides.
- Minimize the size of the reserve pit and rotate the pad.
- Install a silt fence on the backside of spoils piles.
- Apply water to access roads to control dust.
- Test water wells before drilling operations to establish a baseline for post-completion testing.
- Plant trees or landscaping around wellheads, according to surface owner preferences.
- Provide surface owners with plats of wells, pipelines and ancillary facilities.
- Prepare the access road and reclaimed portion of the well pad for cultivation by corrugating, drill seeding, installing watering flowlines, providing compaction equipment, repairing fences, cutting drain ditches, land leveling, and providing additional gated pipe.
- Other mitigation measures that could help reduce impacts to the rural character of the area include the following:
- Require all employees to strictly observe all traffic laws and regulations including speed limits.
- Coordinate with the Fremont County Road Department to develop measures to effectively control dust on all unpaved roads.
- Implement additional visual resource mitigation measures listed in Section 4.11.7 in fields within the WRPA

4.13.8 Residual Impacts

Even after successful implementation of the mitigation measures outlined above, reductions in net income for some agricultural operations and changes in rural character would persist within affected areas of the WRPA ,. These effects may be compensated by surface use payments, depending on the circumstances of the individual parcels under consideration.

4. 13.9 Environmental Justice

EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. The area of analysis for Environmental Justice concerns for the Wind River Natural Gas Development project is the Wind River Indian Reservation, as the WRPA does not contain a high concentration of either minority or low-income populations.

Table 2-14, presented previously, summarizes the potential direct and indirect impacts of the Proposed Action and alternatives. A comparison of the impacts with potentially affected areas where there may be environmental justice concerns indicates that environmental justice impacts of the Wind River Natural Gas Development Project concerns associated with any of the alternatives assessed for the Wind River Natural Gas Development project would range from negligible to moderate, with the exception of the economic and fiscal effects, which would be major but positive.

Human health effects are identified by executive order as a specific concern for environmental justice. Health and safety effects of the Proposed Action and alternatives as a whole would be negligible to minor, except for a moderate impact to the risk of worker related accidents.

Health and safety impacts generally relate to the proximity of persons to drilling, field development and production activities that would occur within the WRPA. Since concentrations of minority and low-income persons on the WRIR are located in the areas of Ethete, Arapaho and Ft. Washakie, communities that are some distance from the WRPA, persons in these areas would not experience any greater impacts to health and safety (impacts that would be negligible to minor, in any case) than the population as a whole.

In terms of risk of worker-related accidents, Tribal Employment Rights Ordinances require at least 50 percent of gas development and operations employees to be members of the Eastern Shoshone and Northern Arapahoe tribes. Impacts to the risk of worker-related accidents (which would be moderate) would therefore disproportionately affect Tribal members, most of whom would likely be residents of the WRIR. However, the increased risk could be offset by several factors. First, the employment preference requirement for Tribal members is a policy that Tribal officials have enacted presumably at the will of the membership and for the benefit of the membership. Second, taking a job created by the Proposed Action or alternatives would be a matter of individual choice, with individuals presumably considering whether the higher risk disclosed here is adequately compensated for by other terms of employment. Finally, the workplace for natural gas drilling, development and operations is governed by a variety of federal and state regulations that promote worker health and safety.

Air and water quality are two areas of potential environmental impact that could affect populations outside the WRPA. The analyses conducted for this assessment indicate that potential impacts to air and water quality would be negligible to minor for all alternatives, with the exception of increased surface water runoff and erosion which would be moderate under Alternative A. Because surface water within the WRPA does not drain toward the areas of the WRIR mentioned above, where concentrations of minority and low-income persons reside, minority and low-income groups would not be disproportionately or even directly affected by moderate impacts from water runoff and erosion.

Although there are no concentrations of Eastern Shoshone or Northern Arapaho living within the WRPA, cultural and recreational resources are both important to the Tribes. Impacts to these resources are anticipated to be minor for all alternatives.

Based on the foregoing assessment, no substantial environmental justice concerns arise in connection with any of the alternatives assessed for the Wind River Natural Gas Development project.

4.14 TRANSPORTATION

4.14.1 Introduction

This section addresses the potential impacts of the Proposed Action and alternatives on transportation conditions (traffic levels, highway and road conditions and safety) in and near the WRPA. The transportation network providing access to and within the WRPA is described in Section 3.14 and includes federal and state highways, Fremont County roads and bridges, and Operator-maintained resource roads on public, tribal, and private land. In a limited number of cases, short segments of roads maintained by the Midvale Irrigation District may also be used.

Transportation issues and concerns identified in the scoping process that are addressed in this assessment include:

- The potential for project-related traffic on local roads to accelerate road and bridge wear and maintenance costs to the county and how those costs would be funded,
- The number and size of vehicles that would be used for the project, their travel frequency, the number of trips anticipated, and the roads that would be used to access the WRPA,
- Traffic safety,
- The feasibility of adopting alternative travel routes, and
- Expected traffic impacts in Pavillion.

Transportation issues raised during scoping that are addressed in other sections of this assessment include:

- An identification of roads that would be closed and reclaimed versus left open following completion of the project (addressed in Section 2.7.2.1), and
- Traffic related dust, emissions and noise (addressed in Sections 4.4 and 4.16, respectively.

For all alternatives, the Operators would use existing federal and state highways and county roads for access to and within in the WRPA. Resource roads would be developed from existing county and tribal roads to wells, groups of wells and facilities; no new thoroughfares would be developed.

4.14.1.1 Assessment Methods and Assumptions

The pace of drilling, number of wells drilled per year and the duration of drilling activity are assumed to drive traffic impacts during the development phase. The number of wells and ancillary facilities in place would drive traffic impacts during production.

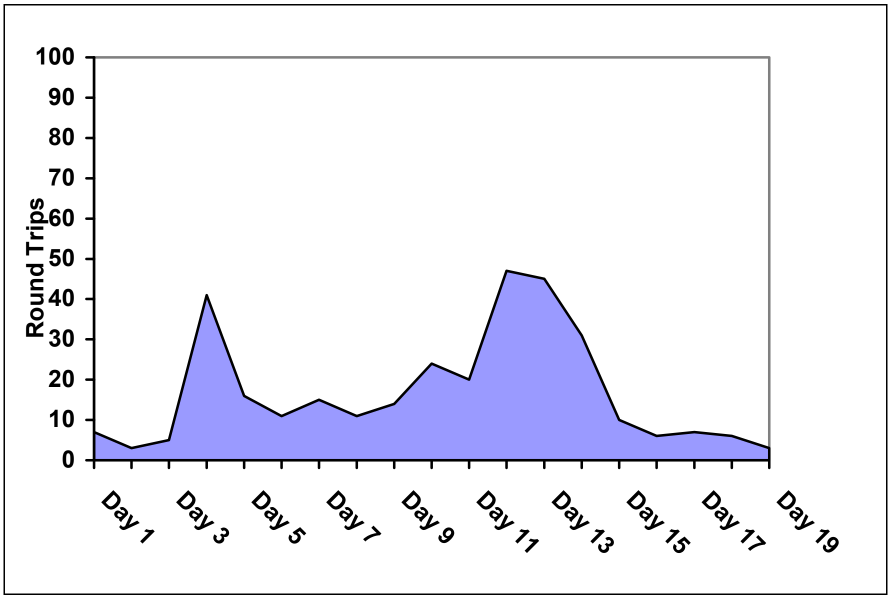
For the development phase, a transportation simulation was conducted to estimate the traffic effects of each alternative. The simulation assigned round trips by type (light vehicles or heavy trucks and equipment) to each of the tasks required to prepare a well site, drill and complete a well and reclaim the areas disturbed for drilling, access and pipeline construction. Drilling and completion requirements vary by field; therefore separate simulations were developed for the Pavillion, Muddy Ridge and for the Sand Mesa, Sand Mesa South and Coastal Extension fields. The figures below display the results of the one-well simulations for each field. The figures show daily round trips associated with well site and access road construction, drilling, completion and reclamation.

Pavillion Field

Figure 4.14-1 displays the estimated traffic associated with a typical Pavillion field well. Well staking, cultural and biological clearance and location (well pad and access road) construction would require an average of 2 to 3 days. Drilling would require 7 to 10 days, completion would require 3 to 5 days, pipeline construction would average 3 days and reclamation would require 2 or 3 days, although some of these activities could occur concurrently. For illustration purposes, it is assumed that each drilling and completion activity would occur immediately following the prior activity; however, delays between drilling and completion activities would not alter the results of the assessment.

In all, a typical Pavillion well would generate an estimated total of 322 round trips or an average of 17 round trips per day during the drilling and completion cycle, although as shown by Figure 4.14-1, there would be several peak days of 40 round trips or higher traffic during mobilization (days 3 & 4), demobilization and certain completion activities (days 11 through 14). Assuming 13 Pavillion wells would be drilled in the peak year of WRPA drilling, an estimated 4,186 round trips would be generated in the Pavillion field or an annual average daily traffic (AADT) of about 23. Note that the peak year of drilling in the Pavillion field (as opposed to the WRPA as a whole) would involve 18 wells, which would result in an annual total of 5,796 round trips, or an AADT of about 32.

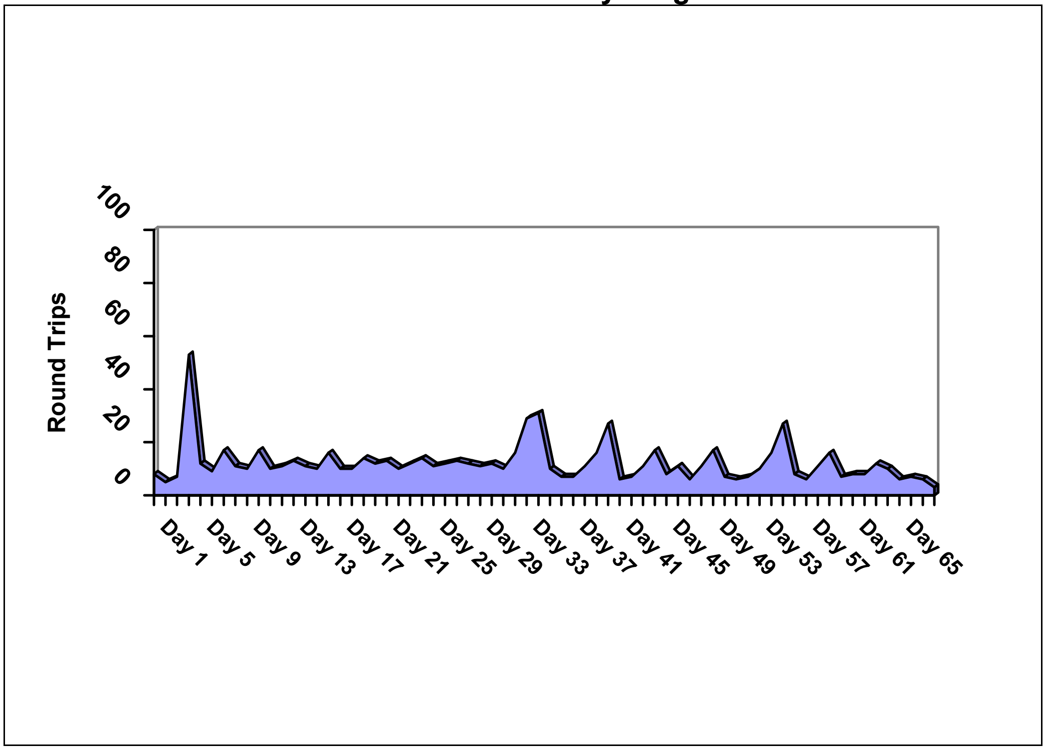
Figure 4.14-1. One-Well Traffic Simulation: Pavillion Field



Muddy Ridge Field

Muddy Ridge wells require substantially longer to drill and complete than Pavillion wells, typically requiring between 60 to 70 days including clearance, access road and location construction, pipeline construction and reclamation. Muddy Ridge wells generate an estimated total of 825 round trips, but average 12 round trips per day because the longer work period offsets peak days of rig-up, rig-down and completion. As shown by Figure 4.14-2, there would be several peak days of 50 round trips or higher traffic during mobilization and rig-up, and several substantially lower peaks during demobilization and certain completion activities. Assuming 12 Muddy Ridge wells would be drilled in the peak year of WRPA drilling, an estimated 9,900 round trips would be generated in the Muddy Ridge field or an annual average daily traffic (AADT) of 54.

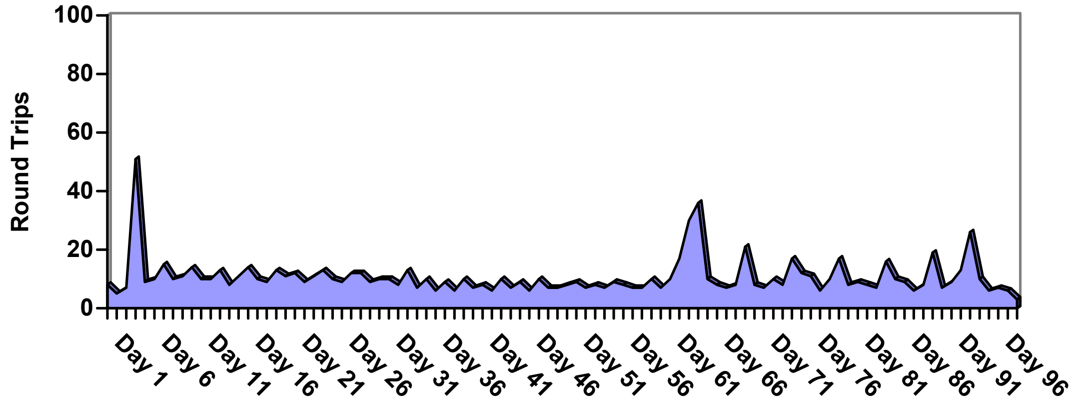
Figure 4.14-2. One-Well Traffic Simulation: Muddy Ridge Field



Sand Mesa, Sand Mesa South and Coastal Extension Fields

The deeper Sand Mesa, Sand Mesa South and Coastal Extension wells would require an average of about 40 to 60 days to drill and 30 days to complete. These wells would require an estimated 1,039 round trips, or a daily average of about 11 round trips. As shown by Figure 4.14-3, there would be several peak days of 50 round trips or higher traffic during mobilization and rig-up and several substantially lower peaks during demobilization and certain completion activities. Assuming a total of 12 wells would be drilled in the Sand Mesa, Sand Mesa South and Coastal Extension fields during the peak year, an estimated 10,598 round trips would be generated in these three development areas or an annual average daily traffic (AADT) of 58. Note that these calculations assume that 50 percent of all Sand Mesa and Sand Mesa South wells and 80 percent of all Coastal Extension fields would be dry holes and therefore would not be completed or generate completion-related traffic.

Figure 4.14-3. One-Well Traffic Simulation: Sand Mesa, Sand Mesa South and Coastal Extension Fields



Source: Tom Brown, Inc. 2003; Blankenship Consulting, LLC 2003.

The traffic estimates derived from the one-well simulations are aggregated for the annual number of wells anticipated for each field, and again aggregated for all development areas, along with estimated gathering system construction traffic, to provide total WRPA development phase traffic estimates. Again note that completion traffic estimates are omitted for wells that are assumed to be non-producing.

For the transportation assessment, annual round trips were converted to AADT by multiplying by two and dividing by 365. This conversion allows comparison with WYDOT traffic counts on affected highway segments. The AADT impacts yielded by this assessment may somewhat overestimate impacts on federal and state highways, because not all vehicles leave the WRPA every day.

Development phase AADT estimates were prepared for the peak year (highest number of wells drilled in the WRPA) for each alternative. Peak year estimates were used to identify the maximum annual traffic that would be generated by the alternative. Total estimates (drilling, field development and production) were also prepared by year for 19 years, including the entire development phase and the first several years of full project operations, depending on the alternative.

For comparison purposes, the AADT associated with the Proposed Action is contrasted with 2001 AADT, and the remaining alternatives are contrasted with the Proposed Action.

Under every alternative, development phase traffic would originate at different locations and travel to different development areas (except for C - No Action, where traffic would travel only to the Pavillion field). Consequently, it was necessary to distribute traffic to each field over a variety of routes. This was accomplished by considering distance and the characteristics of each route and by discussions with Operator personnel and WYDOT and Fremont County Road and Bridge officials.

For all of the action alternatives (Proposed Action, Alternative A and Alternative B), it is anticipated that four drill rigs (one in Pavillion, one in Muddy Ridge, one in Sand Mesa and one alternating between Sand Mesa, Sand Mesa South and Coastal Extension) would be operating within the WRPA at any one time, although other rigs could be added. The rigs would generally be moved to the field at the beginning of the drilling phase and be moved from location to location within the field as wells are completed and new wells begun. Given the continuous nature of drilling, particularly in the Pavillion, Muddy Ridge and Sand Mesa fields, some heavy equipment and completion equipment would also be moved to the WRPA at the beginning of the cycle and remain for the duration. Workforce commuting to and from well sites and the delivery of equipment, materials and supplies would generally originate outside the WRPA. Some movement of equipment would originate inside the WRPA, at TBI's equipment yard on North Portal Road.

In addition to drilling and field development, there would be traffic associated with facility (compressor station) construction. Estimates of traffic associated with facility construction are included in the total estimates for each alternative.

During project operations, gas field traffic would diminish substantially, compared to the development phase. A lease operator or pumper would visit each well daily, and oil and water haulers would visit each production facility as needed. Supervisory personnel, wellhead and meter maintenance, weed control and other maintenance personnel would visit the development areas on an intermittent basis. Higher volumes of traffic lasting several days would occur occasionally at wells requiring downhole maintenance or recompletion. Each alternative would generate additional traffic for compression and production operations.

4.14.2 Proposed Action (325 wells) – Direct and Indirect Impacts

The Proposed Action would involve the drilling of 325 natural gas wells at 325 well locations, including 155 in the Pavillion field, 50 in the Muddy Ridge field, 100 in the Sand Mesa field, 12 in the Sand Mesa South field and 8 in the Coastal Extension field.

4.14.2.1 Development Phase Impacts

As noted above, it is likely that one rig would drill continuously in each of the Pavillion, Muddy Ridge and Sand Mesa fields, with a fourth rig alternating between the, Sand Mesa South and Coastal Extension fields. Table 4.14-1 contrasts the number of wells proposed for the peak year of the Proposed Action with the number of wells drilled during 2001. The table also contrasts the AADT associated with these years, by field, as does Figure 4.14-4. As discussed in the introduction of this section, the estimated AADT associated with the Proposed Action is higher than in 2001, even the though number of wells is lower, because of the number of deeper/longer duration wells drilled in the Muddy Ridge, Sand Mesa, Sand Mesa South and Coastal Extension fields.

Table 4.14-1. Wells Drilled and Estimated AADT: 2001 and Proposed Action Peak Year, by Field

	2001		Proposed Action Peak Year	
	Wells	AADT	Wells	AADT
Pavillion	39	69	13[1]	23
Muddy Ridge	8	39	12	55
Sand Mesa	1	6	8	38
Sand Mesa South	0	0	3	16
Coastal Extension	0	0	1	6
TOTAL	**48**	**114**	**37**	**139**

[1]13 wells would be drilled in the Pavillion field during the peak year of drilling in the WRPA under the Proposed Action although annual drilling levels in Pavillion would range from 10 to 18 and average 14 under this alternative.

Figure 4.14-4. Estimated Proposed Action Development Phase Peak Year AADT Contrasted with 2001 Development Phase AADT, by Field

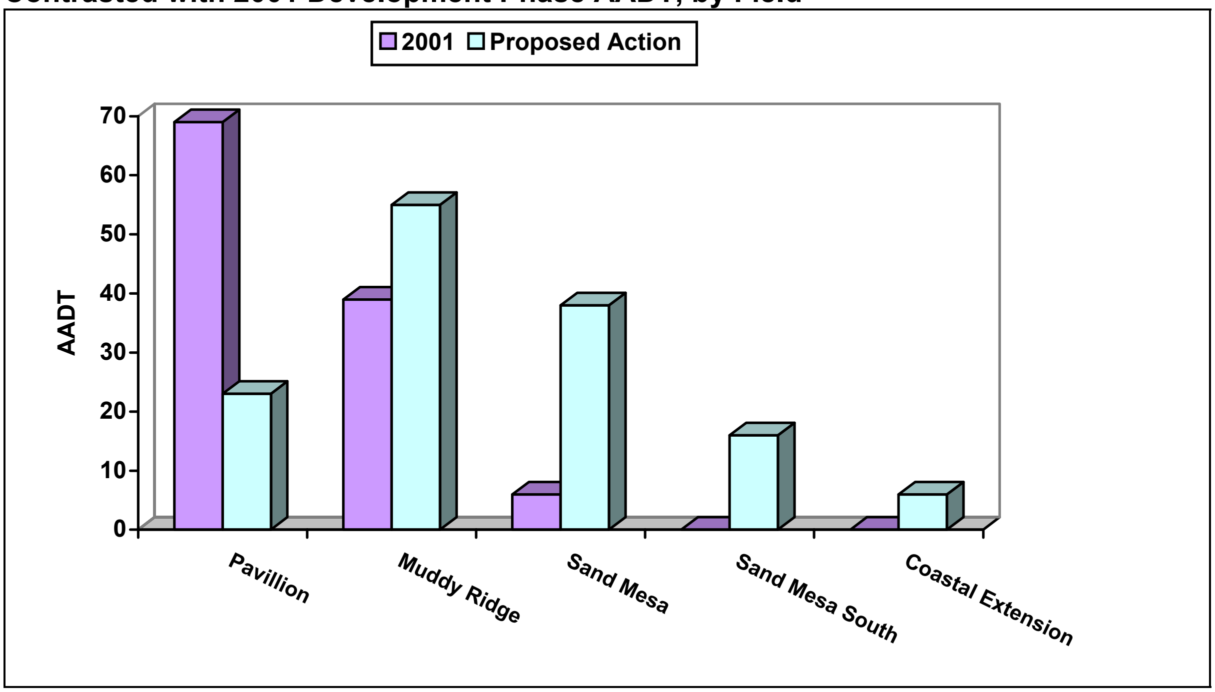
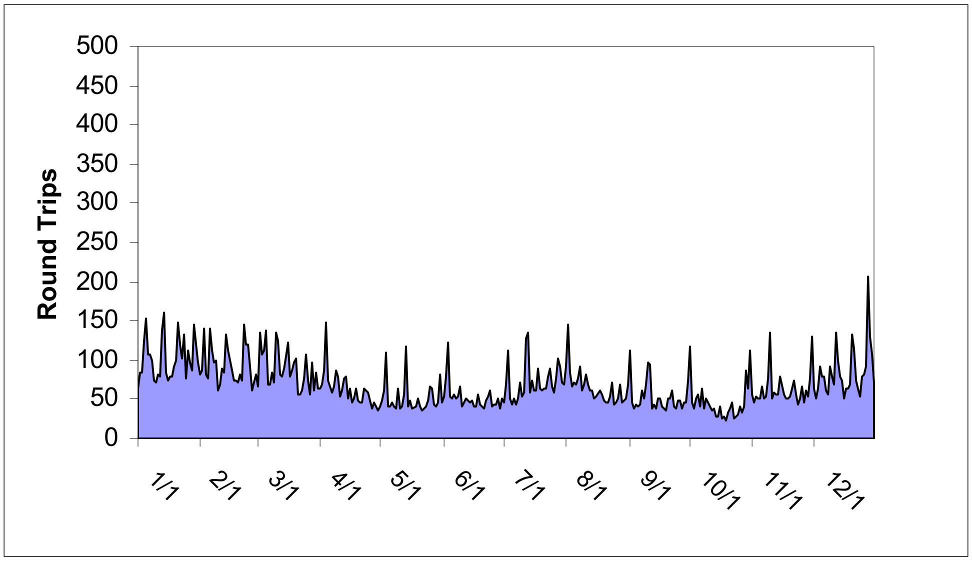


Figure 4.14-5 displays the simulation of total traffic associated with the Proposed Action peak year of drilling. As shown by the simulation, which displays round trips rather than AADT, development phase traffic is likely to be higher in the fall and winter when operators are taking advantage of frozen ground to drill, particularly on irrigated lands in the Pavillion field. The simulation shows that traffic would average around 50 - 75 round trips/day during summer months and increase during winter months, with periodic peaks when traffic-intensive activities at several drill sites coincide.

Figure 4.14-5. Proposed Action Peak Year Development Phase Traffic Simulation: All Fields



Proposed Action Traffic Impacts on Federal and State Highways

Table 4.14-2 and Figure 4.14-6 display estimates of peak-year traffic (including trucks) associated with the Proposed Action, on highway segments providing access to the WRPA.

For comparison purposes, the AADT associated with each alternative is contrasted with adjusted 2001 AADT on affected highway segments. Adjusted 2001 AADT was derived by subtracting estimates of 2001 development phase AADT in the WRPA from 2001 WYDOT AADT counts on each segment. The year 2001 was selected as the base year for this assessment, because it was the most recent for which both WYDOT traffic counts and WRPA drilling data were available.

Combining estimated peak-year AADT with adjusted 2001 AADT allows an assessment of the relative magnitude of project related traffic impacts in a base year context. It is anticipated that background (non-project) traffic volumes on affected highway segments will continue to grow, although as shown in Section 3.14, there is some volatility on particular segments. Section 5.14 provides a discussion of anticipated background growth on affected segments. As background traffic volume on affected segments increases, the project-related traffic would add to but be a smaller percentage of total traffic volume.

Table 4.14-2 shows total traffic impact (including trucks) on selected federal and state highway segments and Tables 4.14-3 shows heavy truck traffic impact. The first and second columns in each table show the affected highway and segment. The third column displays adjusted 2001 AADT for each highway segment, the fourth column presents the peak year Proposed Action AADT for the segment, the fifth column presents the peak year Proposed Action AADT plus adjusted 2001 AADT for the segment and the final column shows the percentage that Proposed Action related AADT comprises of that total.

The estimated Proposed Action peak-year AADT is 139, which is allocated to affected segments. The peak-year traffic associated with the Proposed Action would be a relatively small percentage of total traffic on US 26/789 north of Riverton and US 26 west of Riverton,

Figure 4.14-6. Proposed Action Peak Year AADT on Highways Providing Access to the WRIR

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averaging from less than one percent to about two percent at every location. Proposed Action related traffic would be a larger percentage of total traffic as it converges on US 134 within the WRPA, near the county roads leading north into the Pavillion, Muddy Ridge and Coastal Extension fields. Proposed Action-related traffic would comprise 3 to 4 percent of total traffic along WYO 134 and total an estimated 14 percent at Midvale. The higher percentage of traffic on this segment reflects both the convergence of gas field traffic near these three fields and the lower base traffic counts on WYO 134.

Table 4.14-2. Proposed Action Peak Year AADT Impacts on Affected Highways

Highway	Segment	Adjusted 2001AADT[1]	Proposed Action Peak Year AADT	Proposed Action Peak Year AADT[2] + 2001 Adjusted AADT	Percent Proposed Action Peak Year AADT of Adjusted 2001 AADT
US 26/789	Shoshoni west corporate limits	3,888	14	3,902	<1%
	Junction WYO 134	3,285	49	3,333	1%
	Junction Burma Rd	4,557	78	4,635	2%
	Riverton north corporate limits	8,077	78	8,115	1%
US 26	Riverton west corporate limits	8,382	30	8,412	<1%
	Junction Eight Mile Road	3,522	30	3,552	1%
WYO 134	Junction Burma Rd	642	30	672	4%
	Midvale	414	65	478	14%
WYO 133	Junction US 26	1,017	31	1,048	3%
	Junction WYO 134	867	31	898	3%
	Pavillion west corporate limits	799	8	808	1%

[1]2001 AADT less estimated 2001 WRPA development phase AADT.
[2]Adjusted 2001 AADT plus estimated Proposed Action peak year AADT

Table 4.14-3 displays estimates of the truck traffic associated with the Proposed Action, which accounts for a higher portion of recent truck traffic on affected highways, particularly WYO 134 in the Midvale area and the intersections leading to WYO 134. These relatively high percentages reflect the convergence of gas field traffic on this segment and the lower number of trucks on the highway, as compared to all traffic. Although the percentage of trucks may be high, the absolute number of AADT for trucks is relatively low, i.e., below 20 at every location except Midvale, the north corporate limits of Riverton and the junction with Burma Road on US 26 (truck AADT of 30 for the former and 33 for the latter two).

Table 4.14-3. Proposed Action Peak Year Truck AADT Impacts on Affected Highways

Highway	Segment	Adjusted 2001Truck AADT[1]	Proposed Action Peak Year Truck AADT	Proposed Action Peak Year Truck AADT + Adjusted 2001 Truck AADT	Percent Proposed Action Peak Year Truck AADT of Adjusted 2001 Truck AADT
US 26/789	Shoshoni west corporate limits	595	14	609	2%
	Junction WYO 134	468	19	487	4%
	Junction Burma Rd	511	33	543	6%
	Riverton north corporate limits	598	33	630	5%
US 26	Riverton west corporate limits	201	14	215	6%
	Junction Eight Mile Rd	141	14	154	9%
WYO 134	Junction Burma Rd	71	14	85	16%
	Midvale	41	30	71	42%
WYO 133	Junction US 26	73	14	87	16%
	Junction WYO 134	33	14	47	29%
	Pavillion west corporate limits	44	4	48	8%

[1] 2001 truck AADT less estimated 2001 WRPA development phase truck AADT.

The relatively low percentage of Proposed Action AADT on affected highways indicates that Proposed Action-related wear on federal and state highways would be minor and long term, with the possible exception of WYO 134, where the concentration of gas field traffic and the relatively high percentage of heavy trucks could accelerate maintenance demands, resulting in moderate long term impacts. These demands would be offset by fuel taxes paid by contractors and trucking companies and by the Proposed Action's severance tax contributions to the Wyoming Highway Fund, estimated to be $5 million over the 28 year assessment period. Additionally, WYO 134 may be designated as an industrial highway, which would make it eligible for additional maintenance and construction funds (Pendleton, D. Fremont County, personal communication, 2003).

The relatively low percentage of Proposed Action-related traffic on US 26/789 north of Riverton and US 26 west of Riverton would not result in a substantial increase in the potential for accidents on those highway segments. Similarly, WYO 133 from US 26 north would receive a relatively small portion of gas field traffic, and the good condition of the highway enhances traffic safety conditions. There have been no truck accidents on this segment in the six years prior to 2003, including 2001 when 48 wells were drilled in the WRPA.

The potential for Proposed Action-related increases in highway accidents is greatest on WYO 134, particularly in the area from North Portal Road (FCR 431) to Gabes Road (FCR 412). The potential for accidents would increase due to a high level of additional gas field traffic (relative to total traffic), including a relatively high number of trucks.

Despite the potential for accidents connected with high percentages of truck traffic, actual increases would not necessarily occur on this segment of WYO 134. During 2001, when 47 wells were drilled in the Pavillion and Muddy Ridge fields, 9 accidents occurred on this segment, 2 higher than the 6-year average of 7 accidents, but none of the accidents during that year involved trucks. A mitigating factor is that most traffic would originate from the east, allowing traffic to turn right to enter the county roads that provide access to the three development areas, thereby avoiding the cross-traffic turns that disproportionately increase the potential for accidents. Accident risk for this segment may include an increased likelihood of vehicle-animal collisions. A relatively high proportion of accidents on this segment over the past 6 years (43 percent) involved wildlife or livestock.

Proposed Action Traffic Impacts on County Roads

There are no recent traffic counts for Fremont County roads within the WRPA (Pendleton, D. Fremont County, personal communication, 2003); therefore percentage increases in traffic on county roads have not been calculated. Proposed Action-related traffic effects on Fremont County Roads would be concentrated in two parts of the WRPA.

- In the eastern part of the WRPA, Bass Lake Road (FCR 430) and Sand Mesa Road (FCR 422) provide the primary access to the Sand Mesa and Sand Mesa South fields. The Bass Lake Road bridge over Five Mile Creek is load-limited however, and heavy trucks with loads would use WYO 134 and either Fremont County Road 432 (Bushwacker Road) or FCR 431 (North Portal Road) to Sand Mesa Road. A limited amount of heavy truck may use FCR 339 (Two Valley Road) to WYO 134. Traffic originating within the WRPA and points southeast would also use North Portal Road and Sand Mesa or Bushwacker roads.

- In the western part of the WRPA, development phase traffic would use a variety of county roads to access the Pavillion, Muddy Ridge and Coastal Extension fields including:

  - Eight Mile Road (FCR 385)
  - Gabes Road (FCR 412)
  - North Portal Road (FCR 431)
  - Tunnel Hill Road (FCR 427)
  - East Powerline Road (FCR 424)
  - East Pavillion Road (FCR 330)
  - Burma Road (FCR 320)

Once within these development areas, wells and facilities would be accessed using:

  - West Powerline Road (FCR 425)
  - Indian Ridge Road (FCR 341)
  - Picket Road (FCR 3)
  - Williams Road (FCR 12)
  - Harris Bridge Road (FCR 306)
  - Pattison Farm Road (FCR325)
  - Two Mile Road (FCR 326)
  - South. Muddy Road (FCR 420)
  - North Muddy Road (FCR 421)
  - Sheep Camp Road (FCR426)

- Disneyland Road (FCR433)
- Teachers Road (FCR434)
- Ocean View Road (FCR 468)

Sand Mesa and Sand Mesa South fields

Under the Proposed Action, drilling would occur at the rate of 8 wells/year for 12 years and 4 wells/year for one year in Sand Mesa and 3 wells/year for 4 years in Sand Mesa South, starting in 2006. The combined Proposed Action–related peak year AADT for these two development areas is estimated at 54 (including 21 truck trips). For this assessment, it is assumed that 90 percent of this traffic would access the development areas from the south, using Bass Lake and Sand Mesa roads or for loaded heavy trucks, WYO 134 and either Bushwacker or North Portal roads; the remaining 10 percent would approach from the west on North Portal and Sand Mesa Road. In the recent past, gas field activity in this area of the WRPA has been relatively light, limited to two producing wells in the Sand Mesa field and no wells to date in the Sand Mesa south field. The traffic associated with year-round drilling by two drill rigs would be a substantial increase over historic traffic on Sand Mesa Road and an increase in traffic on Bass Lake Road.

In addition to production-related traffic to existing gas wells in the Sand Mesa field, the Bass Lake Road is currently used by residents of the area including farmers and ranchers, operators of grazing leases to the north and by recreation visitors to the west side of Boysen Reservoir and Lake Cameahwait (both outside the WRPA) and to certain parts of the Sand Mesa Wildlife Habitat Management Area (WHMA). Recreation use of the west side of Boysen reservoir is relatively light and concentrated in the summer months and on weekends. Use of Lake Cameahwait and the Sand Mesa WHMA extends from late spring into the fall hunting season, but similarly generates a relatively small amount of traffic.

Increases in gas field traffic would be most noticeable to other users of these roads during peak periods of drilling mobilization, de-mobilization and during certain completion operations. These peak days would occur several times during each drilling and completion cycle; four to five drilling and completion cycles would occur during summer and fall months. Residential, agricultural and recreational users of the Bass Lake Road could encounter substantial drilling-related traffic during these times, but these periods would be short-term and intermittent. Consequently, impacts associated with conflicts between gas field traffic and residential, agricultural and recreational users of these roads would be minimal.

The Bass Lake Road has a pavement condition index (PCI) rating of 23, which is relatively poor (100 is the best rating). The relatively long-term (13 year) increase in traffic associated with Proposed Action drilling and field development would accelerate the deterioration of the pavement and increase maintenance costs for the county, although the road may be reconstructed during this period. There are two bridges on the Bass Lake Road; as noted above, the bridge over Fivemile Creek is load-limited and the bridge across Muddy Creek has recently been destroyed by fire. The latter will be replaced with a concrete box culvert during 2004.

Sand Mesa Road is a relatively lightly used gravel road. The increase in traffic and heavy truck traffic would result in accelerated road maintenance cost for the county on this road.

Pavillion, Muddy Ridge and Coastal Extension fields

These three development areas would share common access from US 26; closer to and within the three development areas the routes diverge. It is assumed that 70 percent of all traffic would originate in Riverton or points north or east and use Eight Mile Road or Gabe's road from US 26. The remaining 30 percent would come from the WRIR, Lander and points south and west, and would use US 133 to WYO 134. Combined, these three development areas would generate an estimated AADT of 85 (including 37 trucks) during the peak year of the development phase.

Eight Mile Road has a PCI of 72 and the Fremont County Transportation Department has recently patched and chip-sealed the road. Gabe's road is gravel-surfaced. The relatively long-term (11 year) addition of the Proposed Action-related traffic, and heavy truck traffic in particular, would accelerate road maintenance demand on these roads.

Pavillion Field

Proposed Action-related development phase traffic to the Pavillion field (from 10 to 18 wells/year for 11 years – averaging 14 wells/year with a peak-year AADT of 25 including 12.5 trucks) would be distributed over a relatively large number of county roads, once inside the Pavillion field. In addition to North Portal and Tunnel Hill roads discussed above, paved roads providing access to the field would include North Pavillion Road (PCI 47), East Pavillion Road (PCI 8) and Williams Road (PCI 14).

Gravel roads used in the Pavillion field would include:

- Gabes Road
- East Powerline Road
- West Powerline Road
- Indian Ridge Road
- Picket Road
- Harris Bridge Road
- Pattison Farm Road
- Two Mile Road
- Sheep Camp Road
- Disneyland Road
- Teachers Road
- Ocean View Road

All of these roads are currently used to varying degree by area residents, agricultural operators, gas-field operators and, to a lesser extent, recreation visitors. During late spring, summer and early fall, there is increased heavy truck and farm equipment traffic on these roads, associated with agricultural operations and construction and maintenance activities of the MID. There is regular year-round use of many of these roads by the Operator's oil and water hauling trucks, which must access production facilities even during times when the roads are muddy and susceptible to rutting. Occasionally, these roads are used by heavy trucks and equipment associated with well workovers and recompletions.

Most drilling and field development traffic would use routes to the Pavillion field that do not require entering the Town of Pavillion on WYO 133 or East Pavillion Road. It is likely that some use of these segments through the town would be required, but development related traffic through the Town of Pavillion should be minimal.

The potential for Proposed Action related transportation impacts is greatest in the Pavillion field; the field contains the highest number of existing and proposed wells, it has the most residents and it is intensively used for agriculture. There are also more county roads in the Pavillion field than in the other field. These factors combine to yield the highest potential for accidents within the WRPA and the greatest potential for accelerated wear of road surfaces. Notwithstanding these factors, the potential for conflicts with other users and the potential for accidents would be reduced by having most drilling in the Pavillion field occur during the late fall and winter months when agricultural activities and use of county roads are at a minimum.

Impacts on Pavillion area county roads associated with the development phase traffic would vary from road to road and year to year, depending on the number of wells drilled in specific areas of the field in any given year. Impacts would include wear on roads caused by heavy truck and equipment traffic and the unavoidable use of roads during muddy conditions. Accelerated wear on county roads results in increased demand for county road maintenance and reconstruction, with associated costs for the Fremont County Transportation Department. Proposed Action related impacts to county roads in the Pavillion area would range from minor to moderate over the long term, depending on the level of development accessed by a particular road at a particular time.

Muddy Ridge Field

Proposed Action-related traffic to the Muddy Ridge field (12 wells/year for 4 years, 2 wells/1 year; estimated peak year AADT of 55 including 23 trucks) would use the Tunnel Hill Road, a 14.2-mile road with 4 miles of paved surface (PCI 48). The northern portion of road is gravel surface. The Wyoming Canal bridge on the Tunnel Hill Road needs to be replaced and the road needs to be realigned to the new bridge location (Pendleton, D. Fremont County Transportation Department Superintendent, personal communication, 2003). Proposed Action-related traffic to the Muddy Ridge field would accelerate deterioration and associated maintenance demand on both the Tunnel Hill Road and the Wyoming Canal bridge.

The northern segment of Tunnel Hill Road is lightly used by the few residents and grazing operators in the area and by users of Tribal lands to the north; the primary source of traffic is the Muddy Ridge field. Given the anticipated level of Proposed Action related traffic and heavy truck traffic which would be concentrated on the northern segment of this road, accelerated demand for road maintenance is likely to be moderate and long term.

A small segment of the gravel-surfaced North Muddy Road also crosses the Muddy Ridge field; it is anticipated that this road would only be lightly used by gas field traffic.

Coastal Extension Field

Proposed Action-related traffic to the Coastal Extension field (one well/year for 8 years, estimated peak year AADT of 6.2 including 2.4 trucks) would use the North Portal Road (some traffic to the other two development areas may also use the southern segment of this road), as would residents and visitors to homes, farms and recreation features in the area. This 6.9-mile road has 5 miles of paved surface with a PCI of 34 and 1.9 miles of gravel surface. The two bridges on North Portal Road have sufficiency index ratings in the 20 to 30 percent range. WYDOT is scheduled to let bids for reconstruction of these bridges in 2004, therefore it is likely that reconstruction will be complete by 2006, when the first Coastal Extension well is scheduled to be drilled under the Proposed Action. A short segment of the gravel surface North Muddy Road could also by used by gas field traffic.

The northern portion of North Portal road is lightly used by residents, grazing operators and recreation visitors. Given that only one well would be drilled annually, Proposed Action related accelerated road maintenance requirements would likely be minor and long term on this segment.

Proposed Action Development of Private and Operator Maintained Roads

Well and facility access road construction methods and standards are described in Section 2.7.2.1. The Operators estimate that each proposed new well would require an average of 0.15 miles of new or upgraded access road, for a total of approximately 49 miles of new roads. Roads that access wells on irrigated land and roads that access dry holes would be reclaimed immediately. All new roads would be classified as resource roads, providing access to a well site or several well sites from the existing county road network. Some agricultural and recreational users of the areas, particularly in the Sand Mesa, Sand Mesa South and Coastal Extension fields may also use these roads to access new areas of the development area for agricultural or recreational purposes, but this use is expected to be minimal. Resource roads would be constructed and maintained by the operators and result in no direct fiscal impact on state or county government, consequently traffic impacts on private and Operator – maintained roads would be considered minor and long term.

In a few cases, the Operators may use MID ditch roads to access well locations. Use of MID roads by the Operators would require permits from the district, which would specify the terms of use.

4.14.2.2 Proposed Action Production Traffic Impacts

Gas fields generate substantially less traffic during production than during the development phase on both a daily and an annual basis. Producing wells in the WRPA would be visited daily for monitoring and maintenance by a pumper; currently 3 to 5 pumpers operate in the WRPA and the Operators estimate that an additional pumper would be required for each 30 producing wells. Production facilities, many of which serve multiple wells, are also regularly visited by water and oil haulers. The frequency of these trips varies from field to field and facility to facility. For example, the Pavillion field generates very little oil and is visited by an oil hauler monthly; in contrast there are about 4 truckloads of oil or condensate generated each week at the Muddy Ridge field. Pumpers and oil and water haulers visit multiple wells and production facilities during the course of a work day (Griff, M. Tom Brown, Inc., personal communication, December 1, 2003).

Production supervisors, a variety of maintenance workers, roustabouts, weed control workers and others would visit the WRPA on both routine and intermittent schedules. In these cases, workers would travel to the development areas and visit a single well or in some cases multiple wells and production facilities, traveling over multiple county and Operator-maintained roads.

Periodically, wells require workovers and other downhole maintenance, resulting in multiple trips to a single well over several days. Additionally, crews working 24 hours/day, seven days/week currently maintain compressor stations and production plants. The existing compressor station and production plant crews would provide services to new facilities with small incremental increases in employment and traffic as new wells come on line and old wells cease production.

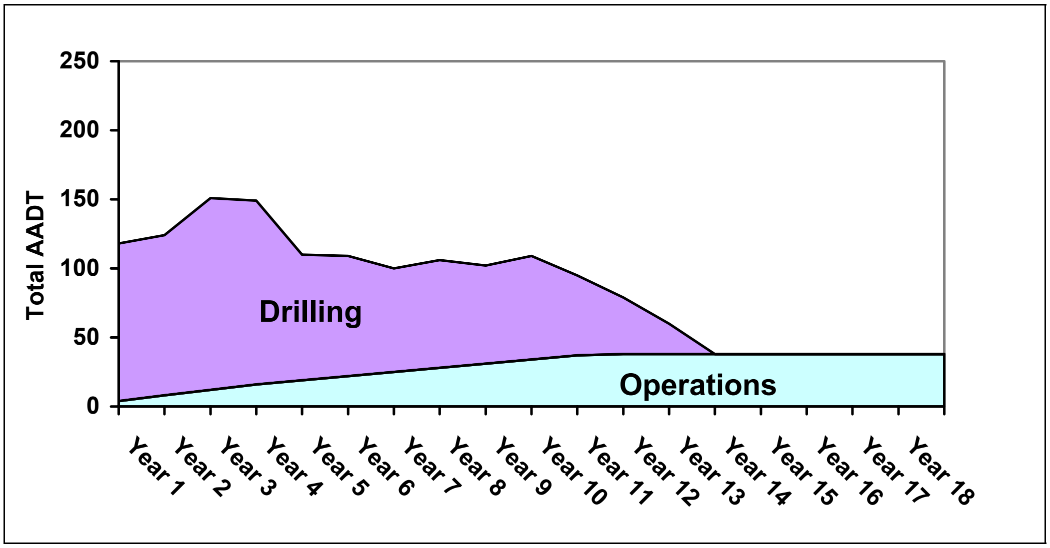
Based on estimates of travel for existing facilities, it is estimated that each well would generate an average of 0.21 AADT production-related trips to and from the WRPA and trucks would make about 58 percent of these trips. This estimate would yield an AADT of about 38, once drilling is completed

Although production related traffic to and from the WRPA would be substantially lower than during the development phase of the Proposed Action, in many cases each trip to the WRPA would involve visits to multiple wells and production facilities. Most county roads within the WRPA were not designed to accommodate high levels of heavy truck traffic. Although farmers, ranchers and MID personnel use these roads for heavy truck traffic, they typically can avoid using the road during muddy conditions. In contrast, many of the gas production trips must occur daily or weekly, regardless of conditions on county roads. During muddy conditions, use of gravel roads by heavy trucks, such as those used to haul oil and water, can result in rutting of the roadbed, requiring more frequent maintenance by the county. In addition, constant use by heavy truck traffic results in a loss of fines in the roadbed, making dust suppression and hardening agents such as magnesium chloride less effective. Although with county permission the Operators sometimes blade roads and apply water to suppress dust, the constant truck traffic associated with the production related traffic, particularly water and fuel haulers, would result in accelerated road maintenance demand for the Fremont County Transportation Department. These impacts would range from minor to moderate across the WRPA, depending on the road and the number of wells associated with a particular area.

4.14.2.3 Total Proposed Action-Related Traffic Impacts

Figure 4.14-6 displays estimates of the total incremental Proposed Action-related traffic (drilling, field development and production) for a 19-year period including five years of production after the development phase is complete.

Figure 4.14-6. Proposed Action Total AADT, Drilling, Field Development and Production: Year 1 – Year 19



As shown by Figure 4.14-6, total AADT for the Proposed Action would average about 100 for most of the development phase, except during several peak years when combined development and production-related AADT would average around 150. During the 11th year of the development phase, AADT would begin declining toward the operational level of 38.

This sustained level of traffic would result in minor, long term maintenance and safety impacts to federal and state highways, with the possible exception of WYO 134 where impacts could be moderate and long term.

The primary transportation impact would result from the sustained increases in traffic on Fremont County roads that provide access to and within the development areas and from periods of short-term intensive increases in traffic on specific roads as wells are drilled, completed and re-completed. The Fremont County roads providing access to the five development areas (Bass Lake Road, Burma Road, Eight Mile Road, North Portal Road and Tunnel Hill Road) would receive minor to moderate maintenance and safety impacts as would most of the county roads that provide access within the development areas. The Fremont County General Fund revenues accruing from ad valorem tax on production, estimated at $29 million over the 28 year assessment period, would offset the increased road maintenance costs to county government. In the case of the development phase, the county could incur increased maintenance costs before it receives incremental ad valorem revenues from new production; however, the relatively rapid pace of development would result in substantially increased revenue flows to the county shortly after the Proposed Action drilling begins. Moreover, the relatively high levels of production in early years would provide substantial revenues during the development phase, when accelerated road maintenance demand is likely to be highest. County and other revenues from production are discussed in detail in section 4.13.

Based on the foregoing assessment, Proposed Action – related traffic on county roads within the WRPA is likely to result in minor to moderate impacts, depending on the road and the level of development that would occur in a specific area at a specific time.

Impacts to private and Operator – maintained resource roads would be considered minor and long term.

4.14.3 Alternative A (485 wells) – Direct and Indirect Impacts

4.14.3.1 Drilling and Field Development

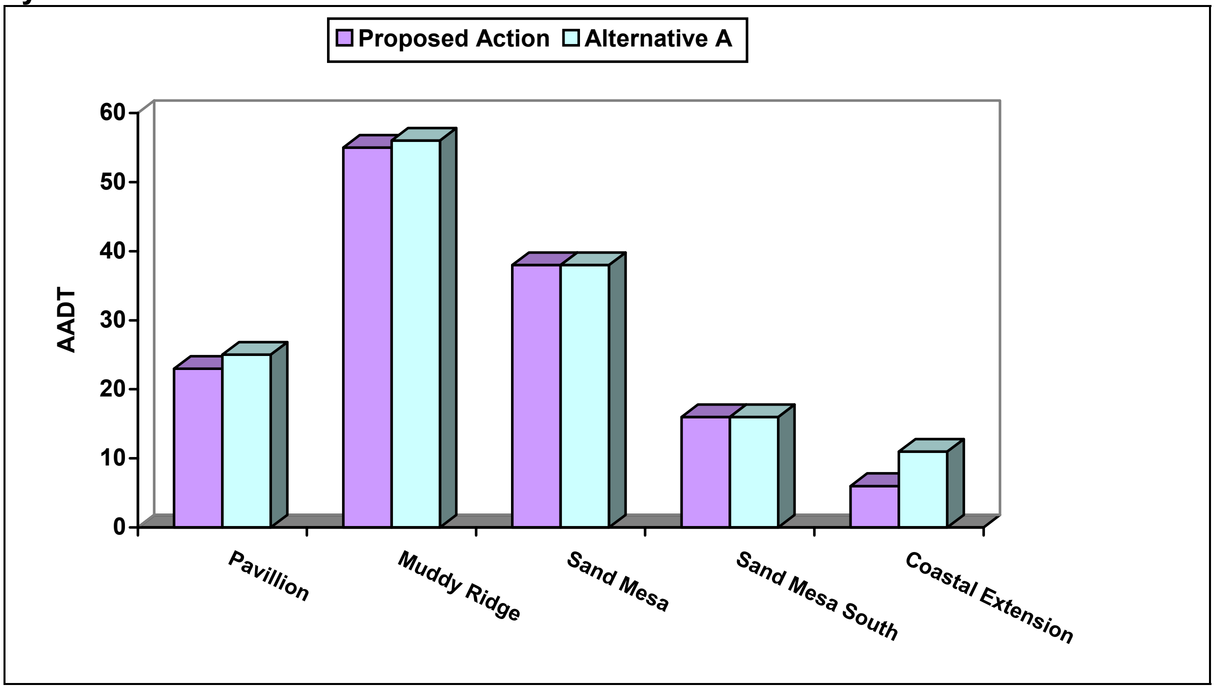
Table 4.14-4 contrasts the number of peak-year wells associated with Alternative A (39) with those associated with the Proposed Action (37). The two additional wells drilled during the peak year of Alternative A would be drilled in the Pavillion and Coastal Extension fields. Table 4.14-4 and Figure 4.14-7 contrast the estimated peak year AADT associated with these two alternatives, by field. In the case of Muddy Ridge, the slight difference in AADT is a result of traffic associated with development of a gathering system for the additional wells under this alternative.

Table 4.14-4. Peak Year Wells Drilled and Estimated AADT: Proposed Action and Alternative A, by Field

	Proposed Action		Alternative A	
	Wells	AADT	Wells	AADT
Pavillion	13[1]	23	14	25
Muddy Ridge	12	55	12	56
Sand Mesa	8	38	8	38
Sand Mesa South	3	16	3	16
Coastal Extension	1	6	2	11
TOTAL	**37**	**139**	**39**	**145**

Because the annual number of wells drilled would be similar under Alternative A and the Proposed Action, the difference in AADT between the two alternatives is also minor, a difference in AADT of 6, or 4 percent.

Figure 4.14-7. Peak Year Alternative A AADT Contrasted with Proposed Action AADT by Field.



Alternative A Traffic Effects on Federal and State Highways

Differences in the percentage increase in AADT on area highways between Alternative A and the Proposed Action would be negligible during the peak year, as shown by Table 4.14-5. Estimated Alternative A increases in AADT (including trucks) are identical at for every highway segment except for the WYO 134 junction with Burma Road and the WYO 134 junction with WYO 133, where the AADT of Alternative A is one percentage point higher than the Proposed Action on both segments.

Table 4.14-5. Comparison of Alternative A and Proposed Action Peak Year AADT Increases on Affected Highways

Highway	Segment	Alt. A Peak Year AADT	Alt. A Peak Year AADT + Adjusted 2001 AADT[1]	Percent Alt. A Peak Year AADT of Adjusted 2001 AADT	Percent Proposed Action Peak Year AADT of Adjusted 2001 AADT
US 26/789	Shoshoni west corporate limits	14	3,902	<1%	<1%
	Junction WYO 134	49	3,333	1%	1%
	Junction Burma Rd	80	4,637	2%	2%
	Riverton north corporate limits	80	8,157	1%	1%
US 26	Riverton west corporate limits	32	8,414	<1%	<1%
	Junction Eight Mile Road	32	3,554	1%	1%
WYO 134	Junction Burma Rd	32	674	5%	4%
	Midvale	69	483	14%	14%
WYO 133	Junction US 26	33	1,050	3%	3%
	Junction WYO 134	33	900	4%	3%
	Pavillion west corporate limits	9	808	1%	1%

[1]Adjusted AADT is 2001 AADT less estimated 2001 WRPA development phase AADT.

Similarly the Alternative A peak year truck AADT is within one or two percentage points of the Proposed Action, as shown in Table 4.14-6.

Table 4.14-6. Comparison of Alternative A and Proposed Action Peak Year Truck AADT Increases on Affected Highways

Highway	Segment	Alt. A Peak Year Truck AADT	Alt. A Peak Year Truck AADT + Adjusted 2001 Truck AADT	Percent Alt. A Peak Year Truck AADT of Adjusted 2001 Truck AADT	Percent Proposed Action Peak Year Truck AADT of Adjusted 2001 Truck AADT
US 26/789	Shoshoni west corporate limits	15	610	2%	2%
	Junction WYO 134	19	487	4%	4%
	Junction Burma Rd	34	544	6%	6%
	Riverton north corporate limits	34	631	5%	5%
US 26	Riverton west corporate limits	15	216	7%	6%
	Junction Eight Mile Rd	15	155	10%	9%
WYO 134	Junction Burma Rd	15	86	17%	16%
	Midvale	32	73	43%	42%
WYO 133	Junction US 26	15	88	17%	16%
	Junction WYO 134	15	48	31%	29%
	Pavillion west corporate limits	4	49	9%	8%

Given similar peak-year levels of drilling for Alternative A and the Proposed Action, peak-year transportation impacts to federal and state highways would be similar as well. The longer duration of drilling activity associated with Alternative A (see Figure 4.14-7) would result in minor, long term traffic maintenance and safety impacts, but these would be offset by the longer term and higher fuel tax payments and contributions to the state highway fund, estimated to be $6.2 million over the 28 year assessment period.

<u>Alternative A Traffic Impacts on County Roads</u>

As with federal and state highways, Alternative A peak year impacts on County Roads would be similar to those described for the Proposed Action during the peak year. However, the sustained, high levels of drilling associated with Alternative A would result in a longer duration of impacts. The Coastal Extension field would also generate additional traffic associated with the drilling of two wells/year rather than one under the Proposed Action. The substantially longer duration of drilling would result in minor to moderate long term traffic impacts including wear on county roads and the increased potential for accidents, depending on the road and level of development in a particular area. The longer term demand for county road maintenance would result in higher expenditures for the county, over time.

Alternative A Development of Private and Operator Maintained Roads

The Operators estimate that a total of approximately 74 miles of new roads would be required under Alternative A. As with the Proposed Action, these roads would be classified as resource roads, providing access to a well site or several well sites from the existing county road network. No new thoroughfares would be created and resource roads would be constructed and maintained by the operators and result in no fiscal impact on state or county government, consequently traffic impacts on private and Operator – maintained roads would be considered minor and long term.

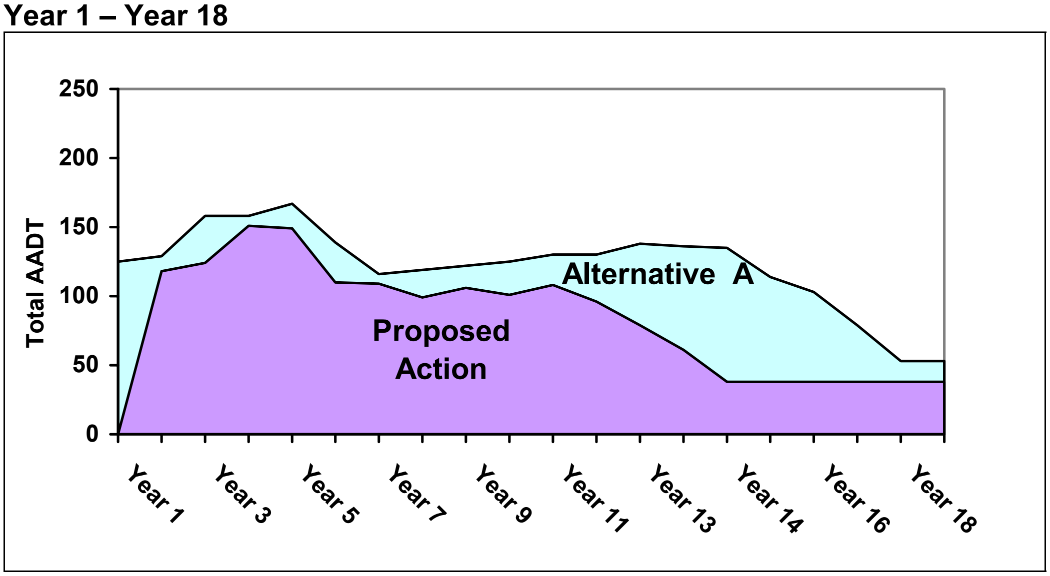
4.14.3.2 Alternative A Production Traffic Impacts

As with the Proposed Action, production-related traffic with Alternative A would increase as wells and production facilities come on line. After year 18, production traffic would level off at an estimated AADT of 53, about 39 percent higher than the Proposed Action.

4.14.3.3 Total Alternative A Traffic Impacts

Figure 4.14-8 contrasts estimates of the total incremental Alternative A -related traffic (drilling, field development and production) with that of the Proposed Action for an 18-year period including one year of production after the development phase is complete.

Figure 4.14-8. Alternative A Total AADT, Drilling, Field Development and Production: Year 1 – Year 18



As shown by the figure, AADT would be higher than the Proposed Action in every year, and remain substantially higher for five to eight years after Proposed Action AADT would begin to decline. This longer term sustained increase in AADT would result in minor, long term impacts to federal and state highway maintenance and safety conditions (with the exception of WYO 134 near Midvale, where impacts could be moderate and long term) and minor to moderate, long term impacts for county roads including accelerated deterioration and increased maintenance costs for the county. The potential for increases in accidents would remain higher for a longer period of time as well. The longer term demand for highway and county road maintenance under Alternative A would be offset by the higher fuel taxes and state severance tax payments and higher Fremont County general fund revenues on production, estimated to be $45 million over the 28 year assessment period.

Alternative A – related traffic impacts on private and Operator- maintained resource roads would be considered minor and long term.

4.14.4 Alternative B (233 wells) – Direct and Indirect Impacts

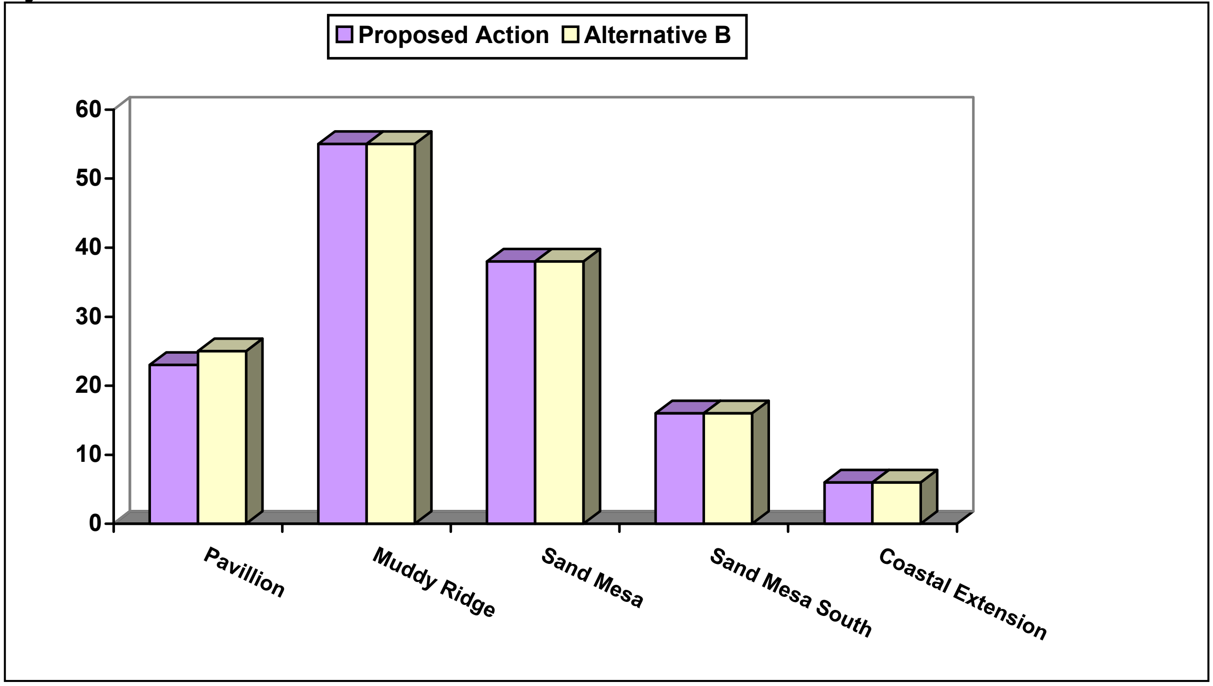
Table 4.14-7 contrasts the peak-year drilling level associated with Alternative B (38 wells) with those associated with the peak year under the Proposed Action (37 wells). During the peak year of drilling, 14 wells would be drilled in the Pavillion field under Alternative B, as compared to 13 under the Proposed Action; peak-year drilling levels would be the same in the other four development areas. However, fewer total wells (233) would be drilled under Alternative B, and the drilling period would be three years shorter (see Figure 4.14-10). As shown in Table 4.14-7 and in Figure 4.14-9, the difference in AADT between the two alternatives would be negligible during the peak year; less than one percent of total AADT during that year.

Table 4.14-7. Peak Year Wells Drilled and Estimated AADT: Alternative B and Proposed Action, by Field

	Proposed Action		Alternative B	
	Wells	AADT	Wells	AADT
Pavillion	13[1]	23	14	25
Muddy Ridge	12	55	12	55
Sand Mesa	8	38	8	38
Sand Mesa South	3	16	3	16
Coastal Extension	1	6	1	6
TOTAL	**37**	**139**	**38**	**140**

[1]13 wells would be drilled in the Pavillion field during the peak year of drilling in the WRPA under the Proposed Action although annual drilling levels in Pavillion would range from 10 to 18 and average 14 under this alternative.

Figure 4.14-9. Peak Year Alternative B AADT Contrasted with Proposed Action AADT by Field.



4.14.4.1 Development Phase Impacts

Alternative B Traffic Impacts on Federal and State Highways

Given almost identical levels of drilling, the peak-year effects on area highways would be virtually the same for Alternative B as for the Proposed Action. Table 4.14-8, peak-year percentage increases on affected highway segments are the same under Alternative A as under the Proposed Action. Alternative B fuel taxes and contributions to the State Highway Fund would be less however. Wyoming State Highway Fund contributions would be an estimated $2 million over the 28 year assessment period.

Table 4.14-8. Comparison of Peak Year Alternative B and Proposed Action AADT Increases on Affected Highways

Highway	Segment	Alt. B Peak Year AADT	Alt. B Peak Year AADT + Adjusted 2001 AADT	Percent Alt. B Peak Year AADT of Adjusted 2001 AADT	Percent Proposed Action Peak Year AADT of Adjusted 2001 AADT
US 26/789	Shoshoni west corporate limits	14	3,902	<1%	<1%
	Junction WYO 134	48	3,332	1%	1%
	Junction Burma Rd	78	4,635	2%	2%
	Riverton north corporate limits	78	8,155	1%	1%
US 26	Riverton west corporate limits	30	8,412	<1%	<1%

Table 4.14-8. (Continued)

	Junction Eight Mile Road	30	3,552	1%	1%
WYO 134	Junction Burma Rd	30	6,72	4%	4%
	Midvale	66	479	14%	14%
WYO 133	Junction US 26	31	1,048	3%	3%
	Junction WYO 134	31	898	3%	3%
	Pavillion west corporate limits	9	808	1%	1%

As shown by Table 4.14-9, there are minor differences in peak-year truck AADT between the two Alternatives on two segments, however these differences are both within one percentage point.

Table 4.14-9. Comparison of Peak Year Alternative B and Proposed Action Truck AADT Increases on Affected Highways

Highway	Segment	Alt. B Peak Year Truck AADT	Alt. B Peak Year Truck AADT + Adjusted 2001 Truck AADT	Percent Alt. B Peak Year Truck AADT of Adjusted 2001 Truck AADT	Percent Proposed Action Peak Year Truck AADT of Adjusted 2001 Truck AADT
US 26/789	Shoshoni west corporate limits	14	609	2%	2%
	Junction WYO 134	19	486	4%	4%
	Junction Burma Rd	33	543	6%	6%
	Riverton north corporate limits	33	630	5%	5%
US 26	Riverton west corporate limits	14	215	7%	6%
	Junction Eight Mile Rd	14	155	9%	9%
WYO 134	Junction Burma Rd	14	85	17%	16%
	Midvale	30	72	42%	42%
WYO 133	Junction US 26	14	88	16%	16%
	Junction WYO 134	14	48	30%	29%
	Pavillion west corporate limits	4	49	8%	8%

Alternative B Traffic Impacts on County Roads

Although peak year traffic impacts on county roads would be similar under Alternative B and the Proposed Action, long term impacts would be less because of the fewer number of wells drilled and the shorter duration of drilling. Less traffic would mean less project-related wear on county roads and bridges and a lower potential for increases in accidents.

Alternative B Development of Private and Operator Maintained Roads

The Operators estimate that a total of approximately 35 miles of new roads would be required under Alternative B. As with the Proposed Action, these roads would be classified as resource roads, no new thoroughfares would be created and resource roads would be constructed and maintained by the operators, resulting in no fiscal impact on state or county government.

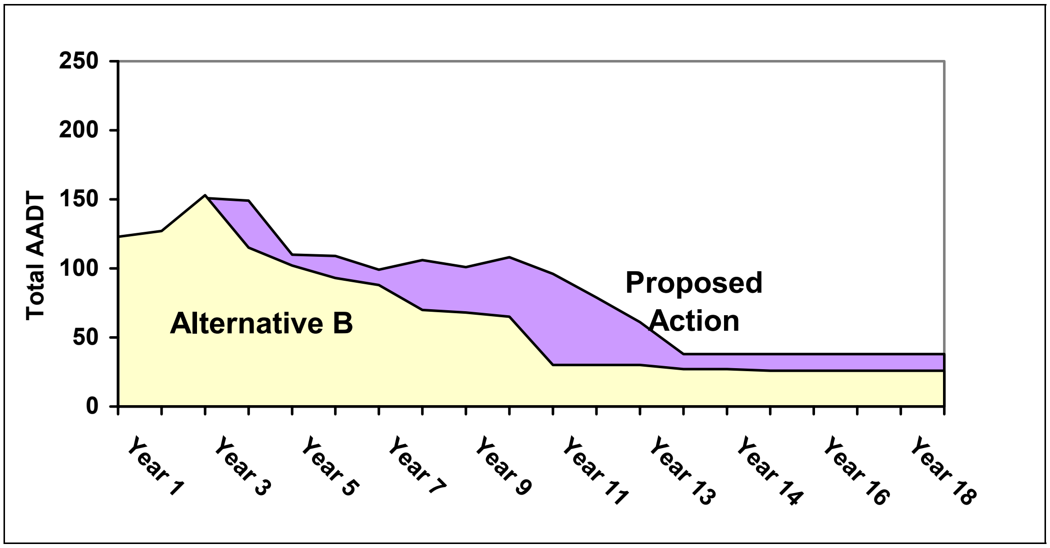
4.14.4.2 Alternative B Production-Related Traffic Impacts

During production, after the development phase is completed, Alternative B would generate an estimated AADT of 26, about 32 percent fewer total production-related trips per day than the Proposed Action.

4.14.4.3 Total Alternative B Related Traffic

Figure 4.14-10 contrasts estimated total AADT for Alternative B and the Proposed Action. Alternative B development phase AADT would begin to diminish shortly after the peak year, resulting in lower traffic levels over fewer years than the Proposed Action. This would result in lower level of maintenance impacts on area highways and county roads and lower potential for increased accidents. The lower levels of development and production under this alternative would result in correspondingly lower revenues from fuel taxes and state severance taxes and fewer ad valorem property tax revenues to the county general fund, estimated to be $9.5 million over the 28 year period. Based on the forgoing, traffic impacts of Alternative B on state and federal highway maintenance demand and safety conditions would be minor and long term. Traffic impacts on county road maintenance demand would range for minor to moderate over the long term, and impacts to private and operator maintained resources roads would be minor and long term.

Figure 4.14-10 Alternative B Total AADT, Drilling, Field Development and Production: Year 1 – Year 19



4.14.5 Alternative C (No Action) – Direct and Indirect Impacts

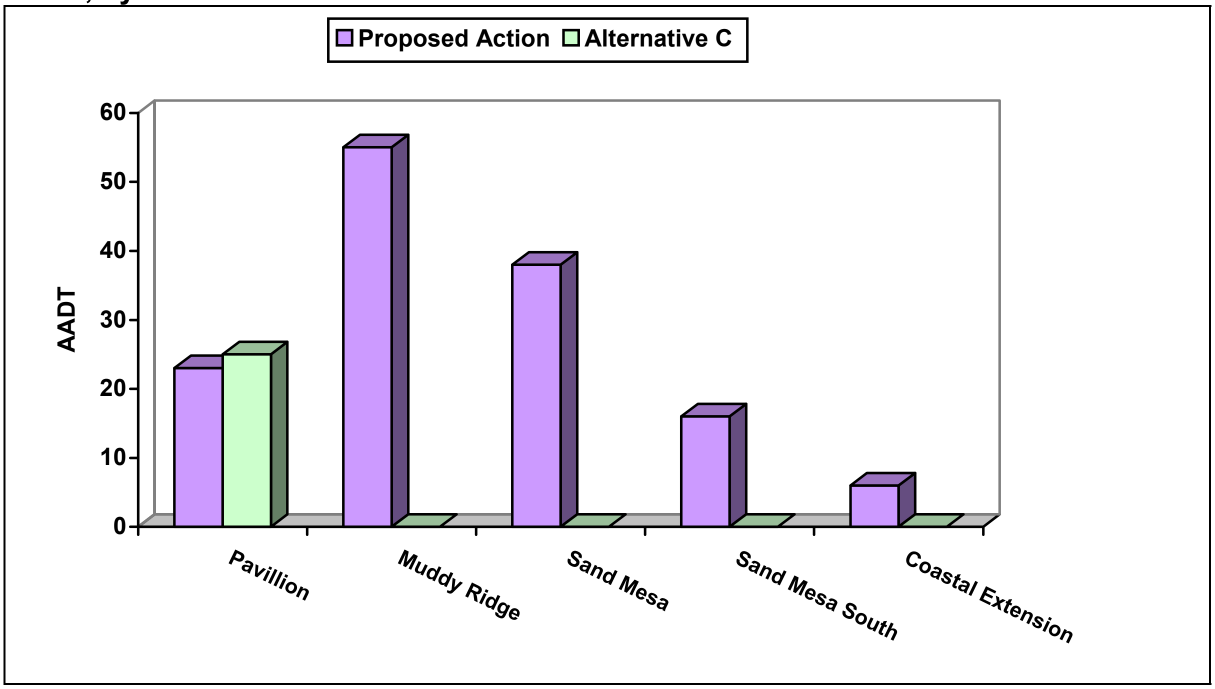
Under Alternative C (No Action) wells would only be drilled in the Pavillion field--a total of 100 over 8 years, with 14 drilled in 7 years and 2 in the final year, as shown in Table 4.14-10. The annual drilling level in the Pavillion field would be the same for Alternative C as the annual average for the Pavillion field under the Proposed Action, but actual drilling would range from 10 to 18 wells/year under the Proposed Action and last for 11 years. Table 4.14-10 and Figure 4.14-8 display the difference in AADT between the two Alternatives; Alternative C AADT would be about 18 percent of the AADT associated with the Proposed Action.

Table 4.14-10. Peak Year Wells Drilled and Estimated AADT: Alternative C and Proposed Action, by Field

	Proposed Action		Alternative C – No Action	
	Wells/Year	AADT	Wells/Year	AADT
Pavillion	13[1]	23	14	25
Muddy Ridge	12	55	0	0
Sand Mesa	8	38	0	0
Sand Mesa South	3	16	0	0
Coastal Extension	1	6	0	0
TOTAL	**37**	**139**	**14**	**25**

[1]13 wells would be drilled in the Pavillion field during the peak year of drilling in the WRPA under the Proposed Action although annual drilling levels in Pavillion would range from 10 to 18 and average 14 under this alternative.

Figure 4.14-11. Peak Year Alternative C AADT Contrasted with Proposed Action AADT, by Field



4.14.5.1 Alternative C (No Action) Development Phase Impacts

Alternative C Traffic Impacts on Federal and State Highways

Project-related increases in AADT levels on affected highways would be substantially lower under Alternative C than under the Proposed Action. The Alternative C (No Action) percentage of adjusted 2001 AADT would be one percent or less on every segment except on WYO 134 near Midvale, where it would be an estimated four percent.

Table 4.14-11. Comparison of Peak Year Alternative C (No Action) and Proposed Action AADT Increases on Affected Highways

Highway	Segment	Alt. C Peak Year AADT	Alt. C Peak Year AADT + Adjusted 2001 AADT	Percent Alt. C Peak Year AADT of Adjusted 2001 AADT	Percent Proposed Action Peak Year AADT of Adjusted 2001 AADT
US 26/789	Shoshoni west corporate limits	2	3,890	<1%	<1%
	Junction WYO 134	0	3,285	0%	1%
	Junction Burma Rd	9	4,565	<1%	2%
	Riverton north corporate limits	9	8,085	<1%	1%
US 26	Riverton west corporate limits	9	8,391	<1%	<1%
	Junction Eight Mile Road	9	3,531	<1%	1%
WYO 134	Junction Burma Rd	9	651	1%	4%
	Midvale	17	431	4%	14%
WYO 133	Junction US 26	7	1,024	1%	3%
	Junction WYO 134	7	874	1%	3%
	Pavillion west corporate limits	2	802	<1%	1%

Similarly, truck traffic associated with Alternative C would be substantially lower than the Proposed Action. Highway segments providing access to the Pavillion field, particularly WYO 134 and, to a lesser extent, WYO 133, would be the only ones noticeably affected by Alternative C. The most heavily affected segment (Midvale) would experience truck traffic estimated at about 19 percent of adjusted 2001 truck traffic, as compared to 42 percent under the Proposed Action.

Table 4.14-12. Comparison of Peak Year Alternative C (No Action) and Proposed Action Truck AADT Increases on Affected Highways

Highway	Segment	Alt. C Peak Year Truck AADT	Alt. C Peak Year Truck AADT + Adjusted 2001 Truck AADT	Percent Alt. C Peak Year Truck AADT of Adjusted 2001 Truck AADT	Percent Proposed Action Peak Year Truck AADT of Adjusted 2001 Truck AADT
US 26/789	Shoshoni west corporate limits	3	598	<1%	2%
	Junction WYO 134	0.0	468	0%	4%
	Junction Burma Rd	5	515	1%	6%
	Riverton north corporate limits	5	602	1%	5%
US 26	Riverton west corporate limits	5	206	2%	6%
	Junction Eight Mile Rd	5	145	3%	9%
WYO 134	Junction Burma Rd	5	76	6%	16%
	Midvale	10	51	19%	42%
WYO 133	Junction US 26	4	78	5%	16%
	Junction WYO 134	4	38	11%	29%
	Pavillion west corporate limits	1	46	3%	8%

Alternative C effects on federal and state highways would be negligible on every affected segment with the possible exception of WYO 134, where impacts could be minor. Fuel tax contributions would be substantially lower under Alternative C, as would contributions to the Wyoming Highway Fund, estimated to be $1.6 million over the 28 year assessment period.

Alternative C Traffic Impacts on County Roads

Alternative C would involve 35 percent fewer wells drilled in the Pavillion field than under the Proposed Action, which would result in reduced wear on county roads in that area and less potential for accidents. The southern portions of North Portal and Tunnel Hill roads would receive some traffic headed to and from the Pavillion field, and gas field traffic to serve existing production in the Muddy Ridge and Sand Mesa fields would continue. County roads providing access to the Sand Mesa and Sand Mesa South would not be affected under Alternative C. Neither would the northern portions of county roads providing access to the Muddy Ridge and Coastal Extension fields.

Alternative C Development of Private and Operator Maintained Roads

Most access roads to wells in the Pavilion field (about two thirds) would be reclaimed immediately after completion of the well. The Operators estimate that a total of approximately 5.5 miles of new roads would be required under Alternative C. As with the Proposed Action, these roads would be classified as resource roads, no new thoroughfares would be created and resource roads would be constructed and maintained by the operators resulting in no fiscal impact on state or county government.

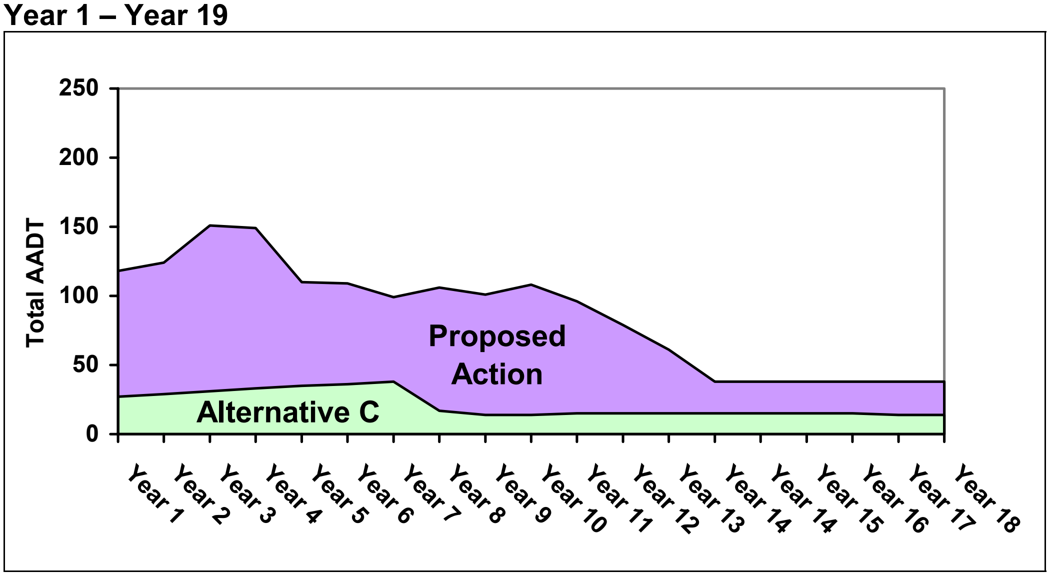
4.14.5.2 Alternative C Production Traffic Impacts

After completion of the development phase, estimated production AADT would be about 14 under Alternative C (No Action). This would be about 38 percent of Proposed Action Production AADT.

4.14.5.3 Total Alternative C Traffic Impacts

As shown by Figure 4.14-12, total Alternative C AADT would be substantially less than total AADT associated with the Proposed Action during all years.

Figure 4.14-12. Alternative C Total AADT, Drilling, Field Development and Production: Year 1 – Year 19



Traffic impacts would be substantially less under Alternative C, and would be limited to federal and state highways and county roads providing access to the Pavillion field and county roads providing access to and within the Pavillion field. Consequently, the potential for wear on county roads and increased accidents would be limited to those roads and highways, and would be less than other alternatives. Accelerated road maintenance demand would be less than other alternatives, but Alternative C contributions to the county general fund would also be less, estimated at $6 million over the 28 year assessment period.

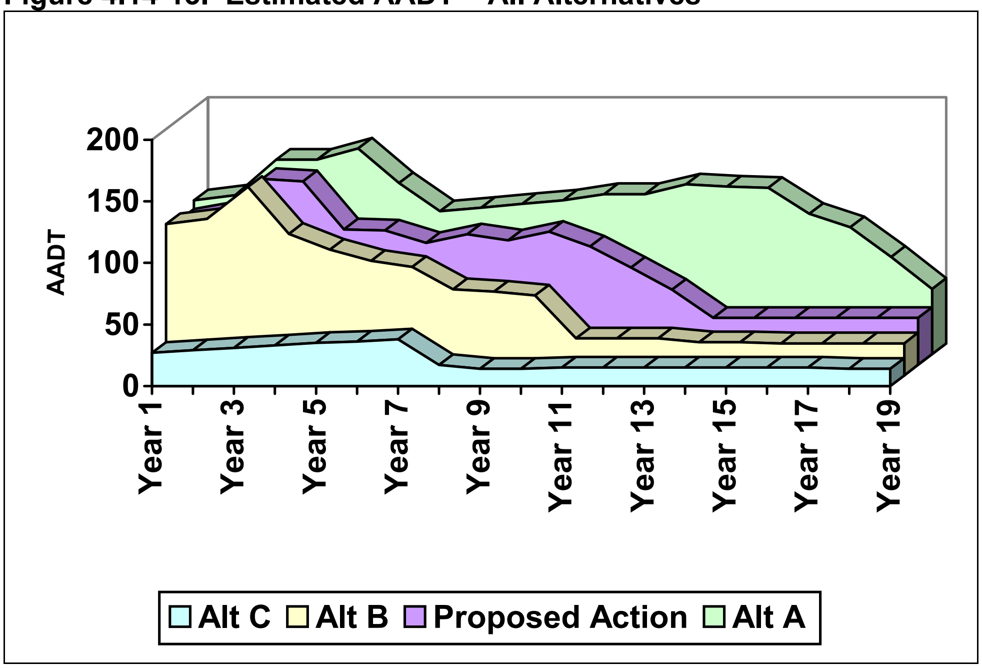
Based on the foregoing, Alternative C – related traffic impacts on federal and state highway maintenance demand and safety conditions would be negligible and long term, except for WYO 134, which would be minor and long term. Traffic impacts to county road maintenance demand would range from minor to moderate over the long term (depending on the road and level of development in a particular area) and traffic impacts to private and Operator maintained resource roads would be minor and long term.

4.14.6 Impacts Summary

Figure 4.14-3 contrasts total AADT for the four alternatives. The traffic and heavy truck traffic associated with each alternative would increase traffic levels on federal and state highways and county roads providing access to the WRPA, and on county roads providing access within the WRPA. Traffic related effects would include:

- Accelerated road maintenance demand, which would be anticipated to be negligible to minor on highways and minor to moderate (as those terms are defined for this assessment) on county roads providing access to and within the WRPA.
- Increased potential for accidents on highways and roads providing access to and within the WRPA, with more risk on highways and roads where there are higher concentrations of gas field traffic.

Figure 4.14-13. Estimated AADT – All Alternatives



Both accelerated road maintenance requirements and the potential for increased accidents would result from traffic volume. Therefore anticipated transportation impacts would increase with the number of wells developed under each alternative, so that Alternative C (No Action) would generate the fewest transportation impacts, and Alternative A would generate the highest level of transportation impacts.

Correspondingly, the revenues that would accrue to federal, state and local government (and be available to offset the costs associated with increased highway and road maintenance demand) would also increase with the number of producing wells associated with an alternative.

Resource roads would be constructed to individual wells or groups of wells under each alternative, but would be abandoned and reclaimed when not needed, according to the wishes of the surface owner. The number of resource roads increases with the number of wells drilled, but are anticipated to attract a minimal level of use by agricultural operators and a few recreation users. No new thoroughfares are planned under any alternative.

4.14.7 Additional Mitigation Measures

Implementation of the following measures would help avoid, manage and mitigate potential transportation impacts of the Proposed Action and alternatives.

- The Operators, the Shoshone and Arapaho tribes, the BIA, Fremont County, the BOR and WYDOT should form a transportation planning committee to address natural gas access and road maintenance issues. Prior to each year's drilling program, the operators would meet with the committee and present their drilling and field development program. The members of the committee would identify road maintenance issues, road and bridge sufficiency and safety issues, and preferred access routes. The committee as a whole would identify measures to avoid or minimize impacts and assign responsibilities for addressing issues. The committee would meet throughout the year as necessary.

- The Operators should require all employees and contractors to comply with all federal, state, county and reservation traffic laws and regulations.

- The Operators should routinely coordinate with the BIA, The Shoshone and Arapaho Tribes and the Fremont County Transportation Department to identify emerging road maintenance issues and hazards.

- The Operators should cooperate with the Fremont County Transportation Department to repair any extraordinary damage caused by employees or contractors.

- The operators should instruct employees and contractors to avoid use of WYO 133 and East Pavillion Road within the Town of Pavillion.

- The Operators, the BIA and the Tribes should cooperate with Fremont County to identify and pursue federal and state funds to improve roads and bridges within the WRPA.

- The Operators should limit use of roads by trucks and heavy equipment during periods when roads are muddy, to the extent possible.

4.14.8 Residual Impacts

Gas field traffic would continue for as long as wells are kept in production in the WRPA, resulting in some level of accelerated road maintenance demand. Correspondingly, severance and ad valorem tax revenues would accrue to state and local government and be available to offset maintenance costs as long as the development areas are producing.

4.15 HEALTH AND SAFETY

4.15.1 Introduction

The potential effects on human health and safety associated with implementation of any of the alternatives are addressed in this section. Potential effects to human health and safety that could be associated with additional natural gas development in the WRPA include:

- Occupational accidents that could be experienced by project workers;
- An increase in traffic hazards and accidents on public roads, as well as health effects associated with noise and air emissions from project-related vehicles and fugitive dust from roads;
- Increased hazards related to accidental ignition of wildfires;
- Pipeline hazards and potential for accidental rupture or damage of pipelines by heavy equipment; and
- Effects to health and safety related to the use of hazardous materials and accidental spills or releases of hazardous materials.

Federal regulations related to health and safety requirements for oil and gas operations are specified under 43 CFR Ch. II, subpart 3162.5 – Environmental Obligations. These regulations require the approval of a drilling and operations plan that addresses the applicable procedures to be employed for protection of environmental quality, including control and removal of wastes, spill prevention, fire prevention and fighting procedures, and safety precautions. For this analysis, it was assumed that the natural gas development operations in the WRPA would also comply with applicable tribal, state and federal regulations, including the Occupational Safety and Health Act (OSHA), the Resource Conservation and Recovery Act (RCRA), and the Superfund Amendments and Reauthorization Act (SARA) Title III.

4.15.2 Proposed Action – 325 New Wells

In general, compliance with 43 CFR Ch. II, subpart 3162.5, and other regulations related to health and safety and environmental protection would minimize risks to human health and safety. The following is a discussion of health and safety impact issues identified as concerns for the Proposed Action.

4.15.2.1 General Emergency Preparedness and Accident Prevention

In general, to reduce the risk and seriousness of accidents and injuries to workers and the public, the Operators would at a minimum develop drilling and operations plans that would cover all potential emergencies, including fires, employee injuries, and chemical releases, among others as mentioned above. The plans would include phone numbers for all medical and emergency services and the people to contact in event of emergencies. In addition, the Operators would not allow firearms to be brought into the area by employees and contractors. The emergency plans would be posted at the Operators' local offices and field facilities.

The Operators would also take measures to protect the public, livestock, and wildlife from hazards at natural gas facilities. Specifically, warning signs and fencing would be posted around facilities, as required by regulations to prevent unauthorized access and alert the public to potential hazards in the area.

4.15.2.2 Occupational Hazards

Construction, operation, and maintenance of the Proposed Action would utilize both contractors and traditional oil and gas workers to staff the project. Statistical data on occupational accidents and fatalities for the oil and gas extraction labor category are available from the U.S. Bureau of Labor Statistics. Nationwide, the oil and gas industry experienced an accident rate of 3.2 accidents per 100 full-time workers and 23.1 fatalities per 100,000 workers in 2001 (U.S. Bureau of Labor Statistics 2003). Over the life of the Proposed Action, the Operators would employ an average of 195 oil and gas workers per year. Based on this employment rate, it is statistically probable that about 6.2 occupational accidents would occur each year as a result of the Proposed Action, which would be a moderate impact. Similarly, based on the national rate for fatal accidents in the industry, there is a 4 percent chance of one fatality occurring each year as a result of the Proposed Action. The number of occupational accidents would likely be higher during the earlier years of the project where construction activity (compressors, gas plants, pipelines) and employment would be more intensive. Following the completion of all construction and drilling in the later years of the project, employment would be reduced and the number of occupational accidents is expected to decline.

OSHA, U.S. DOT, BIA BLM, and the Tribes regulate various safety aspects of the oil and gas industry. Compliance of the Operators with applicable safety regulations would greatly reduce the probability of occupational accidents for the Proposed Action. Assuming compliance by the Operators with these regulations, health and safety impacts related to occupational hazards would be below the national rate for the industry and would be characterized as minor and long term.

4.15.2.3 Increased Vehicular Traffic

Implementation of the Proposed Action would result in an increase in traffic on some of the public roads in the Project Area, along with proportionate increases in the risk of traffic accidents, fugitive dust from roads, and noise emissions from project-related vehicles.

With proper posting of speed limit signs on roads used by project-related vehicles, and/or compliance with posted speed limits on county roads, the risk of additional accidents is expected to be low and the resulting health and safety impact would be rated as minor and long term.

Project-related vehicle traffic on unpaved roads would generate fugitive dust emissions that could affect the health of area residents adjacent to these roads. To reduce these impacts, dust control on roads and project facilities would be accomplished through watering or use of magnesium chloride, resulting in negligible impacts on health and safety. Potential effects to human health and safety are unlikely to occur specifically from the use of magnesium chloride for dust suppression on natural gas-related roads. In general, one application of magnesium chloride would control dust for up to one year. Impacts to human health and safety from the use of magnesium chloride for dust control on roads associated with implementation of the Proposed Action are expected to be negligible, and long term as EPA and the State of Wyoming has approved use of this chemical on public roads, with appropriate application procedures.

Vehicle related noise could disturb local residents who live near roads serving the WRPA, but given its periodic and short-term nature, it is unlikely noise would represent a threat to the health of local residents. Proper maintenance of project-related vehicles to assure their mufflers are in proper working order and adherence to posted speed limits would reduce noise generated by passing vehicles, resulting in minor impacts.

Detailed discussions of vehicle air pollutant emissions and fugitive dust are addressed in Section 4.4 – (Air Quality). The estimated increase in daily traffic for the Proposed Action and roads potentially affected are analyzed in the Section 4.14 – (Transportation) and Noise impacts are addressed in detail in Section 4.16.

4.15.2.4 Fire Hazards

Project-related construction and operation would increase the risk of wildfires in the WRPA due to heavy equipment and production equipment operation, welding, and other activities. Since wells and other project-related equipment would be constructed on pads cleared of vegetation, the risk of wildfires and damage to property and resulting impact on health and safety would generally be minor and short term. To mitigate this risk of accidental ignition of wildfires, fire suppression equipment would be available during construction and maintained on-site at various facilities. In addition, implementation of a "no smoking" policy, shut down devices on gas handling equipment, and adequate training typically incorporated into natural gas production projects would minimize the risk of fire to negligible levels.

Since gas wells and facilities are always located a safe distance from residences and other public facilities, the risk to property from fires moving off-site would be limited to range fires that would have a low probability of affecting homes or other structures. Welding along pipelines has the potential for igniting grass or brushfires. Given the limited extent of public use and number of residences in and immediately adjacent to the WRPA, the risk to the public from potential wildfires would be negligible.

4.15.2.5 Pipeline Hazards

Additional natural gas development may increase the potential for leaks or ruptures of gas pipelines. Most ruptures occur when heavy equipment accidentally strikes the pipeline while operating in close proximity. These ruptures may result in a fire or explosion if a spark or open flame ignites the escaping gas.

Approximately 140 miles of new pipeline would be associated with the Proposed Action. Based on a statistical average of one safety incident per year per 4,035 miles of total pipeline (OPS 2003), less than one additional pipeline safety incident (including ruptures) is statistically probable over the entire life of the project. Accordingly, given the relatively low risk of potential pipeline accidents in the WRPA and its relatively rural character, the risk to public health and safety from the Proposed Action is minor and long term.

To minimize the risk of pipeline failure, materials used in the pipelines would be designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers would be posted at frequent intervals along the pipelines, including road crossings and other areas likely to be disturbed by construction activity to warn excavators and to reduce the risk of accidental rupture. The Operators would also monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses were detected, the wells would be shut in until the problem is isolated and addressed.

4.15.2.6 Use of Hazardous Materials, Pesticides, and Accidental Spills and Releases of Hazardous Substances

The drilling of natural gas wells, construction of gas facilities, and gas production require the use and storage of various chemicals and compounds that are regulated hazardous materials. Natural gas, natural gas liquids or condensates, and produced water could all contain regulated hazardous substances, such as benzene, hexane, various polynuclear aromatic hydrocarbons (PAHs), heavy metals, and other compounds. Construction and drilling equipment would require gasoline and diesel fuels, lubricants, and coolant to operate. Drilling and fracturing fluids, which include some hazardous additives or constituents, would also be required by the Proposed Action. Additional hazardous materials that are used for natural gas development include sodium hydroxide and buffers (to regulate the pH of the drilling mud), acids for well stimulation, and surfactants (soap-like materials to remove carbon dioxide during gas processing), inert gases (not toxic, flammable, or explosive), and welding and cutting materials. Other than the minimal amounts of herbicides that are used to control noxious weeds, pesticides are not generally used for natural gas development.

Disposal of some quantities of crude oil or condensate typically involves the sale of these wastes to a waste oil recycler. Contaminated soils are generally disposed of in an approved landfill used for non-hazardous wastes or are treated on site (through land farming or aeration) if permitted by the local regulatory agencies.

Table 4.15-1 identifies the general types of wastes generated during each phase of typical oil and gas operations. Appendix E – Hazardous Materials Management Plan - provides a detailed description of hazardous and extremely hazardous materials that would be produced, used, stored, transported, and disposed of as a result of the Proposed Action.

Table 4.15-1: Waste Generation during Various Phases of Oil and Gas Development.

Project Phase	Process Waste Water	Residual Wastes Generated
Well Development	Drilling muds, organic acids, alkalis, diesel oil, crankcase oils, acidic stimulation fluids (hydrochloric and hydrofluoric acids)	drill cuttings (some oil-coated), drilling mud solids, weighting agents, dispersants, corrosion inhibitors, surfactants, flocculating agents, concrete, casing, paraffins
Production	Produced water possibly containing heavy metals, radionuclides, dissolved solids, oxygen-demanding organic compounds, and high levels of salts. Also may contain additives including biocides, lubricants, corrosion inhibitors, wastewater containing glycol, amines, salts, and untreatable emulsions	Produced sand, elemental sulfur, spent catalysts, separator sludge, tank bottoms, used filters, sanitary wastes
Maintenance	Completion fluid, wastewater containing well-cleaning solvents (detergents and degreasers), paint, stimulation agents	Pipe scale, waste paints, paraffins, cement, sand
Abandoned Wells, Spills and Blowouts	Escaping oil and brine	Contaminated soils, sorbents

Source: EPA 2000.

Federal and WOGCC regulations address the transport, storage, and disposal of hazardous materials or wastes. Assuming that the operators comply with the regulations, these rules would minimize the potential for spills or contamination of surface drainages or groundwater or releases of air emissions. Regulations for handling, storage, and disposal of hazardous materials are codified at 49 CFR Parts 171 and 179. EPA requires a Spill Prevention Control and Countermeasures Plan (SPCC) under 40 CFR Part 112 for storage of large quantities of petroleum products, such as fuels. Oil spills must be reported to the EPA National Response Center as required by 40 CFR Part 110. Federal and state operating and reporting requirements include provisions to clean up and mitigate spills or releases of chemicals, product, or wastes.

Human health and safety would likely be protected through compliance by the Operators with all applicable federal and state laws concerning safe operation of natural gas facilities. In addition, as mentioned previously, the Operators would develop emergency response plans and employee-training programs that address spill prevention and control measures for hazardous materials and wastes. Accordingly, impacts to human health and safety from hazardous materials, pesticides, and wastes typically associated with natural gas development are expected to be negligible.

4.15.3 Alternative A – Increase the Number of Wells to 485

The implementation of Alternative A would result in health and safety impacts similar in magnitude to those described for the Proposed Action, including risks of occupational accidents, traffic-related hazards, hazards related to accidental ignition of wildfires, pipeline hazards, and risks associated with hazardous materials. Since Alternative A would generally increase the duration of construction well drilling activity and only modestly increase the number of wells that would be drilled in a given year, the level of potential impacts to human health and safety would only slightly increase over those described for the Proposed Action and be minor and long term.

In general, compliance with 43 CFR Ch. II, subpart 3162.5, and other regulations related to health and safety and environmental protection would minimize risks to human health and safety. The following is a discussion of health and safety impact issues associated with Alternative A. As described for the Proposed Action, the Operators would develop plans that would cover all potential emergencies, including fires, employee injuries, and chemical releases to reduce the risk and seriousness of accidents and injuries to workers and the public. In addition, warning signs and fencing would be installed around facilities, as required by regulations to prevent unauthorized access and alert the public to potential hazards in the area.

4.15.3.1 Occupational Hazards

Over the life of Alternative A, the Operators would employ an average of 226 oil and gas workers per year. Based on this employment rate, it is statistically probable that about 7.2 occupational accidents would occur each year as a result of Alternative A, which would be a minor, long term impact. Similarly, based on the national rate for fatal accidents in the industry, there is a 5 percent chance of one occupational fatality per year as a result of Alternative A.

OSHA, U.S. DOT, BIA, BLM and the Tribes regulate various safety aspects of the oil and gas industry. Compliance of the Operators and their contractors with applicable safety regulations would greatly reduce the probability of occupational accidents and fatalities for Alternative A.

4.15.3.2 Increased Vehicular Traffic

Implementation of Alternative A would result in an increase in traffic on some of the public roads in the Project Area, along with proportionate increases in traffic, noise and air emissions from project-related vehicles. These potential impacts are addressed in detail in Sections 4.14, 4.16, and 4.4 respectively. Assuming proper posting of speed limit signs on roads used by project-related vehicles, and compliance with those posted speed limits, the risk of additional accidents is expected to be low. Accordingly, the potential impact to human health and safety associated with additional project-related traffic is rated as minor and long term.

Project-related vehicle traffic on unpaved roads would generate fugitive dust emissions that could affect the health of area residents adjacent to these roads. To reduce these impacts, dust control on roads and project facilities would be accomplished through watering or use of magnesium chloride, resulting in negligible impacts on health and safety. Potential effects to human health and safety are unlikely to occur from the use of magnesium chloride for dust suppression on natural gas-related roads. Impacts to human health and safety from the use of magnesium chloride for dust control on roads associated with implementation of Alternative A are expected to be negligible as EPA and the State of Wyoming has approved use of this chemical on public roads, with appropriate application procedures.

Vehicle related noise could disturb local residents who live near roads serving the Project Area, but given its periodic and short-term nature, it is unlikely noise would represent a threat to the health of local residents. Proper maintenance of project-related vehicles to assure their mufflers are in proper working order and adherence to posted speed limits would reduce noise generated by passing vehicles, resulting in minor impacts.

4.15.3.3 Fire Hazards

Project-related construction and operation would increase the risk of fires in the WRPA due to heavy equipment and production equipment operation, welding, and other activities. Since wells and other project-related equipment would be constructed on pads cleared of vegetation, the risk of wildfires and damage to property would generally be low. Fire suppression equipment that would be available during construction and maintained on-site at various facilities, combined with a “no smoking” policy, shut down devices on gas handling equipment, and adequate training typically incorporated into natural gas production projects would minimize the risk of fire to negligible levels.

4.15.3.4 Pipeline Hazards

Additional natural gas development under Alternative A may increase the potential for leaks or ruptures of gas pipelines, which could result in fires or explosions. Materials used in the pipelines would be designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers would be posted at frequent intervals along the pipelines, including road crossings and other areas likely to be disturbed by construction activity to warn excavators and to reduce the risk of accidental rupture. The Operators would also monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses were detected, the wells would be shut in until the problem is isolated and addressed.

Approximately 322 miles of new pipeline would be associated with Alternative A. Based on a statistical average of one safety incident per year per 4,035 miles of total pipeline (OPS 2003), less than one additional pipeline safety incident (including ruptures) is statistically probable over the entire life of the project. Accordingly, given the relatively low risk of potential pipeline accidents in the WRPA and its relatively rural character, the risk to public health and safety from Alternative A is minor and long term.

4.15.3.5 Use of Hazardous Materials, Pesticides, and Accidental Spills and Releases of Hazardous Substances

The drilling of natural gas wells, construction of gas facilities, and gas production require the use and storage of various hazardous materials. Natural gas, natural gas liquids or condensates, and produced water could all contain regulated hazardous substances, such as benzene, hexane, various polynuclear aromatic hydrocarbons (PAHs), heavy metals, and other compounds. Construction and drilling equipment would require gasoline and diesel fuels, lubricants, and coolant to operate. Drilling and fracturing fluids, which include some hazardous additives or constituents, would also be required by the project. Assuming that the Operators comply with applicable hazardous materials rules and regulations, the potential for spills or contamination and related impacts to human health and safety would be minimized.

Human health and safety would likely be protected by the Operators’ compliance with all applicable federal and state laws concerning safe operation of natural gas facilities. In addition, as mentioned previously, the Operators would develop emergency plans and employee-training programs that address spill prevention and control measures for hazardous materials and wastes. Accordingly, impacts to human health and safety from hazardous materials, pesticides, and wastes typically associated with natural gas development are expected to be negligible and long term for Alternative A.

4.15.4 Alternative B – Decrease the Number of Wells to 233

Under implementation of Alternative B, fewer wells would be drilled, fewer well pads, pipelines, and roads would be constructed, and the total number of natural gas facilities would be lower. In terms of potential health and safety impacts, the primary difference when compared with the Proposed Action would be the shortened duration of impacts as the drilling program would be completed in 10 years as opposed to 13 years for the Proposed Action. During that shorter drilling period, the magnitude of impacts would be comparable to those described for the Proposed Action as the annual number of wells drilled and employment would be very similar.

4.15.4.1 Occupational Hazards

Over the life of Alternative B, the Operators would employ an average of 197 oil and gas workers per year. Based on this employment rate, it is statistically probable that about 6.3 occupational accidents would occur each year as a result of Alternative B, which would be a minor, long-term impact. Similarly, based on the national rate for fatal accidents in the industry, there is a 5 percent chance of one fatality occurring each year as a result of Alternative B.

OSHA, the USDOT, and the WOGCC regulate various safety aspects of the oil and gas industry. Compliance of the Operators and their contractors with applicable safety regulations would greatly reduce the probability of occupational accidents for Alternative B.

4.15.4.2 Increased Vehicular Traffic

Implementation of Alternative B may result in an increase in traffic relative to current conditions for some of the public roads in the WRPA, along with proportionate increases in traffic, noise and air emissions from project-related vehicles. These potential impacts are addressed in detail in Sections 4.14, 4.16, and 4.4 respectively. Assuming proper posting of speed limit signs on roads used by project-related vehicles, and compliance with those posted speed limits, the risk of additional accidents is expected to be low. Accordingly, the potential impact to human health and safety associated with additional project-related traffic under Alternative B is rated as minor and long term.

Project-related vehicle traffic on unpaved roads would generate fugitive dust emissions that could affect the health of area residents adjacent to these roads. To reduce these impacts, dust control on roads and project facilities would be accomplished through watering or use of magnesium chloride, resulting in negligible impacts on health and safety. Potential effects to human health and safety are unlikely to occur from the use of magnesium chloride for dust suppression on natural gas-related roads. Impacts to human health and safety from the use of magnesium chloride for dust control on roads associated with implementation of Alternative B are expected to be negligible as EPA and the State of Wyoming has approved use of this chemical on public roads, with appropriate application procedures.

Vehicle related noise could disturb local residents who live near roads serving the Project Area, but given its periodic and short-term nature, it is unlikely noise would represent a threat to the health of local residents. Proper maintenance of project-related vehicles to assure their mufflers are in proper working order and adherence to posted speed limits would reduce noise generated by passing vehicles, resulting in minor impacts.

4.15.4.3 Fire Hazards

Project-related construction and operation would increase the risk of fires in the WRPA due to heavy equipment and production equipment operation, welding, and other activities. Fire suppression equipment that would be available during construction and maintained on-site at various facilities, combined with a “no smoking” policy, shut down devices on gas handling equipment, and adequate training typically incorporated into natural gas production projects would minimize the risk of fire to negligible levels.

4.15.4.4 Pipeline Hazards

Natural gas development under Alternative B may increase the potential for leaks or ruptures of gas pipelines, which could result in fires or explosions. Materials used in the pipelines would be designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers would be posted at frequent intervals along the pipelines, including road crossings and other areas likely to be disturbed by construction activity to warn excavators and to reduce the risk of accidental rupture. The Operators would also monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses were detected, the wells would be shut in until the problem is isolated and addressed.

Approximately 109 miles of new pipeline would be associated with Alternative B. Based on a statistical average of one safety incident per year per 4,035 miles of total pipeline (OPS 2003), less than one additional pipeline safety incident (including ruptures) is statistically probable over the entire life of the project. Accordingly, given the relatively low risk of potential pipeline accidents in the WRPA and its relatively rural character, the risk to public health and safety from Alternative B is minor and long term.

4.15.4.5 Use of Hazardous Materials, Pesticides, and Accidental Spills and Releases of Hazardous Substances

The drilling of natural gas wells, construction of gas facilities, and gas production require the use and storage of various regulated hazardous materials. Natural gas, natural gas liquids or condensates, and produced water could all contain regulated hazardous substances, such as benzene, hexane, various polynuclear aromatic hydrocarbons (PAHs), heavy metals, and other compounds. Construction and drilling equipment would require gasoline and diesel fuels, lubricants, and coolant to operate. Drilling and fracturing fluids, which include some hazardous additives or constituents, would also be required by Alternative B. Assuming that the Operators comply with applicable hazardous materials rules and regulations, the potential for spills or contamination and related impacts to human health and safety would be minimized.

Human health and safety would likely be protected by the Operators' compliance with all applicable federal and state laws concerning safe operation of natural gas facilities. In addition, as mentioned previously, the Operators would develop emergency plans and employee-training programs that address spill prevention and control measures for hazardous materials and wastes. Accordingly, impacts to human health and safety from hazardous materials, pesticides, and wastes typically associated with natural gas development are expected to be negligible for Alternative B.

4.15.5 Alternative C (100 wells) – No Action

Under implementation of Alternative C, fewer wells would be drilled; fewer well pads, pipelines, and roads would be constructed, all in the Pavillion Field exclusively. Not only would geographic area and roads affected be smaller than described for the other alternatives, the duration of potential health and safety impacts would be shortest due to the 8-year drilling program. During that shorter drilling period, the magnitude of impacts would be less than those described for the Proposed Action as the annual number of wells drilled and employment would be considerably smaller.

4.15.5.1 Occupational Hazards

Over the life of Alternative C, the Operators would employ an average of just 31 oil and gas workers per year. Based on this employment rate, it is statistically probable that about one occupational accident would occur each year as a result of Alternative C which would be a negligible, long-term impact. Similarly, based on the national rate for fatal accidents in the industry, there is a 1 percent chance of one fatality occurring each year as a result of Alternative C.

OSHA, U.S. DOT, BIA, BLM and the Tribes regulate various safety aspects of the oil and gas industry. Compliance of the Operators and their contractors with applicable safety regulations would greatly reduce the probability of occupational accidents for Alternative C.

4.15.5.2 Increased Vehicular Traffic

Implementation of Alternative C would generate vehicle traffic on roads serving the Pavillion Field, resulting in traffic, noise and air emissions from project-related vehicles. These potential impacts are addressed in detail in Sections 4.14, 4.16, and 4.4 respectively. Assuming proper posting of speed limit signs on roads used by project-related vehicles, and compliance with those posted speed limits, the risk of additional accidents is expected to be low.

Project-related vehicle traffic on unpaved roads would generate fugitive dust emissions that could affect the health of area residents adjacent to these roads. To reduce these impacts, dust control on roads and project facilities would be accomplished through watering or use of magnesium chloride. Potential effects to human health and safety are unlikely to occur from the use of magnesium chloride for dust suppression on natural gas-related roads. Impacts to human health and safety from the use of magnesium chloride for dust control on roads associated with implementation of Alternative C are expected to be unlikely as EPA and the State of Wyoming has approved use of this chemical on public roads, with appropriate application procedures.

Vehicle related noise could disturb local residents who live near roads serving the Pavillion Field, but given its periodic and short-term nature, it is unlikely noise would represent a threat to the health of local residents. Proper maintenance of project-related vehicles to assure their mufflers are in proper working order and adherence to posted speed limits would reduce noise generated by passing vehicles, resulting in minor impacts.

4.15.5.3 Fire Hazards

Project-related construction and operation would increase the risk of fires in the Pavillion Field due to heavy equipment and production equipment operation, welding, and other activities. Fire suppression equipment that would be available during construction and maintained on-site at various facilities, combined with a "no smoking" policy, shut down devices on gas handling equipment, and adequate training typically incorporated into natural gas production projects would minimize the risk of fire to negligible levels.

4.15.5.4 Pipeline Hazards

Natural gas development under Alternative C may increase the potential for leaks or ruptures of gas pipelines, which could result in fires or explosions in and around the Pavillion Field. Materials used in the pipelines would be designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers would be posted at frequent intervals along the pipelines, including road crossings and other areas likely to be disturbed by construction activity to warn excavators and to reduce the risk of accidental rupture. The Operators would also monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses were detected, the wells would be shut in until the problem is isolated and addressed. Accordingly, given the relatively low risk of potential pipeline accidents in the WRPA and its relatively rural character, the risk to public health and safety from Alternative C is negligible and long term.

4.15.5.5 Use of Hazardous Materials, Pesticides, and Accidental Spills and Releases of Hazardous Substances

The drilling of natural gas wells, construction of gas facilities, and gas production require the use and storage of various materials that would be characterized as hazardous. Natural gas, natural gas liquids or condensates, and produced water could all contain regulated hazardous substances, such as benzene, hexane, various polynuclear aromatic hydrocarbons (PAHs), heavy metals, and other compounds. Construction and drilling equipment would require gasoline and diesel fuels, lubricants, and coolant to operate. Drilling and fracturing fluids, which include some hazardous additives or constituents, would also be required by Alternative C. Assuming that the Operators comply with applicable hazardous materials rules and regulations, the potential for spills or contamination and related impacts to human health and safety would be minimized.

Human health and safety would likely be protected by the Operators' compliance with all applicable federal and state laws concerning safe operation of natural gas facilities. In addition, as mentioned previously, the Operators would develop emergency plans and employee-training programs that address spill prevention and control measures for hazardous materials and wastes. Accordingly, impacts to human health and safety from hazardous materials, pesticides, and wastes typically associated with natural gas development are expected to be negligible for Alternative C.

4.15.6 Impacts Summary

For the Proposed Action and each of the project alternatives, there is the potential for the following impacts to human health and safety to occur:

- Increased occupational hazards, accidents, and possibly fatalities to project workers.
- Increased vehicle traffic and related hazards associated with accidents, dust, and noise emissions.
- Increased fire hazards.
- Increased pipeline hazards.
- Impacts related to the use of hazardous materials and pesticides, and accidental spills and releases of hazardous materials and wastes.

All of the project alternatives would generate these types of impacts. Since Alternatives A and B would result in comparable levels of construction and drilling activity during their active lives, but simply vary the duration of the activities, the magnitudes of potential health and safety impacts would be similar to the Proposed Action. For Alternative C, since both the magnitude of construction and drilling activities and the geographic area to be developed are much smaller than the other alternatives, the associated health and safety impact related to occupational hazards is likely to be lower than for the Proposed Action and Alternatives A and B.

4.15.7 Additional Mitigation Measures

As part of this analysis, two additional mitigation measures beyond those identified in Chapter 2, Section 2.8 were identified to avoid, reduce, or minimize adverse effects to human health and safety:

- All employees and subcontractors would be trained in matters concerning potential emergencies and plans addressing them including fire prevention, reporting and response; employee injuries and first aid; general emergency response; and spill prevention and response for chemical spills and releases when they are hired. Refresher courses would be presented annually.
- To minimize the risks of fires and their severity, suppression equipment (fire extinguishers, fire water and hoses) would be available during construction and maintained on-site at various facilities. A “no smoking” policy, shut down devices on gas handling equipment, and adequate fire response training would also be incorporated into natural gas production operations to reduce the risk and severity of fires.

4.15.8 Residual Impacts

Even with the application of mitigation measures identified above, inherent risks associated with natural gas development and production will result in an increase in potential risks to human health and safety related to occupational accidents, traffic-related accidents and hazards, wildfires, pipeline ruptures and accidents, and hazardous materials-related spills or accidental releases. Because these impacts all involve an element of human error which can never be completely eliminated, potential impacts to human health and safety can not be completely mitigated for any of the project alternatives.

4.16 NOISE

The EPA established an average 55 dBA noise level as a guideline for acceptable environmental noise (EPA 1974). This established EPA environmental noise level is used for a basis of evaluating noise effects when no other local, county, or state standard has been established. It is important to note that this noise level was defined by scientific consensus, was developed without concern for economic and technological feasibility, and contained a margin of safety to ensure its protective value of the public health and welfare. Additionally, this noise level is directed at sensitive receptors (residences, schools, medical facilities, certain recreational areas) where people would be exposed to an average noise level over a specific period of time. Finally, this noise level represents an average noise level over a period of time, e.g., 24 hours. Higher intermittent and short-term noise levels, e.g., a heavy truck passing a location, could occur during the period of time. However, the short-term higher noise levels would be balanced by lower noise during most of the period of time.

The context of public health and welfare includes personal comfort and well-being, and the absence of mental anguish, disturbances, and annoyance as well as the absence of clinical symptoms such as hearing loss or demonstrable physiological injury. Therefore, a 55 dBA noise level should not be misconstrued as a regulatory goal. Rather, the 55 dBA noise level should be recognized as a level below which there is no reason to suspect that the public health and welfare of the general population would be at risk from any of the identified effects of noise.

Noise regulatory standards have not been established by the Tribe, Fremont County, or the State of Wyoming. Therefore, a 55 dBA noise level is considered as a reasonable average level that WRPA noise sources could produce without an adverse effect to the general public.

Noise from an individual source is the greatest in the immediate vicinity. Noise decreases with increasing distance from a source. Noise levels at a given distance from a source can be estimated using the Inverse Square Law of Noise Propagation (Harris 1991). Essentially, this law states that noise decreases by 6 dBA with every doubling of distance from a source. For example, if the noise at 50 feet from an industrial engine is 70 dBA, the noise at 100 feet will be 64 dBA, and 58 dBA at 200 feet. This method for estimating noise is:

$$L_2 = L_1 - 20 \times \text{LOG}(R_2/R_1)$$

Where:

L_2 = noise predicted at a selected distance R_2 from the source
L_1 = noise measured at a distance R_1 from the source
LOG = common logarithm base 10

4.16.1 Proposed Action (325 wells) – Direct and Indirect Impacts

Noise above existing WRPA levels would occur during construction, drilling, completion, and operation of natural gas facilities. Elevated noise from construction of well pads and roads, drilling, and completion activities would occur for short time periods (5 to 60 days) at any given location. The impact would be moderate and short term. After construction activities, noise increases from natural gas extraction activities would occur for the LOP near permanent facilities such as compressor stations. Short-term noise increases would be associated with increased truck traffic along access roads and maintenance activities such as workovers at wells.

4.16.1.1 Construction Noise Impacts

Construction noise levels would be moderate but short-term at any given location. Based on an average construction site noise level of 85 dBA at 50 feet from the site, the noise would be above 55 dBA within 1,500 feet of the site. Additionally, elevated noise levels would occur along access roads as vehicles and heavy equipment would travel to each site. Construction noise effects would be the greatest in the Pavillion Field because most residences are in and near the Pavillion Field. However, elevated noise levels would occur for a periods of less than a week at any location and would occur only during daytime because construction would not generally occur between sunset and sunrise.

Noise impacts from drilling activities would be moderate and would last longer than construction activities at any one location. Based on a measured noise level of 50 dBA at ¼ mile (1,320 feet) from a drill rig, the noise would be above 55 dBA within 800 feet of a drill rig. However, drilling noise would occur continuously for 24 hours per days and would last 7-10 days in the Pavillion Field, 60 days in the Muddy Ridge Field, and up to 50 days in the Sand Mesa, Sand Mesa South, and Coastal Extension Fields. Nearby residences within the Pavillion Field could experience elevated noise levels 24 hours per day for the shortest period at any location. Additionally, the Proponents expect that only one rig will operate at any time in the Pavillion Field. Although drilling would occur for longer periods in the other development areas, no residential areas would be near these drilling locations.

The highest noise levels, but much shorter in duration, would occur during venting of gas for a maximum of 24 hours until the well is capped prior to connection to the gathering pipeline system. Venting noise has been measured as 66 dBA at 500 feet. Noise from the venting would be above 55 dBA at distances out to 1,800 feet from the well. However, these elevated noise levels would last for a maximum of one day. Similar to the drilling noise, these noise levels would mostly affect residences at any one location for a day in the Pavillion Field. Although venting noise would occur in the other development areas, no residential areas are located near well locations.

4.16.1.2 Operational Noise Impacts

After construction, drilling, and completion activities, the main operational noise would occur near compressor stations. Noise impacts would be major near compressor stations and minor along access roads. Additional noise sources would include truck traffic and periodic maintenance and operational checks at well sites.

The highest operational noise would occur continuously near compressor stations. Reciprocating engines rated at approximately 1,700 horsepower would be installed to facilitate transmission of natural gas to high-pressure transmission pipelines. Typically, one to six of the larger engines would be installed at any location. Six engines would be installed at the proposed Sand Mesa site to achieve a total capacity of 10,300 horsepower. Two or three engines would be installed at the other proposed sites including two new engines to achieve an increase of 3,300 horsepower at the Pavillion South proposed compressor site.

Noise has been measured at typical compressor units (USGS 1981). A noise level of 77 dBA from one large compressor engine can be expected at 50 feet from a compressor building. This noise level includes the attenuation effects of enclosing compressor engines in buildings to afford protection from the effects of the harsh Wyoming winter weather.

The effect of multiple noise sources is not arithmetically additive, but rather is a

logarithmic summation. The total effect of multiple collocated noise sources is characterized by the following relationship (Harris 1991):

$L = 10 * LOG (10L_1/10 + 10L_2/10 + ... + 10L_n/10)$

where: L_1, L_2, ..., L_n are the source sound levels of individual collocated sources.

L is the overall noise level.
LOG is the common logarithm base 10.

The preceding equation is used to estimate the overall source noise from WRPA compressor stations. Table shows the predicted noise near WRPA compressor stations at 100-foot increments out to 2,000 feet. As shown in Table 4.16-1, noise levels are predicted to exceed 55 dBA:

- Out to 1,600 feet from the 6-engine Sand Mesa compressor station,
- Out to 1,100 feet from the Muddy Ridge and Sand Mesa South 3-engine compressor stations,
- Out to 900 feet from the 2-engine Pavillion South compressor station, and
- Out to 700 feet from the single engine Hidden Valley and Pavillion Plant upgrade compressor stations.

Table 4.16-1. Predicted Noise at Selected Distances from WRPA Proposed Action Compressor Stations

Distance (feet)	Predicted Noise (dBA) for Number of Compressor Engines [1]			
	6 Engines (Sand Mesa)	3 Engines (Muddy Ridge and Sand Mesa South)	2 Engines (South Pavillion)	1 Engine (Hidden valley and Pavillion Plant)
100	78.8	75.8	74.0	71.0
200	72.7	69.7	68.0	65.0
300	69.2	66.2	64.4	61.4
400	66.7	63.7	61.9	58.9
500	64.8	61.8	60.0	57.0
600	63.2	60.2	58.4	55.4
700	61.9	58.8	57.1	**54.1**
800	60.7	57.7	55.9	52.9
900	59.7	56.7	**54.9**	51.9
1000	58.8	55.8	54.0	51.0
1100	57.9	**54.9**	53.2	50.2
1200	57.2	54.2	52.4	49.4
1300	56.5	53.5	51.7	48.7
1400	55.8	52.8	51.1	48.1
1500	55.2	52.2	50.5	47.5
1600	**54.7**	51.7	49.9	46.9
1700	54.2	51.1	49.4	46.4
1800	53.7	50.6	48.9	45.9
1900	53.2	50.2	48.4	45.4
2000	52.7	49.7	48.0	45.0

[1] Bold entries indicate distance from the source where noise level becomes less than 55 dBA.

Inspection of aerial photography indicates that the Pavillion South compressor station would be the only station located near a Noise Sound Receptor (NSR). One residence is approximately 1,600 feet south and the other is approximately 2,700 feet west. The predicted noise levels are 49.9 dBA for the southern residence and less than 48.0 dBA for the western residence.

Based upon the published noise level effects, the health and welfare of the general population would not be at risk from any of the identified effects of noise at that level beyond 1,600 feet from the largest proposed WRPA compressor station. The Pavillion South, Pavillion Plant upgrade, and Muddy Ridge compressor stations are the only ones that would be constructed anywhere near NSRs. Overall, the impact from noise from compressor stations would be moderate and long term. However, as long as these compressor stations would be constructed at least 1,100 feet from established NSRs, no adverse noise effects to public health and welfare would occur.

4.16.2 Alternative A (485 Wells) – Direct and Indirect Impacts

Under Alternative A, the major construction-, drilling-, and completion-related noise impacts would be similar to the Proposed Action at any one location. Because the proposed drilling rate would be similar to the Proposed Action, noise impacts experienced on an annual basis would be similar to the Proposed Action and be moderate and short term. However, noise impacts would occur for about four years longer because of the larger number of wells to be drilled.

Noise from compressor stations would increase slightly because more compressor engines would be needed to transmit the greater amounts of natural gas. One to two more engines at each compressor station would be required to increase the horsepower needed. However, the increase would only be about 1 to 2 dBA for each an additional engine and this difference would be imperceptible to the human ear. Therefore, the impact from compressor stations would be moderate and long term.

Compressor capacity for the South Pavillion compressor station would require an extra engine. The radius of the 55 dBA noise level would increase by 200 feet. The predicted noise levels would increase 1.6 dBA over the Proposed Action at the NSR to the south and 1.7 dBA at the residence to the west.

4.16.3 Alternative B (233 wells) – Direct and Indirect Impacts

Noise levels from construction, drilling, and completion would be similar to the Proposed Action at any one location and be moderate and short term. The annual drilling rates would be similar to the Proposed Action, but because fewer wells would be drilled, the noise levels would occur for about four years less than the Proposed Action.

Noise from compressor stations would be slightly less than under the Proposed Action because less compression, and therefore smaller horsepower requirements, would be needed. However, the noise levels would only be about 1 to 2 dBA lower than the Proposed Action and would not generally be perceptible to the human ear. Therefore, the impact would be moderate and long term.

4.16.4 Alternative C (100 wells) – Direct and Indirect Impacts

Under the No Action (Alternative C), wells would only be drilled on private leases in the Pavillion Field. Noise effects from construction, drilling, and completion at any one location would be slightly less than the effects described for the Pavillion Field in the Proposed Action and be moderate and short term. However, these effects would last about three years less. No drilling would occur in the other development areas so no noise effects would occur.

The only compressor station needed for the No Action Alternative would be the South Pavillion compressor station. The horsepower requirement would be slightly less, but the overall difference in noise would be imperceptible to the human ear. Therefore, the impact of the compressor station would be moderate and long term.

4.16.5 Impacts Summary

Noise from construction, drilling, and completion activities would occur for 5 to 60 days at any one location. Noise impacts would be major during these activities at nearby locations. Noise would exceed the EPA level of 55 dBA for short periods at distances out to 1,600 feet from wells being vented for a 24-hour period, 1,500 feet for general construction activities for about a 5 to 10 day period, and 800 feet for drilling activities for a 9 to 75 day period. However, drilling in the Pavillion Field where most residences exist would typically last only about 9 days.

Noise impacts from compressor stations would exceed the 55 dBA criteria for distances from 700 to 1,600 feet depending on the size of compressor engines needed. Elevated noise levels near compressor stations would occur 24 hours per day for the LOP.

4.16.6 Additional Mitigation Measures

The following mitigation measures could be implemented if a compressor station would have to be located closer than 1,000 feet to an existing NSR:

- Increase the separation distance.
- Construct or use naturally-occurring obstacles in the direct path from the noise source to a receiver. However, these obstacles must be high enough to break the line-of-sight between the compressor station and the NSR. Obstacles can be tightly spaced wood fences (no gaps in the wood panels), concrete fences, earth berms, or naturally occurring hills.

4.16.7 Residual Impacts

After natural gas production and reclamation activities end, no noise residual impacts would exist because all equipment would cease operating.

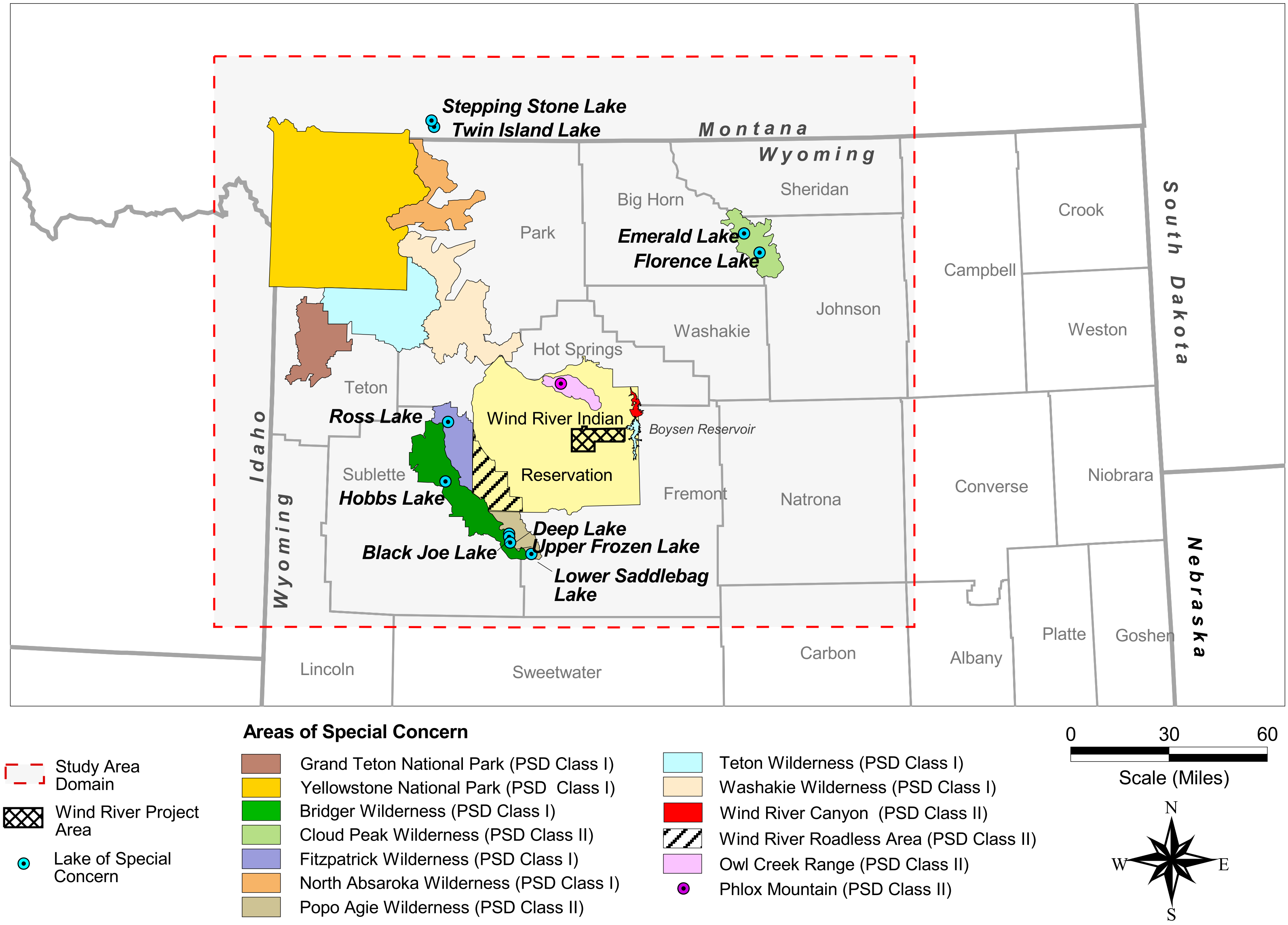


Figure 4.4-1. Areas of Special Concern and High Elevation Lakes.

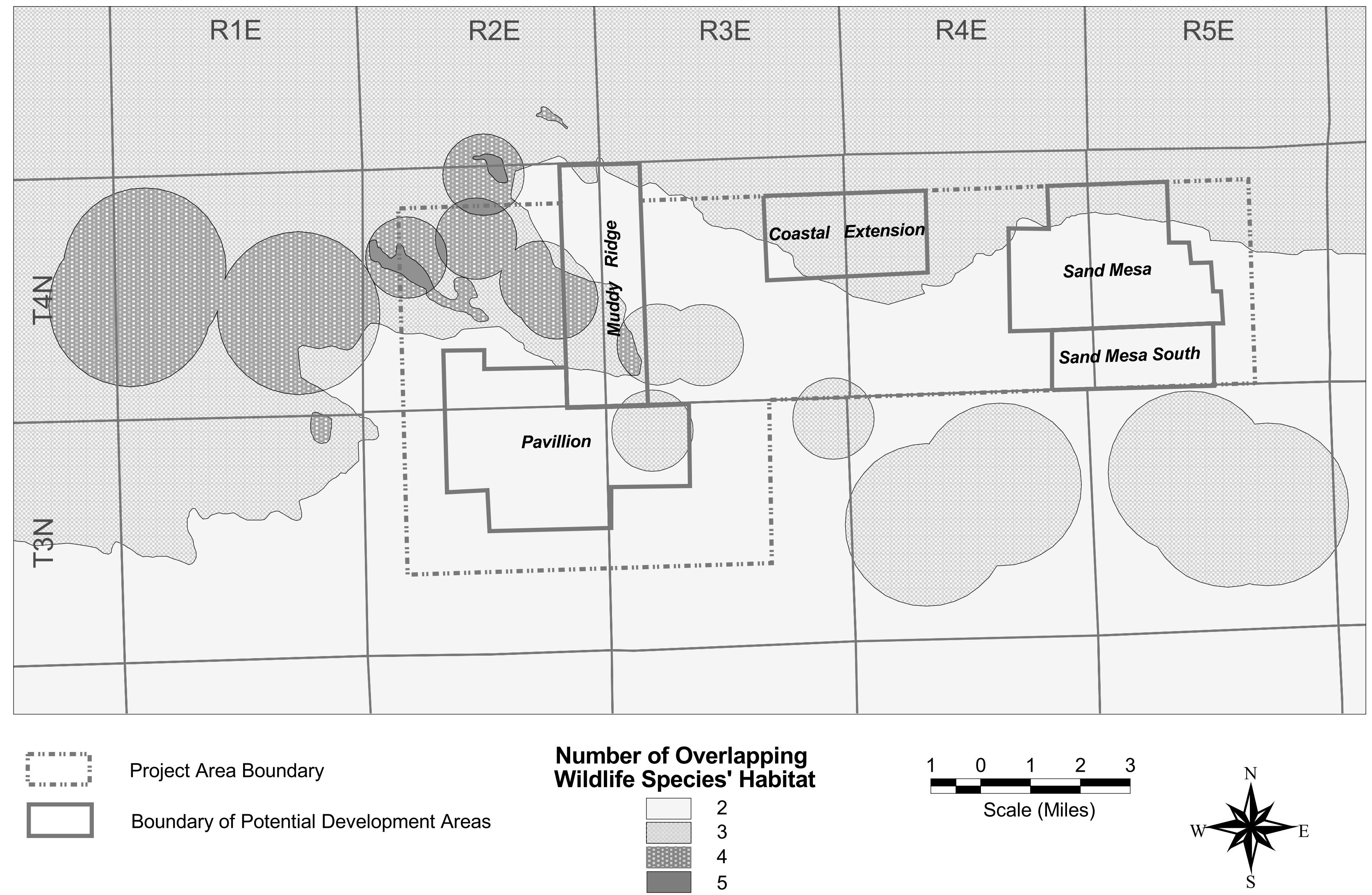


Figure 4.8-1. Distribution and Overlap of Wildlife Habitat. [1]

[1] Physical distribution and overlap of species habitat is depicted by levels of shading. Species habitat mapped include: elk; mule deer; pronghorn antelope; and white-tailed deer ranges; sage grouse leks (observed) and sage grouse nesting habitat (2-mile buffer); mountain plover (observed, 1-mile buffer), raptor nests (observed, 1-mile buffer); and surveyed white-tailed prairie dog colonies.

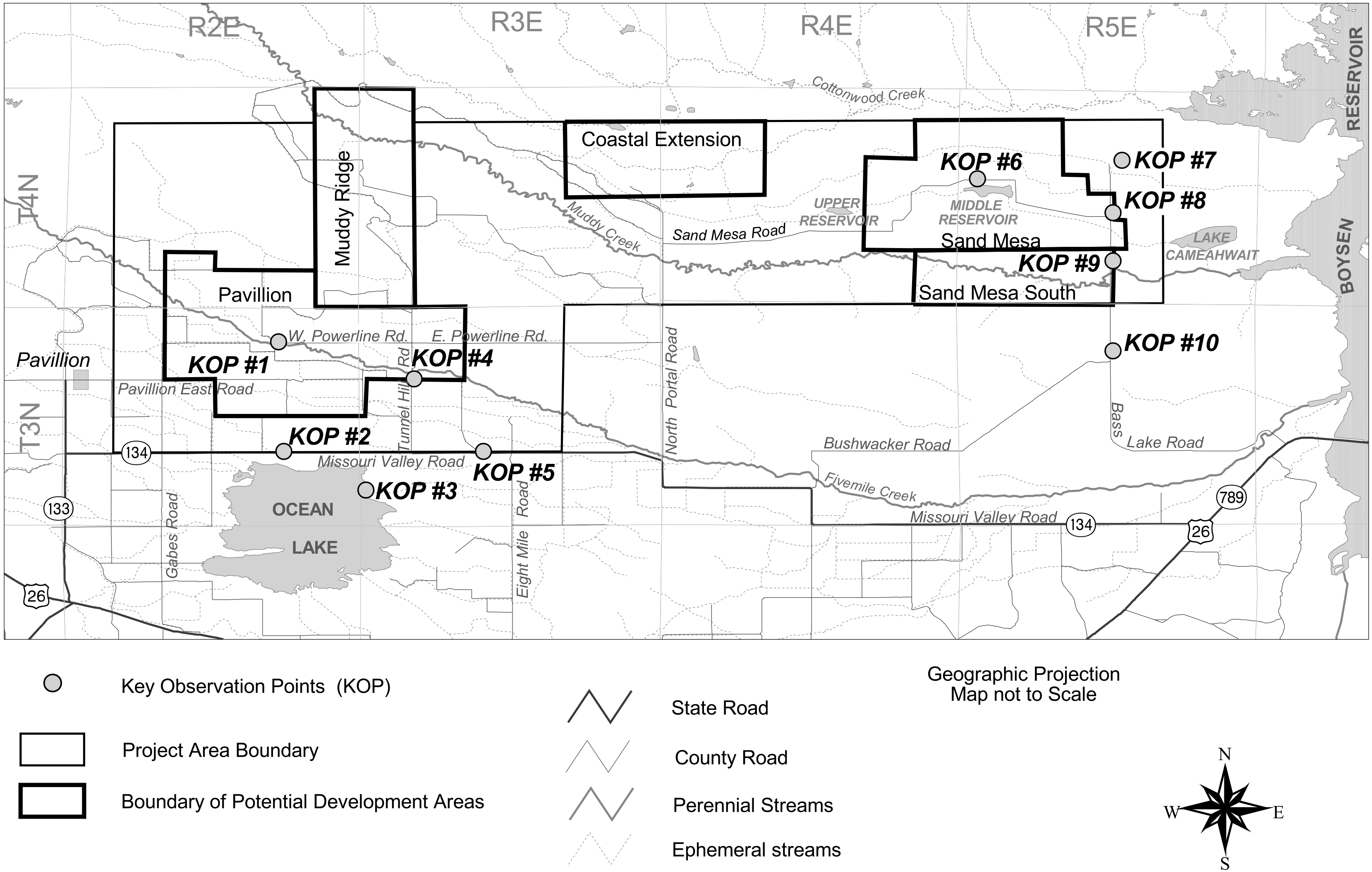


Figure 4.11-1. Key Observation Points (KOP) in and near the Wind River Project Area.

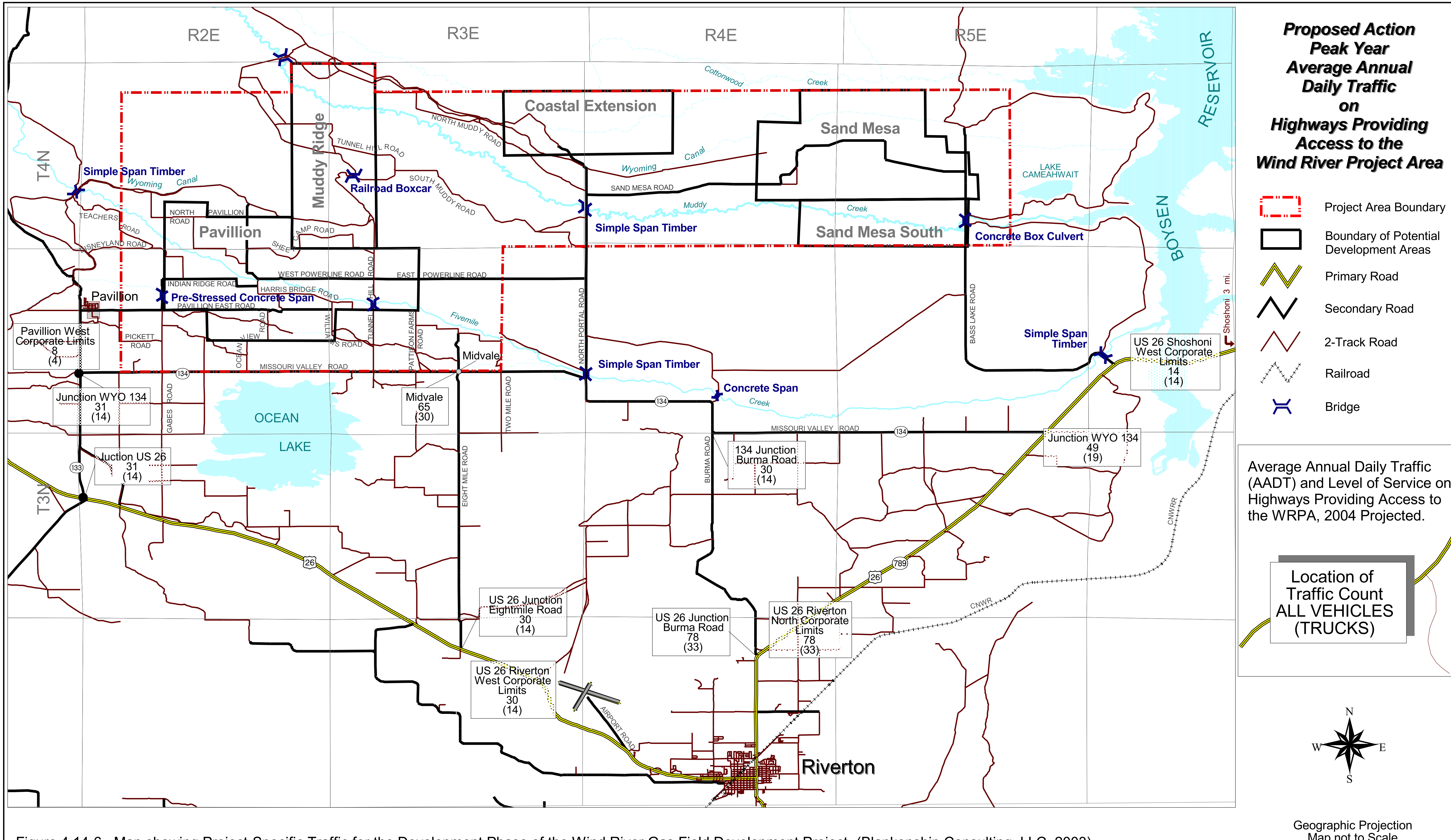


Figure 4.14-6. Map showing Project-Specific Traffic for the Development Phase of the Wind River Gas Field Development Project (Blankenship Consulting, LLC. 2003).

5.0 CUMULATIVE IMPACT ANALYSIS

5.1 INTRODUCTION

The National Environmental Policy Act, as amended (42 U.S. C 4321, et seq.) requires the evaluation of direct, indirect, and cumulative effects (impacts) of a major federal action, as part of the EIS process.

The term cumulative impacts is defined in Section 1508.7 of the Council of Environmental Quality (CEQ) regulations (40 CFR 1508.7) as *"the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

The cumulative impacts discussed in this chapter are based on past, existing and reasonably foreseeable future activities (RFFA) in the cumulative impact analysis (CIA) area. The potential cumulative impacts of an action are assessed at the resource level and vary depending of the resource being evaluated. For example, the CIA area for air encompasses the WRPA, WRIR, and the northwestern part of the State of Wyoming. The CIA area for socioeconomics includes all of Fremont County. On the other hand, the CIA area for recreation is the WRPA and the recreation areas and adjacent to the WRPA and include Boysen Reservoir, Sand Mesa Wildlife Habitat Management Area, and Ocean Lake.

The discussion of potential cumulative impacts assumes implementation of the mitigation measures described in Chapter 2, Section 2.8 and the mitigation measures proposed by the Operators (see Chapter 2, Section 2.3). In addition, it is assumed that the Operators will comply with the guidance prepared by Federal agencies, the State of Wyoming, and county, municipal, and local agencies.

5.2 PAST, EXISTING, AND REASONABLY FORESEEABLE FUTURE ACTIVITIES

Past, existing, and reasonably foreseeable future activities (RFFA) that are considered in this EIS include existing projects and those that are likely to be initiated in the near future in the Wind River Project Area, Wind River Indian Reservation, Bureau of Reclamation Riverton Withdrawal Area, Northwestern Wyoming region, Wyoming Game and Fish Department (WGFD) Wildlife Habitat Management Areas, and State Parks. Information on these areas is provided in the following sections.

5.2.1 Wind River Project Area

The Wind River Project Area (WRPA) is located in Townships 3 and 4 North and Ranges 2 through 5 East in Fremont County Wyoming (see Figure 1-1). It is approximately 21 miles north of Riverton, Wyoming. Approximately 51.4 percent of the WRPA is on private surface, 32.2 percent on Bureau of Reclamation surface, and 51.4 percent on tribal surface (see Table 1-2). The mineral ownership in the WRPA is 88.4 percent tribal and 11.6 percent private (see Table 1-3).

The WRPA is bounded on the east by Boysen State Park. Within and adjacent to the WRPA are the Ocean Lake and Sand Mesa Wildlife Habitat Management Areas, managed by the Wyoming Game and Fish Department. The Sand Mesa WHMA includes Fivemile Creek, Muddy Creek, Middle Depression Reservoir, and a portion of the Muddy Ridge Reservoir.

Past, present and reasonably foreseeable future activities within the WRPA are summarized below.

Oil and gas development has occurred in the WRPA since 1960. There are currently 178 producing gas wells in the WRPA, as well as 62 miles of pipelines, and 16,600 horsepower of existing compression. Most of these wells are in the Pavillion and Muddy Ridge fields. The residual disturbance from the production operations is 285 acres, or 0.31 percent of the WRPA (see Chapter 2, Table 2-2).

A sand and gravel mine is located on BOR land near Boysen Reservoir. Although sand and gravel were mined for many years, it is presently inactive. However, sand and gravel mining is likely to occur again in the reasonably foreseeable future. At the present time the stockpiled gravel at the mining site is used by the BOR for road repair and other uses (Dallman, J., BOR, personal communication, December 2003).

Crops, such as hay and alfalfa, are grown in much of the WRPA by the surface landowners. Oil and gas wells are frequently located within the agricultural fields. These activities are expected to continue in the reasonably foreseeable future.

There is residential development associated with the agricultural lands in the WRPA. There may be some increase in residential development within the WRPA. The town of Pavillion, which has the majority of the residential development, is located just west of the WRPA.

Most of the grazing lands within the WRPA are located on the eastern portion of the WRPA, and are expected to continue in the reasonably foreseeable future.

These activities, in conjunction with the oil and gas operations under the Proposed Action and Alternatives, are evaluated for potential cumulative impacts.

5.2.2 Wind River Indian Reservation

The Wind River Indian Reservation (WRIR) encompasses 3,500 miles and approximately 2.3 million acres. The reservation was established by the Fort Bridger Treaty of July 2, 1868. The WRIR was originally set aside for the Shoshone Tribe. In 1878 the Arapaho Tribe was settled on the reservation. The Shoshone members typically occupy the western areas of the reservation, including Fort Washakie, Crowheart, Burris, and the Dry Creek Ranch area. The Arapaho Tribe principally occupies the eastern section of the reservation, including Ethete and Arapaho. Current census data reports that there are 5,953 Arapaho tribal members and 2,650 Shoshone tribal members (http://www.wyoming.com/~arapahoe/about_us.htm).

Past, existing and reasonably foreseeable future northwest activities (RFFA) in the WRIR are identified below.

- Oil and gas development has occurred on the WRIR since the 1960s and will continue to occur on the reservation, northwest of the WRPA, through existing lease option agreements.
- Gravel mining has occurred on the WRIR. Most of the gravel mines are presently inactive, but initiation of gravel mining is anticipated in the future.
- Various crops, such as hay, alfalfa, and corn, are planted on agricultural land on the reservation.
- An increase in residential development is expected in the towns of Fort Washakie, Ethete, and Arapaho, and Riverton, Wyoming.
- Commercial development, including a casino, hotel, and various stores, is planned for the WRIR approximately 20 miles south of Riverton.

5.2.3 Bureau of Reclamation Riverton Withdrawal Area

A large portion of the WRPA lies within the Riverton Reclamation Withdrawal Area, Which consists of numerous irrigation canals, laterals, and drains. The area established as the Bureau of Reclamation Riverton Withdrawal Area is within the Boundary of the Wind River Indian Reservation. Under the 1905 Act, the WRIR was opened to settlement. In 1939, the area was closed to issuance of new fee patents from trust lands. In 1953, the United States purchased the non-patented lands within the WRIR for $6.25 per acre.

The Riverton Reclamation Withdrawal Area is managed for the BOR by the Midvale Irrigation District (MID), which delivers irrigation water to private landowners through an Irrigation Water Delivery System. The BOR surface consists of a total of 29,896 acres or 32.7 percent of the WRPA (see Table 1-2).

5.2.4 Fremont County

Fremont County is in the west-central portion of the State of Wyoming. It is 9,266 mi^2 (23,999 sq. km.) with a population of 33,662. Activities in Fremont County include cattle and sheep ranching, oil and gas production, mineral mining (including uranium, phosphate, bentonite), recreation, and timber resources. Important wildlife resources in Fremont County include big game, waterfowl, upland game birds, threatened and endangered plant and animal species, and cultural and natural history resources. The WRPA is located in the north-central part of Fremont County. The cumulative impact analysis area for socioeconomics includes the WRPA, the Midvale Irrigation District, and Fremont County.

5.2.5 Watersheds in the Cumulative Impact Analysis Area

The major surface water drainages within the WRPA include Fivemile Creek, Muddy Creek, Cottonwood Drain, and Cottonwood Creek, covering 915 mi^2, which comprise the northern portion of the Boysen Reservoir watershed (see Figure 3.5-1). The headwaters for these creeks are in the Owl Creek Mountains to the north of the WRPA. Fivemile Creek drains the southern portion of the WRPA, Muddy Creek drains the central portion, and Cottonwood Creek drains a small portion of the northern part of the WRPA. Fivemile and Muddy Creeks are mainly perennial streams, whereas Cottonwood Creek is an intermittent stream. Each of these streams flows into Boysen Reservoir, constructed in 1951, which flows into the Wind

River. Surface water from all streams to the west (approximately 7,700 square miles) flows into Boysen Reservoir (see Section 3.5, Water Resources).

Other water bodies within the WRPA include the Wyoming Canal and the Pilot Canal, which are managed by the Midvale Irrigation District, Riverton Unit. Sources of water for the canals include Bull Lake Dam and Reservoir, Wind River Diversion Dam, and Pilot Butte Dam and Reservoir located upstream (i.e., west) of the WRPA. The flows of each of the major streams within the WRPA are affected by irrigation diversions, storage structures, and drains within the WRPA.

Two large water bodies adjacent to the WRPA are Ocean Lake and Boysen Reservoir. Ocean Lake (one mile south of the Pavillion field) is a natural lake and lies entirely within the Fivemile Creek watershed. It has a surface area of approximately 6,440 acres and is bounded on the east side by the WGFD Wildlife Habitat Management Area. The lake receives water from runoff and irrigation drains, and discharges into Fivemile Creek through the Ocean Drain. Boysen Reservoir is located on the eastern edge of the WRPA, with a small portion of the reservoir inside the WRPA. In addition, there are two small reservoirs Upper Depression and Middle Depression Reservoirs that are also within the WRPA. Both of these reservoirs discharge into Lake Cameahwait, which discharges into Boysen Reservoir and ultimately the Wind River.

The cumulative impact analysis area for soils, vegetation and wetlands, and water resources, and wildlife, includes the Fivemile Creek, Muddy Creek, and Cottonwood Creek sub-basins.

5.2.6 Northwestern Wyoming Region

The northwestern portion of the State of Wyoming is evaluated for the analysis of far-field cumulative impacts on air quality. The PSD Class I wilderness areas nearest to the WRPA are the Bridger and Fitzpatrick Wilderness areas located directly west of the WRPA in the Wind River Range. Contiguous with the Bridger Wilderness area are two PSD Class II areas, the Popo Agie Wilderness and the Wind River Roadless Area. More distant PSD Class I areas are the Teton and Yellowstone National Parks, and the Washakie, Teton, Cloud Peaks, and North Absaroka Wilderness areas (see Figure 3.4.-5). The analysis of cumulative air quality impacts includes consideration of oil and gas development, livestock grazing, gravel mining, recreational activities, residential development, and commercial and industrial development.

Figure 5-1. Location of NEPA projects within Fremont County, Wyoming.

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5.2.7 State Parks and WGFD Wildlife Habitat Management Areas

Boysen Reservoir, located along the eastern boundary of the WRPA, is a state park. Only a small portion of the park is within the WRPA. However, the park is widely used for recreation activities, such as camping, boating, fishing, and swimming.

Ocean Lake is also a popular destination for recreational activities. It is located outside the WRPA and is approximately one mile south of the Pavillion field. The eastern portion of Ocean Lake is a Wildlife Habitat Management Area, managed by the Wyoming Game and Fish Department.

The Sand Mesa WHMA traverses the WRPA. This WHMA includes Fivemile and Muddy Creeks, the riparian areas adjacent to these creeks, and Middle Depression Reservoir and Upper Depression Reservoir.

5.2.8 Past Environmental Assessments conducted in or near the WRPA

Oil and gas activities within and near the WRPA have been evaluated in Environmental Assessments (EAs). Some of these EAs were prepared for oil and gas operations within the WRPA, while the other EAs are for reasonably foreseeable future activities west and north of the WRPA on reservation lands. The general location of these oil and gas leases and other projects is shown in Figure 5-1.

"*Tom Brown, Inc., Pavillion North Oil/Gas Lease Wind River Indian Reservation, Fremont County, Wyoming, Environmental Assessment and Finding of No Significant Impact"* (BIA 1992) was prepared to evaluate the potential effects of proposed leasing of 25,216 acres in Pavillion North for oil and gas exploration and development by Tom Brown, Inc. A total of 17,068 acres are within the WRIR and 8,148 surface acres are located within the Riverton Reclamation Withdrawal Area.

"*Tom Brown, Inc., Haymaker Creek, Indian Butte, Little Dome, and Owl Creek Oil/Gas Lease Option Proposals Located within the Wind River Reservation of Fremont County, Wyoming, Environmental Assessment and Finding of No Significant Impact*" (BIA 1994a) was prepared to determine the potential environmental impacts resulting from the issuance of four separate oil and gas lease options to Tom Brown, Inc. for a total of 341,960 mineral acres, of which 290,608 surface acres are within the WRIR and 113,432 surface acres are within the Riverton Reclamation Withdrawal Area.

"*Tom Brown, Inc. Winchester Butte Oil/Gas Lease Option, Environmental Assessment and Finding of No Significant Impact*" (BIA 1994b) was prepared to determine the potential environmental impacts resulting from issuance of an oil and gas lease option to Tom Brown, Inc. The proposed lease option encompasses approximately 101,760 acres within the Winchester Butte Prospect and would grant TBI the exclusive right to explore for hydrocarbon reserves and lease those lands within the optioned area that demonstrate the potential for oil and gas production. Approximately 87,106 acres are within the WRIR and 14,654 surface acres are within the Riverton Reclamation Withdrawal Area.

"*Tom Brown, Inc.; Brownlie, Wallace, Armstrong & Bander Exploration; and Enron Oil & Gas Company; Black Mountain Oil and Gas Lease Option Area, Environmental Assessment and Finding of No Significant Impact*" (BIA 1995) was prepared for the purpose of evaluation and possible leasing of 108,160 acres of land within the WRIR, between the town of Ethete on the east and Fort Washakie on the west.

"*Tom Brown, Inc. and Brownlie, Wallace, Armstrong & Bander Exploration, Wind River Oil and Gas Exploration License Agreement, Environmental Assessment and Finding of No Significant Impact*" (BIA 1996) would grant Tom Brown, Inc. and Brownlie, Wallace, Armstrong & Bander Exploration exclusive rights for oil/gas exploration and development on approximately 514,905 mineral acres within the WRIR for geophysical evaluation and exploratory drilling.

Other Environmental Assessments prepared for industrial operations within Fremont County are listed below.

The "*Record of Decision for the Environmental Impact Statement on the Jackpot Uranium Mine Plan of Operation Fremont and Sweetwater Counties, Wyoming*" (BLM 1995) was prepared to assess the impacts of a proposed uranium mine project in the Green Mountain area of southeastern Fremont County and northeastern Sweetwater County. This proposed project has not been implemented.

The "*Record of Decision, Altamont Gas Transportation Project*" (BLM 1991) was prepared to assess the potential impacts from a 30-inch diameter gas pipeline transmission system. This proposed project was not implemented.

"*Environmental Assessment and Plan of Development for the Lost Creek Gathering System Project, Finding of No Significant Impact*" (BLM 1999) was prepared to assess the impacts of a 120-mile, 24-inch natural gas gathering system from Burlington Resources' Lost Cabin Gas Plant in Fremont County, Wyoming, southward to an interconnection with an existing interstate natural gas transmission pipeline that parallels Interstate 80 near Wamsutter in Sweetwater County, Wyoming.

"Pacific Power and Light company Spence-Bairoil, Jim Bridger Transmission Line Project" was prepared to assess the impacts of a proposed pipeline. The pipeline route is from Casper, Wyoming to Jeffrey City and follows the Gas Hill Haul Road.

5.3 POTENTIAL CUMULATIVE IMPACTS BY RESOURCE

The potential cumulative effects of past, current and reasonable foreseeable future activities on the resource elements are discussed in the following sections.

5.3.1 Geology/Minerals/Paleontology

5.3.1.1 Geological Resources

Cumulative impacts to geological, mineral, and paleontological resources from the Proposed Action or Alternatives and reasonably foreseeable future activities include increased erosion, removal of areas for future mineral development, and impacts to fossils, both negative and beneficial.

Future projects that may be permitted within and near the WRPA include additional oil and gas development, sand and gravel mining, and timber harvesting in the Owl Creek and Wind River Mountains. Additional oil and gas pipelines may also be needed as production in the region increases. Other commercial development includes construction of a casino, a hotel, and shops just south of Riverton. In addition, increased residential development, possibly with additional roads, is expected in Ft. Washakie, Ethete, and Arapaho.

5.3.1.2 Increased Erosion

Each future project would increase the area potentially subjected to erosion. Residential and commercial development, as well as additional oil and gas development, would remove topsoil and vegetation from selected areas, thus increasing runoff and, potentially, erosion of surficial materials. Increased erosion would be a temporary cumulative impact for projects involving residential development and pipeline construction, because these areas would be revegetated after construction. Timber harvesting and oil and gas development would potentially result in minor, long-term increases in erosion.

5.3.1.3 Mineral Extraction

Within and adjacent to the WRPA, increased mining for sand and gravel is expected to occur on Tribal and other lands. Residential development, casino development, and additional oil and gas development may decrease the area available for extraction of sand and gravel. However, as stated in the mitigation section of Chapter 2, the Operators would avoid precluding the development of these resources and any conflicts would be mediated by the BIA or other agencies. Some loss of these resources may occur over time as development occurs outside the WRPA, including the consumption of the materials to build these projects. Local regulatory agencies would need to review proposed developments carefully to minimize the loss of these resources.

5.3.1.4 Paleontological Resources

The development of oil and gas wells and associated infrastructure as described for the Proposed Action and alternatives, as well as other reasonably foreseeable projects, including mining of surface mineral resources and construction materials, may have a cumulative impact on paleontological resources. Construction can directly impact fossil resources, and newly built roads can open previously inaccessible areas to illegal collection and destruction of fossil resources by vandalism. Scientifically significant fossils and fossil localities containing them are rare and not uniformly distributed throughout the geologic deposits in the WRPA. As a result, loss of fossil resources from rare and scientifically important localities and the loss of some of these areas themselves would have a cumulative impact. On the other hand, development could increase the potential for discovering scientifically significant fossil resources. If such resources are discovered, and the nature and significance of the paleontological material is recognized, adequate measures would be applied to ensure proper handling and recovery of the resource. Mitigation of these impacts would be accomplished by conducting paleontological surveys prior to construction and requiring that construction stop when fossils are encountered.

5.3.2 Soils

Cumulative impacts to soils from the Proposed Action or Alternatives and reasonably foreseeable future activities include increased erosion, increased runoff, compaction, and loss of topsoil productivity.

Future projects that may be permitted within and near the WRPA include additional oil and gas development, sand and gravel mining, and timber harvesting in the Owl Creek and Wind River Mountains. Additional oil and gas pipelines may also be proposed as production in the region increases. Other commercial development includes construction of a casino, hotel, and shops just south of Riverton. In addition, increased residential development is expected in Ft. Washakie, Ethete, and Arapaho.

5.3.2.1 Increased Runoff and Erosion

Each future project would increase the area potentially subjected to erosion. Residential and commercial development, as well as additional oil and gas development, would remove topsoil and vegetation from selected areas, thus increasing runoff and, potentially, erosion of surficial materials. Increased erosion would be a temporary impact for projects involving residential development and pipeline construction, since these areas would be revegetated after construction. Timber harvesting and oil and gas development would potentially result in minor, long-term increases in erosion. Clear-cutting of timber would lead to increases in runoff from the affected areas. This increased runoff could lead to more erosion along waterways and the migration of the gulleys of small streams in the upstream direction. Application of Best Management Practices during construction of future projects would mitigate these cumulative impacts.

5.3.2.2 Soil Compaction

Oil and gas, residential, and commercial development result in increased soil compaction at sites underlain by the project facilities. Future projects and development would lead to additional areas of soil being lost. However, the cumulative impacts to soil would be offset by the beneficial effects of the future projects.

5.3.2.3 Loss of Topsoil Productivity

Soil that is excavated loses its structure and therefore, some productivity. Stockpiling of topsoil during construction for future projects would lead to some loss of productivity of the soils that are reapplied to affected areas as reclamation material. This loss of productivity is a temporary effect that decreases as the soil receives moisture and is cultivated with plants.

5.3.3 Air Quality

5.3.3.1 Introduction

As an unavoidable result of project related activities, additional pollutants would be emitted to the atmosphere. Emissions generated from project activities would act in concert with emissions generated from other cumulative sources, both existing and future.

To assess total air quality impacts, emission inventories were developed for a number of cumulative source categories. Specifically, the cumulative inventories estimated emissions for the following source groups:

- Permitted Sources – Sources permitted by State agencies that are currently operating;
- Reasonably Foreseeable Future Actions – Sources permitted by State Agencies that have yet to initiate operations;
- Tribal Sources – Sources located on Tribal lands permitted by the EPA;
- Well Emissions – Sources of emissions related to oil and gas wells, and
- Reasonably Foreseeable Development – Sources associated with NEPA projects that are not yet fully developed.

Potential emissions for cumulative source categories are summarized in Table 5.3-1. As shown, the primary pollutant of concern emitted by the cumulative sources is NO_X. Detailed documentation of the emission inventories is provided in a separate report; Emissions Inventory for the Wind River Natural Gas Development Project (Buys & Associates, 2004).

Table 5.3-1. Summary of Potential Cumulative Source Emissions.

Pollutant	Permitted Sources (tons/yr)	Reasonably Foreseeable Future Actions (tons/yr)	Tribal Sources (tons/yr)	Well Sources (tons/yr)	Reasonably Foreseeable Development (tons/yr)	Total Cumulative Sources (tons/yr)
NO_X	2,116	4,621	382	73	14,684	21,876
SO_X	109	124	-	-	1	234
PM_{10}	67	109	-	-	47	223
$PM_{2.5}$	23	109	-	-	47	179

The cumulative air quality assessment focused upon potential impacts that could occur within areas of special concern (i.e., Federal designated Class I areas and areas identified as important to the Tribes and the USFS). To assess potential cumulative impacts, the CALPUFF set of dispersion models were applied. The CALPUFF set of models (CALMET, CALPUFF, CALPOST, and associated utilities) were designed specifically to assess ambient air quality impacts at significant distances from the source and therefore long pollutant travel times. For the cumulative assessment, impacts from the following source categories were summed: permitted sources, RFFA sources, Tribal sources, well sources and RFD sources. Potential impacts that would result from the combination of cumulative Project Alternatives sources were evaluated. The predicted pollutant concentrations were compared to the most stringent of the State of Wyoming and National Air Quality Standards (WAAQS, NAAQS) and (for informational purposes only) to the Prevention of Significant Deterioration (PSD) increments. For simplicity, predicted impacts were compared to the more stringent Class I increments, irregardless of impact location and actual PSD Class designation. In addition, the predicted concentration and deposition results were processed to evaluate potential visibility and acid deposition impacts for comparison with the Federal Land Manager (FLM) Limits of Acceptable Change (LAC).

Throughout this analysis all comparisons with PSD increments are intended only to evaluate a level of concern and do not represent a regulatory PSD increment consumption analysis. PSD Increment consumption analyses are applied to large industrial sources and are solely the responsibility of the State and the Environmental Protection Agency.

5.3.3.2 Cumulative Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources, including state permitted, Tribal land, RFFA, RFD and oil and gas wells, are summarized below. The predicted cumulative impacts will occur independent from any further development within the WRPA.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that may occur as a result of cumulative sources are summarized in Table 5.3-2 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, impacts resulting from cumulative sources are predicted to occur at levels below the ambient standards. The greatest impact resulting from cumulative sources is for NO_X, at a predicted concentration of 2.36 $\mu g/m^3$.

Table 5.3-2. Cumulative Source Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	0.08	Cloud Peak Wilderness	61	61.08	150	40.7%
	Annual	0.00	Grand Teton National Park	22	22.00	50	44.0%

<u>PSD Increments</u>

Table 5.3-3 compares cumulative source impacts with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Increments.

Table 5.3-3. Cumulative Source PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.4%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	0.08	Cloud Peak Wilderness	8	1.0%
	Annual	0.00	Grand Teton National Park	4	0.1%

Terrestrial Acid Deposition

Results of the nitrogen and sulfur atmospheric deposition analysis are illustrated in Tables 5.3-4 and 5.3-5 Cumulative source nitrogen and sulfur deposition rates are predicted to remain below both the “Red Line” and “Green Line” levels of concern (LOC), indicating that total deposition rates would be acceptable. The greatest nitrogen deposition rate is predicted to occur within the Cloud Peak Wilderness area. Cumulative deposition rates for the other areas of special concern would be approximately ten times less than the rate predicted for Cloud Peak. Increases in sulfur deposition are predicted to be two to three orders of magnitude less than the existing background rates and would therefore be inconsequential.

Table 5.3-4. Cumulative Source Total Nitrogen Deposition LAC Comparison.

Area of Special Concern	Predicted Nitrogen (N) Deposition (kg/ha/yr)	Background Nitrogen (N) Deposition (kg/ha/yr)	Total Nitrogen (N) Deposition (kg/ha/yr)	Nitrogen (N) "Green Line" (kg/ha/yr)	Nitrogen (N) "Red Line" (kg/ha/yr)	Total Nitrogen (N) Percent of "Green Line"	Total Nitrogen (N) Percent of "Red Line"
Bridger Wilderness	0.02	1.3	1.3	3.0	10.0	44.0%	13.2%
Cloud Peak Wilderness	0.37	1.3	1.7	3.0	10.0	55.7%	16.7%
Fitzpatrick Wilderness	0.01	1.3	1.3	3.0	10.0	43.7%	13.1%
North Absaroka Wilderness	0.01	1.1	1.1	3.0	10.0	36.9%	11.1%
Owl Creek Range	0.01	1.3	1.3	3.0	10.0	43.8%	13.1%
Popo Agie Wilderness	0.01	1.3	1.3	3.0	10.0	43.8%	13.1%
Phlox Mountain	0.01	1.3	1.3	3.0	10.0	43.7%	13.1%
Grand Teton NP	0.01	1.1	1.1	3.0	10.0	37.0%	11.1%
Teton Wilderness	0.01	1.1	1.1	3.0	10.0	36.9%	11.1%
Washakie Wilderness	0.01	1.1	1.1	3.0	10.0	37.0%	11.1%
Wind River Canyon	0.01	1.3	1.3	3.0	10.0	43.8%	13.2%
Wind River Roadless Area	0.01	1.3	1.3	3.0	10.0	43.8%	13.1%
Yellowstone NP	0.01	1.1	1.1	3.0	10.0	36.9%	11.1%
Maximum	**0.37**	**1.3**	**1.7**	**3.0**	**10.0**	**55.7%**	**16.7%**

Table 5.3-5. Cumulative Source Total Sulfur Deposition LAC Comparison.

Area of Special Concern	Predicted Sulfur (S) Deposition (kg/ha/yr)	Background Sulfur (S) Deposition (kg/ha/yr)	Total Sulfur (S) Deposition (kg/ha/yr)	Sulfur (S) "Green Line" (kg/ha/yr)	Sulfur (S) "Red Line" (kg/ha/yr)	Total Sulfur (S) Percent of "Green Line"	Total Sulfur (S) Percent of "Red Line"
Bridger Wilderness	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
Cloud Peak Wilderness	0.002	1.1	1.1	5.0	20.0	22.0%	5.5%
Fitzpatrick Wilderness	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
North Absaroka Wilderness	0.001	0.9	0.9	5.0	20.0	18.0%	4.5%
Owl Creek Range	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
Popo Agie Wilderness	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
Phlox Mountain	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
Grand Teton NP	0.004	0.9	0.9	5.0	20.0	18.1%	4.5%
Teton Wilderness	0.002	0.9	0.9	5.0	20.0	18.0%	4.5%
Washakie Wilderness	0.001	0.9	0.9	5.0	20.0	18.0%	4.5%
Wind River Canyon	0.001	1.1	1.1	5.0	20.0	22.0%	5.5%
Wind River Roadless Area	0.000	1.1	1.1	5.0	20.0	22.0%	5.5%
Yellowstone NP	0.002	0.9	0.9	5.0	20.0	18.0%	4.5%
Maximum	**0.004**	**1.1**	**1.1**	**5.0**	**20.0**	**22.0%**	**5.5%**

Aquatic Acid Deposition

Cumulative source emissions are predicted to impact ANC levels at two lakes located within the Cloud Peak Wilderness. Impacts to ANC at Florence Lake in excess of the LAC are predicted. Changes in ANC are also predicted at Emerald Lake. However, the predicted impacts at Emerald Lake are less than the LAC. For the remaining lakes of special concern, changes in ANC would be substantially less than the LAC. All predicted impacts are shown in Table 5.3-6.

Table 5.3-6. Cumulative Source ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.15	0.22%
Deep Lake	59.9	10% or 6.0 µeq/l	0.15	0.25%
Emerald Lake	69.8	10% or 7.0 µeq/l	2.09	3.00%
Florence Lake	33.0	10% or 3.3 µeq/l	3.36	10.2%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.12	0.17%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.15	0.27%
Ross Lake	53.5	10% or 5.4 µeq/l	0.10	0.18%
Stepping Stone Lake	19.9	1 µeq/l	0.05	0.23%
Twin Island Lake	17.6	1 µeq/l	0.05	0.29%
Upper Frozen Lake	5.0	1 µeq/l	0.15	3.07%
Maximum			**3.36**	**10.2%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative emission sources are predicted to cause a total of 24 days of visibility impairment greater than 1.0 deciview. The majority of the impaired days, 12, are predicted to occur within the Cloud Peak Wilderness area. Other areas that would exhibit impaired visibility are Popo Agie Wilderness, Wind River Canyon, Wind River Roadless Area, and the Owl Creek Range including Phlox Mountain. The greatest change in visibility, 2.03 dv, is predicted to occur within the Wind River Canyon as shown in Table 5.3-7.

Table 5.3-7. Cumulative Source Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.96
Cloud Peak Wilderness	12	1.65
Fitzpatrick Wilderness	0	0.70
North Absaroka Wilderness	0	0.73
Owl Creek Range	3	1.90
Popo Agie Wilderness	3	1.14
Phlox Mountain	1	1.32
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.89
Wind River Canyon	3	2.03
Wind River Roadless Area	2	1.18
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**24**	**2.03**

5.3.3.3 Cumulative and Proposed Action Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources in conjunction with Proposed Action sources are summarized below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of cumulative and Proposed Action sources are summarized in Table 5.3-8 and compared with the most stringent Wyoming and National ambient air quality standards. Project sources would contribute slightly to the predicted cumulative source particulate matter concentrations. Predicted NO_2 and SO_2 concentrations would not change substantially as a result of Project emissions. As illustrated below, impacts resulting from Cumulative and Proposed Action sources are predicted to occur at levels below the ambient standards.

Table 5.3-8. Cumulative and Proposed Action Total Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	1.51	Wind River Canyon	61	62.51	150	41.7%
	Annual	0.13	Wind River Canyon	22	22.13	50	44.3%

PSD Increments

Table 5.3-9 compares cumulative and Proposed Action impacts with PSD Class I Increments. As shown, increases in pollutant concentrations are not predicted to exceed the increments.

Table 5.3-9. Cumulative and Proposed Action Total PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.5%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	1.51	Wind River Canyon	8	18.9%
	Annual	0.13	Wind River Canyon	4	3.3%

Terrestrial Acid Deposition

Proposed Action sources would not contribute substantially to cumulative terrestrial deposition rates of nitrogen or sulfur. Cumulative and Proposed Action deposition rates would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable.

Aquatic Acid Deposition

Cumulative and Proposed Action sources would impact ANC levels at Florence Lake in excess the LAC. Measurable decreases in ANC less than the LAC are also predicted at Emerald Lake. For the remaining lakes of special concern, all predicted changes in ANC levels, as summarized in Table 5.3-10, would be significantly less than the LAC.

Table 5.3-10. Cumulative and Proposed Action Total ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.17	0.25%
Deep Lake	59.9	10% or 6.0 µeq/l	0.17	0.28%
Emerald Lake	69.8	10% or 7.0 µeq/l	2.12	3.0%
Florence Lake	33.0	10% or 3.3 µeq/l	3.39	10.3%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.12	0.18%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.17	0.31%
Ross Lake	53.5	10% or 5.4 µeq/l	0.10	0.19%
Stepping Stone Lake	19.9	1 µeq/l	0.05	0.23%
Twin Island Lake	17.6	1 µeq/l	0.05	0.30%
Upper Frozen Lake	5.0	1 µeq/l	0.17	3.4%
Maximum			**3.39**	**10.3%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative and Proposed Action sources would cause 30 days of visibility impairment greater than 1.0 deciview. As presented in Table 5.3-11, the majority of the impaired days, 12, are predicted to occur within the Cloud Peak Wilderness area. Other areas that would exhibit impaired visibility are Popo Agie Wilderness, Wind River Canyon, Wind River Roadless Area, Bridger Wilderness and the Owl Creek Range including Phlox Mountain. The greatest change in visibility, 2.15 dv, is predicted to occur within the Wind River Canyon.

Table 5.3-11. Cumulative and Proposed Action Total Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	2	1.10
Cloud Peak Wilderness	12	1.66
Fitzpatrick Wilderness	0	0.72
North Absaroka Wilderness	0	0.76
Owl Creek Range	4	1.97
Popo Agie Wilderness	3	1.27
Phlox Mountain	1	1.34
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.90
Wind River Canyon	6	2.15
Wind River Roadless Area	2	1.26
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**30**	**2.15**

5.3.3.4 Cumulative and Proposed Action Post-Construction Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources in conjunction with Proposed Action sources following the completion of construction activities are summarized below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of cumulative and post-construction Proposed Action sources are summarized in Table 5.3-12 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, impacts are predicted to occur at levels below the ambient standards. Following the completion of construction activities, particulate matter concentrations would be reduced to levels only slightly greater than the predicted cumulative source impact.

Table 5.3-12. Cumulative and Proposed Action Post-Construction Total Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	0.10	Wind River Canyon	61	61.10	150	40.7%
	Annual	0.01	Wind River Canyon	22	22.01	50	44.0%

PSD Increments

Table 5.3-13 compares cumulative and post-construction Proposed Action impacts with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 5.4-13. Cumulative and Proposed Action Post-Construction Total PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.5%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	0.10	Wind River Canyon	8	1.3%
	Annual	0.01	Wind River Canyon	4	0.19%

Terrestrial Acid Deposition

Proposed Action post-construction emissions would not contribute substantially to cumulative terrestrial deposition rates of nitrogen or sulfur. Cumulative and post-construction Proposed Action deposition rates would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable

Aquatic Acid Deposition

The completion of construction activities would result in only minor reductions in ANC impacts. The reduced impacts would result primarily from the decrease in NO_X emissions following the completion of drilling operations. Cumulative emissions in conjunction with post-construction Proposed Action sources are predicted to cause changes in ANC levels at Florence Lake which exceed the LAC. For the remaining lakes of special concern, the predicted ANC impacts would be less than the LACs. All impacts are summarized in Table 5.3-14.

Table 5.3-14. Cumulative and Proposed Action Post-Construction Total ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.16	0.24%
Deep Lake	59.9	10% or 6.0 µeq/l	0.16	0.27%
Emerald Lake	69.8	10% or 7.0 µeq/l	2.11	3.0%
Florence Lake	33.0	10% or 3.3 µeq/l	3.38	10.2%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.12	0.17%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.16	0.30%
Ross Lake	53.5	10% or 5.4 µeq/l	0.10	0.19%
Stepping Stone Lake	19.9	1 µeq/l	0.05	0.23%
Twin Island Lake	17.6	1 µeq/l	0.05	0.30%
Upper Frozen Lake	5.0	1 µeq/l	0.17	3.31%
Maximum			**3.38**	**10.2%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Following the completion of construction activities, cumulative and Proposed Action visibility impacts would be reduced from 30 days to 25 days of impairment greater than 1.0 deciview. The reduction in visibility impacts would result primarily from a decrease in particulate matter generated from construction activities and the elimination of NO_X emissions from drill rig engines. As presented in Table 5.3-15, the majority of the impaired days, 12, are predicted to occur within the Cloud Peak Wilderness. Other areas that would exhibit impaired visibility are Popo Agie Wilderness, Wind River Canyon, Wind River Roadless Area, Bridger Wilderness and the Owl Creek Range including Phlox Mountain. The greatest change in visibility, 2.10 dv at Wind River Canyon, represents a slight reduction from the 2.15 dv impact predicted for the construction phase of the Proposed Action.

Table 5.3-15. Cumulative and Proposed Action Post-Construction Total Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	1	1.02
Cloud Peak Wilderness	12	1.66
Fitzpatrick Wilderness	0	0.71
North Absaroka Wilderness	0	0.75
Owl Creek Range	3	1.94
Popo Agie Wilderness	3	1.19
Phlox Mountain	1	1.33
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.89
Wind River Canyon	3	2.10
Wind River Roadless Area	2	1.22
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**25**	**2.10**

5.3.3.5 Cumulative and Alternative A Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources in conjunction with Alternative A sources are summarized below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of cumulative and Alternative A sources are summarized in Table 5.3-16 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, impacts are predicted to occur at levels below the ambient standards.

Table 5.3-16. Cumulative and Alternative A Total Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (µg/m³)	Maximum Impact Location	Background Concentration (µg/m³)	Background Plus Impact (µg/m³)	WAAQS NAAQS Standard (µg/m³)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	1.63	Wind River Canyon	61	62.63	150	41.8%
	Annual	0.14	Wind River Canyon	22	22.14	50	44.3%

PSD Increments

Table 5.3-17 compares cumulative and Alternative A impacts with PSD Class I Increments. As demonstrated, increases in pollutant concentrations would not exceed the Class I Increments.

Table 5.3-17. Cumulative and Alternative A Total PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.5%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	1.63	Wind River Canyon	8	20.4%
	Annual	0.14	Wind River Canyon	4	3.5%

Terrestrial Acid Deposition

Alternative A emissions would not contribute substantially to cumulative terrestrial deposition rates of nitrogen or sulfur. Cumulative and Alternative A deposition rates would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable.

Aquatic Acid Deposition

Cumulative source and Alternative A emissions are predicted to cause changes in ANC levels at Florence Lake which exceed the LAC. For the remaining lakes of special concern, the predicted ANC impacts would be less than the LACs. All impacts are summarized in Table 5.3-18.

Table 5.3-18. Cumulative and Alternative A Total ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (μeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (μeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 μeq/l	0.17	0.26%
Deep Lake	59.9	10% or 6.0 μeq/l	0.17	0.29%
Emerald Lake	69.8	10% or 7.0 μeq/l	2.13	3.1%
Florence Lake	33.0	10% or 3.3 μeq/l	3.39	10.29%
Hobbs Lake	69.9	10% or 7.0 μeq/l	0.12	0.18%
Lower Saddlebag	55.5	10% or 5.6 μeq/l	0.18	0.32%
Ross Lake	53.5	10% or 5.4 μeq/l	0.11	0.20%
Stepping Stone Lake	19.9	1 μeq/l	0.05	0.23%
Twin Island Lake	17.6	1 μeq/l	0.05	0.30%
Upper Frozen Lake	5.0	1 μeq/l	0.18	3.5%
Maximum			**3.39**	**10.3%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative and Alternative A sources would cause 34 days of visibility impairment greater than 1.0 deciview. Cloud Peak Wilderness area would experience the greatest number of impaired days. Other areas that would exhibit impaired visibility are Popo Agie Wilderness, Wind River Canyon, Wind River Roadless Area, Bridger Wilderness and the Owl Creek Range including Phlox Mountain. As presented in Table 5.3-19, the greatest change in visibility, 2.22 dv, is predicted to occur within the Wind River Canyon.

Table 5.3-19. Cumulative and Alternative A Total Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	2	1.13
Cloud Peak Wilderness	12	1.66
Fitzpatrick Wilderness	0	0.73
North Absaroka Wilderness	0	0.77
Owl Creek Range	6	1.99
Popo Agie Wilderness	3	1.31
Phlox Mountain	1	1.35
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.90
Wind River Canyon	8	2.22
Wind River Roadless Area	2	1.28
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**34**	**2.22**

5.3.3.6 Cumulative and Alternative B Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources in conjunction with Alternative B emissions are summarized below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of cumulative and Alternative B sources are summarized in Table 5.3-20 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, impacts are predicted to occur at levels below the ambient standards.

Table 5.3-20. Cumulative and Alternative B Total Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	1.48	Wind River Canyon	61	62.48	150	41.7%
	Annual	0.13	Wind River Canyon	22	22.13	50	44.3%

PSD Increments

Table 5.3-21 compares cumulative and Alternative B impacts with PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the increments.

Table 5.3-21. Cumulative and Alternative B Total PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (µg/m^3)	Maximum Impact Location	PSD Class I Increment (µg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.5%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	1.48	Wind River Canyon	8	18.5%
	Annual	0.13	Wind River Canyon	4	3.2%

Terrestrial Acid Deposition

Alternative B emissions would not contribute substantially to cumulative terrestrial deposition rates of nitrogen or sulfur. Cumulative and Alternative B deposition rates would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable.

Aquatic Acid Deposition

Cumulative and Alternative B emissions are predicted to cause changes in ANC which exceed the LAC at Florence Lake. For the remaining lakes of special concern, the predicted ANC impacts would be less than the LACs. All impacts are summarized in Table 5.3-22.

Table 5.3-22. Cumulative and Alternative B Total ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.16	0.2%
Deep Lake	59.9	10% or 6.0 µeq/l	0.16	0.3%
Emerald Lake	69.8	10% or 7.0 µeq/l	2.11	3.0%
Florence Lake	33.0	10% or 3.3 µeq/l	3.38	10.2%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.12	0.2%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.17	0.3%
Ross Lake	53.5	10% or 5.4 µeq/l	0.10	0.2%
Stepping Stone Lake	19.9	1 µeq/l	0.05	0.2%
Twin Island Lake	17.6	1 µeq/l	0.05	0.3%
Upper Frozen Lake	5.0	1 µeq/l	0.17	3.3%
Maximum			3.38	10.2%

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative and Alternative B sources are predicted to cause 28 days of visibility impairment greater than 1.0 deciview. The majority of the impaired days, 12, are predicted to occur within the Cloud Peak Wilderness. Other areas that would exhibit impaired visibility are Popo Agie Wilderness, Wind River Canyon, Wind River Roadless Area, Bridger Wilderness and the Owl Creek Range including Phlox Mountain. As presented in Table 5.3-23, the greatest change in visibility, 2.12 dv, is predicted to occur within the Wind River Canyon.

Table 5.3-23. Cumulative and Alternative B Total Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	2	1.07
Cloud Peak Wilderness	12	1.66
Fitzpatrick Wilderness	0	0.71
North Absaroka Wilderness	0	0.75
Owl Creek Range	3	1.95
Popo Agie Wilderness	3	1.24
Phlox Mountain	1	1.34
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.89
Wind River Canyon	5	2.12
Wind River Roadless Area	2	1.25
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**28**	**2.12**

5.3.3.7 Cumulative and Alternative C Sources - Direct and Indirect Impacts

Potential air quality impacts resulting from cumulative sources in conjunction with the No Action Alternative sources are summarized below.

Ambient Air Quality Standards

Predicted maximum pollutant concentrations that could occur as a result of cumulative and No Action sources are summarized in the Table 5.3-24 and compared with the most stringent Wyoming and National ambient air quality standards. As demonstrated, impacts are predicted to occur at levels below the ambient standards.

Table 5.3-24. Cumulative and Alternative C Total Ambient Air Quality Standards Comparison.

Pollutant	Averaging Time	Maximum Predicted Impact (μg/m^3)	Maximum Impact Location	Background Concentration (μg/m^3)	Background Plus Impact (μg/m^3)	WAAQS NAAQS Standard (μg/m^3)	Impact Percentage of WAAQS/ NAAQS
NO_2	Annual	2.36	Cloud Peak Wilderness	3.4	5.76	100	5.8%
SO_2	3-hour	0.39	Grand Teton National Park	132	132.39	1300	10.2%
	24-hour	0.08	Grand Teton National Park	43	43.08	260	16.6%
	Annual	0.01	Grand Teton National Park	9	9.01	60	15.0%
PM_{10}	24-hour	0.22	Wind River Canyon	61	61.22	150	40.8%
	Annual	0.01	Wind River Canyon	22	22.01	50	44.0%

PSD Increments

Table 5.3-25 compares cumulative and No Action source impacts with the PSD Class I Increments. As demonstrated, increases in pollutant concentrations are not predicted to exceed the Class I Increments.

Table 5.3-25. Cumulative and Alternative C Total PSD Increment Comparison.

Pollutant	Averaging Time	Maximum Impact (μg/m^3)	Maximum Impact Location	PSD Class I Increment (μg/m^3)	Impact Percentage Of PSD Class I Increment
NO_2	Annual	2.36	Cloud Peak Wilderness	2.5	94.4%
SO_2	3-hour	0.39	Grand Teton National Park	25	1.5%
	24-hour	0.08	Grand Teton National Park	5	1.6%
	Annual	0.01	Grand Teton National Park	2	0.4%
PM_{10}	24-hour	0.22	Wind River Canyon	8	2.7%
	Annual	0.01	Wind River Canyon	4	0.3%

Terrestrial Acid Deposition

Emissions resulting from the No Action Alternative would not contribute substantially to cumulative terrestrial deposition rates of nitrogen or sulfur. Cumulative and Alternative C deposition rates would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable.

Aquatic Acid Deposition

Cumulative and No Action source emissions are predicted to cause changes in ANC levels at Florence Lake which exceed the LAC. As shown in Table 5.3-26, predicted changes in ANC levels would less than the LAC for the remaining lakes of special concern.

Table 5.3-26. Cumulative and Alternative C Total ANC Impacts.

High Elevation Lake	Baseline 10%Lowest ANC (µeq/l)	Level of Acceptable Change [1]	Predicted Change in ANC (µeq/l)	Percentage Change In ANC
Black Joe Lake	67.0	10% or 6.7 µeq/l	0.15	0.22%
Deep Lake	59.9	10% or 6.0 µeq/l	0.15	0.25%
Emerald Lake	69.8	10% or 7.0 µeq/l	2.10	3.00%
Florence Lake	33.0	10% or 3.3 µeq/l	3.36	10.18%
Hobbs Lake	69.9	10% or 7.0 µeq/l	0.12	0.17%
Lower Saddlebag	55.5	10% or 5.6 µeq/l	0.15	0.27%
Ross Lake	53.5	10% or 5.4 µeq/l	0.10	0.19%
Stepping Stone Lake	19.9	1 µeq/l	0.05	0.23%
Twin Island Lake	17.6	1 µeq/l	0.05	0.29%
Upper Frozen Lake	5.0	1 µeq/l	0.16	3.11%
Maximum			**3.36**	**10.18%**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (µeq/l), a LAC of no greater than 1 µeq/l is applied. For lakes with existing ANC levels greater than 25 µeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative and No Action sources are predicted to cause 24 days of visibility impairment greater than 1.0 deciview. The No Action Alternative would not substantially contribute to visibility impacts resulting from cumulative sources. As presented in Table 5.3-27, visibility impacts that may result from the combination of cumulative and no action sources are essentially equivalent to the predicted impacts for the cumulative sources alone.

Table 5.3-27. Cumulative and Alternative C Total Visibility Impairment.

Area of Special Concern	Number of Days with Δ dv Greater Than 1.0	Greatest Predicted Δ dv
Bridger Wilderness	0	0.98
Cloud Peak Wilderness	12	1.65
Fitzpatrick Wilderness	0	0.70
North Absaroka Wilderness	0	0.73
Owl Creek Range	3	1.90
Popo Agie Wilderness	3	1.15
Phlox Mountain	1	1.32
Grand Teton NP	0	0.55
Teton Wilderness	0	0.35
Washakie Wilderness	0	0.89
Wind River Canyon	3	2.04
Wind River Roadless Area	2	1.19
Yellowstone NP	0	0.42
Total Days / Max Δ dV	**24**	**2.04**

5.3.3.8 Summary of Cumulative Air Quality Impacts

Ambient Air Quality Standards and PSD Increments

Maximum predicted pollutant concentrations are summarized in Table 5.3-28 for cumulative sources in conjunction with project alternatives. Predicted impacts would not exceed the ambient standards or PSD Class I increments. Impacts upon SO_2 concentrations would be negligible. However, moderate impacts upon NO_2 and PM_{10} concentrations are predicted. The duration of the PM_{10} impacts would be short-term, occurring predominately during the development phase of the project. Following the completion of construction activities, PM_{10} impacts would be reduced to minor levels. The moderate NO_2 impacts would be long-term, existing for the duration of the project.

Table 5.3-28. Summary of Ambient Air Quality Impacts.

Pollutant	Averaging Time	Cumulative Source Maximum Predicted Impact (μg/m^3)	Cumulative and Proposed Action Maximum Predicted Impact (μg/m^3)	Cumulative and Proposed Action Post-Construction Maximum Predicted Impact (μg/m^3)	Cumulative and Alternative A Maximum Predicted Impact (μg/m^3)	Cumulative and Alternative B Maximum Predicted Impact (μg/m^3)	Cumulative and Alternative C Maximum Predicted Impact (μg/m^3)
NO_2	Annual	2.36	2.36	2.36	2.36	2.36	2.36
SO_2	3-hour	0.39	0.39	0.39	0.39	0.39	0.39
	24-hour	0.08	0.08	0.08	0.08	0.08	0.08
	Annual	0.01	0.01	0.01	0.01	0.01	0.01
PM_{10}	24-hour	0.08	1.51	0.10	1.63	1.48	0.22
	Annual	0.00	0.13	0.01	0.14	0.13	0.01

Terrestrial Acid Deposition

Total deposition rates resulting from cumulative and project sources would remain below both the “Red Line” and “Green Line” LOC, indicating that total deposition rates would be acceptable. Impacts upon total sulfur deposition would be negligible. Minor long-term nitrogen deposition impacts are predicted to occur at Could Peak Wilderness as a result of cumulative sources. The Wind River Project would not substantially contribute to the Cloud Peak deposition impacts. Nitrogen deposition impacts are predicted to be negligible for the remaining areas of special concern.

Aquatic Acid Deposition

Predicted impacts to lake ANC resulting from cumulative and project sources are summarized in Table 5.3-29. As a result of cumulative sources impacts are predicted to occur at two lakes located in Cloud Peak Wilderness. Moderate long-term impacts are predicted to occur at Florence Lake, where changes in ANC are predicted to exceed the level of acceptable change. Minor long-term impacts are predicted to occur at Emerald Lake where changes in ANC levels would be detectable. The contribution of Project sources upon these cumulative impacts would be negligible. Impacts to ANC at the remaining lakes of special concern would be negligible.

Table 5.3-29. Summary of Predicted ANC Impacts.

High Elevation Lake	Level of Acceptable Change [1] (μeq/l)	Cumulative Source Predicted Change in ANC (μeq/l)	Cumulative and Proposed Action Predicted Change in ANC (μeq/l)	Cumulative and Proposed Action Post-Construction Predicted Change in ANC (μeq/l)	Alternative A Predicted Change in ANC (μeq/l)	Alternative B Predicted Change in ANC (μeq/l)	Alternative C Predicted Change in ANC (μeq/l)
Black Joe Lake	6.7	0.15	0.17	0.16	0.17	0.16	0.15
Deep Lake	6.0	0.15	0.17	0.16	0.17	0.16	0.15
Emerald Lake	7.0	2.09	2.12	2.11	2.13	2.11	2.10
Florence Lake	3.3	3.36	3.39	3.38	3.39	3.38	3.36
Hobbs Lake	7.0	0.12	0.12	0.12	0.12	0.12	0.12
Lower Saddlebag	5.6	0.15	0.17	0.16	0.18	0.17	0.15
Ross Lake	5.4	0.10	0.10	0.10	0.11	0.10	0.10
Stepping Stone Lake	1.0	0.05	0.05	0.05	0.05	0.05	0.05
Twin Island Lake	1.0	0.05	0.05	0.05	0.05	0.05	0.05
Upper Frozen Lake	1.0	0.15	0.17	0.17	0.18	0.17	0.16
Maximum		**3.36**	**3.39**	**3.38**	**3.39**	**3.38**	**3.36**

1 - For lakes with existing acid neutralizing capacity (ANC) levels less than 25 microequivalents per liter (μeq/l), a LAC of no greater than 1 μeq/l is applied. For lakes with existing ANC levels greater than 25 μeq/l, the LAC is no greater than a 10 percent change in the background ANC

Visibility Impairment

Cumulative and Project sources would contribute to regional visibility impacts. Tables 5.3-30 and 5.3-31 summarize the predicted visibility impacts. Moderate long-term visibility impacts are predicted to occur at Cloud Peak Wilderness as a result of cumulative sources. However, the contribution from Project sources to the Cloud Peak impacts would be negligible. Moderate short-term visibility impacts are predicted to occur at Wind River Canyon and the Owl Creek Range, which includes Phlox Mountain. However impacts at these areas would be reduced to minor levels following the completion of project construction activities. Minor long-term visibility impacts would also occur at Bridger Wilderness, Popo Agie Wilderness, and the Wind River Roadless Area.

Table 5.3-30. Summary of Predicted Visibility Impairment Days.

Area of Special Concern	Cumulative Source Number of Days with Δ dv Greater Than 1.0	Cumulative and Proposed Action Number of Days with Δ dv Greater Than 1.0	Cumulative and Proposed Action Post-Construction Number of Days with Δ dv Greater Than 1.0	Cumulative and Alternative A Number of Days with Δ dv Greater Than 1.0	Cumulative and Alternative B Number of Days with Δ dv Greater Than 1.0	Cumulative and Alternative C Number of Days with Δ dv Greater Than 1.0
Bridger Wilderness	0	2	1	2	2	0
Cloud Peak Wilderness	12	12	12	12	12	12
Fitzpatrick Wilderness	0	0	0	0	0	0
North Absaroka Wilderness	0	0	0	0	0	0
Owl Creek Range	3	4	3	6	3	3
Popo Agie Wilderness	3	3	3	3	3	3
Phlox Mountain	1	1	1	1	1	1
Grand Teton NP	0	0	0	0	0	0
Teton Wilderness	0	0	0	0	0	0
Washakie Wilderness	0	0	0	0	0	0
Wind River Canyon	3	6	3	8	5	3
Wind River Roadless Area	2	2	2	2	2	2
Yellowstone NP	0	0	0	0	0	0
Total Days	**24**	**30**	**25**	**34**	**28**	**24**

Table 5.3-31. Summary of Predicted Visibility Impairment.

Area of Special Concern	Cumulative Source Greatest Predicted Δ dv	Cumulative and Proposed Action Greatest Predicted Δ dv	Cumulative and Proposed Action Post-Construction Greatest Predicted Δ dv	Cumulative and Alternative A Greatest Predicted Δ dv	Cumulative and Alternative B Greatest Predicted Δ dv	Cumulative and Alternative C Greatest Predicted Δ dv
Bridger Wilderness	0.96	1.10	1.02	1.13	1.07	0.98
Cloud Peak Wilderness	1.65	1.66	1.66	1.66	1.66	1.65
Fitzpatrick Wilderness	0.70	0.72	0.71	0.73	0.71	0.70
North Absaroka Wilderness	0.73	0.76	0.75	0.77	0.75	0.73
Owl Creek Range	1.90	1.97	1.94	1.99	1.95	1.90
Popo Agie Wilderness	1.14	1.27	1.19	1.31	1.24	1.15
Phlox Mountain	1.32	1.34	1.33	1.35	1.34	1.32
Grand Teton NP	0.55	0.55	0.55	0.55	0.55	0.55
Teton Wilderness	0.35	0.35	0.35	0.35	0.35	0.35
Washakie Wilderness	0.89	0.90	0.89	0.90	0.89	0.89
Wind River Canyon	2.03	2.15	2.10	2.22	2.12	2.04
Wind River Roadless Area	1.18	1.26	1.22	1.28	1.25	1.19
Yellowstone NP	0.42	0.42	0.42	0.42	0.42	0.42
Maximum Δ dv	**2.03**	**2.15**	**2.10**	**2.22**	**2.12**	**2.04**

5.3.4 Water Resources

Potential cumulative impacts on water resources would involve the combination of impacts from the proposed gas development activities in the WRPA with those impacts attributed to ongoing oil and gas development activities, recent construction projects, and reasonably foreseeable future projects. Cumulative impacts are assessed for the WRPA and the northern portion of the Boysen Reservoir watershed which includes the Fivemile Creek, Muddy Creek, and Cottonwood Creek drainage areas.

5.3.4.1 Wind River Project Area

Surface Water

Since oil and gas exploration and development activities must comply with federal and tribal environmental laws, major water quality and quantity impacts are not expected on a cumulative scale. On-going erosion of drill pads, roads, and other facilities result in increased sediment loading into Fivemile, Muddy, and Cottonwood Creeks. However, containment of sediment on-site and the reclamation of roadside ditches and pipeline right-of-ways have reduced sediment loading to creeks from these operations. Estimated sediment loading to the Boysen Reservoir, as presented in Appendix N for existing oil and gas operations, are 11 tons per year. According to the USGS (1994), approximately 561,000 tons per year of suspended sediment are carried by the Wind River into Boysen Reservoir. Each of the alternatives (Proposed Action and Alternatives A, B and C) and the existing development would represent less than 0.001 percent of the suspended solids entering Boysen Reservoir. Thus, the impacts from the Proposed Action and alternatives on surface water would be considered negligible. Overall, the cumulative impacts of the Wind River gas development project and other reasonably foreseeable future projects in the vicinity of the WRPA are expected to be minor.

The main source of salts, Sodium Adsorption Ratio (SAR), and other pollutants, as described in Chapter 3.5, in the WRPA, is from irrigation return water. There is a slight potential for increased salt, SAR, and nutrient loading in the WRPA, mainly due to agriculture activities. In terms of trace metals and other dissolved solids, the Wind River gas development project is expected to have no impact, unless there is a spill or loss of containment. To minimize such an impact, a Spill Prevention, Control, and Countermeasure (SPCC) Plan would be implemented. If an incident does occur, steps would be taken to contain it immediately to minimize the impact. Thus, the cumulative impacts of the Proposed Action or alternatives and other projects on surface water would be considered negligible.

Groundwater

To date, no serious groundwater pollution problems have been reported in the watershed within and adjacent to WRPA. Some concerns have been voiced by landowners to the Operators on the deterioration of the water quality of domestic water wells. However, studies conducted by consultants indicated that oil and gas activities were not directly responsible for the problems. In addition, oil and gas operations are required to implement Spill Prevention, Control and Countermeasure Plans minimizing the potential impacts of spills and loss of containment within and near the WRPA.

In terms of groundwater usage, all water for the construction and operation within the WRPA would be from water wells. As described in Chapter 4, these wells may been a permit or change of use from the State Water Engineer for state water rights and the Tribes for reserved water rights. It is estimated that total annual use over a 20-to 40- year life of project would be approximately 0.01 percent to 0.02 percent of the annual water available, and would result in negligible cumulative impacts.

5.3.4.2 Affected Watershed

Surface Water

As described in Chapter 3.5, the Fivemile Creek, Muddy Creek, and Cottonwood Creek watersheds have a total area of 915 mi^2. Within the affected watersheds, there is a potential of cumulative impacts from other activities occurring upstream from the WRPA. Evaluation of the Wyoming Department of Environmental Quality (2003) database for National Pollution Discharge Elimination System (NPDES) permits indicates that six permits have been issued for the Fivemile Creek drainage basin, with only one permit being current. There are no NPDES permits issued for Muddy Creek and Cottonwood Creek. As development occurs upstream from the WRPA additional discharges into theses streams may occur. Because produced water from each of the Alternatives will not be directly discharged into surface water, no NPDES permit would be required for the proposed operations. Thus, there would only be cumulative impacts to the streams from produced water and condensate if accidental spills occurred.

Based on a report by the USGS (1994), it is estimated that 243 tons of sediment are generated per square mile of the watersheds in the Wind River Basin or 222,300 tons/year for the combined basins of Fivemile, Muddy, and Cottonwood Creeks. The sediment increase from the Proposed Action is 47 tons/yr, Alternative A is 71 tons/yr, and Alternative B is 41 tons/yr and Alternative C is 16 tons/yr. These are 0.02 percent, 0.04 percent, and 0.02 percent, and 0.01 percent of the total sediment loading in these basins, respectively. These changes in sediment loading would not be measurable and are considered negligible in terms of potential cumulative impacts.

Groundwater

In the upper portions of the watershed, as with the WRPA, there have been no serious groundwater pollution problems. By complying with tribal and federal laws, using state-of-the-art drilling methods, lining pits, and implementing SPCC plans, the Proposed Action or Alternatives would not impact the groundwater systems. Because up-gradient groundwater systems discharge into streams prior to reaching the WRPA, no cumulative impacts would be expected to the groundwater system.

5.3.5 Vegetation and Wetlands

Cumulative effects of the Proposed Action or Alternatives to vegetation and wetlands were determined by combining the effects of each alternative with other past, present, and reasonably foreseeable future actions. Actions that have the potential to result in cumulative effects to vegetation and wetlands in conjunction with the oil/gas development within the WRPA are identified in Section 5.2.

The area analyzed for cumulative impacts on sagebrush, desert-shrub, mixed-grass prairie, greasewood fans and flats, and saltbush fans and flats, consists of all potential oil/gas exploration and development fields within the boundaries of the WRPA, and major and minor drainages, ponds and reservoirs, in the Boysen Reservoir watershed (which includes Muddy, Fivemile, and Cottonwood Creeks, Middle Depression Reservoir and state wildlife habitat management area ponds) within and adjacent to the WRPA. Specific locations where vegetation disturbance would occur within the WRPA are not currently known.

Likewise, in assessing cumulative impacts, it was not possible to specifically determine where future projects near the WRPA would occur.

5.3.5.1 Vegetation

Long-term disturbances are 422.7 acres under the Proposed Action, 611.9 acres under Alternative A, 325.1 acres under Alternative B, and 79.3 acres under Alternative C. Even when these effects are combined with the potential effects resulting from vegetation removal associated with gravel and sand mining, future transportation improvements, residential and commercial development, and timber harvesting, the cumulative impacts to vegetation would be minor.

Of more importance are the incremental effects of ecological changes in native Wyoming big sagebrush vegetation associated with proportionately higher growth of non-native grasses and loss of shrub cover. Past introduction of invasive grasses has changed the habitat and contributed to the decline in native species. Invasive grasses have changed the sagebrush habitat's physical structure, hydrology and salinity, productivity, energy flow, and fire cycle. Dominance of cheatgrass, and the shortening of fire return intervals, has modified ecosystem relationships. Declines in species diversity through competition, disruption of the food web, and genetic hybridization of sagebrush species is evident. These sagebrush habitat modifications and species modifications could create an irreversible shift in the ecosystem. With more sagebrush vegetation burned, there are fewer roots to hold the soil, resulting in increased erosion. Erosion increases sediment in the streams and reduces vegetative cover along riparian areas.

5.3.5.2 Wetlands

Riparian wetlands are subjected to many sources of disturbance in addition to oil and gas activities. Other sources that would impact riparian areas include use of ORVs and other recreation activities, and livestock grazing. Residential and commercial development would add additional motorized vehicles and visitors to the watershed.

The incremental effect from oil/gas development on riparian areas and wetlands would be indistinguishable from other types of land use effects. Foot traffic from hunting, hiking, and, grazing would occur in accessible riparian areas. Grazing occurs in some areas and affects the density of some wetland and riparian vegetation. Thus, current and future oil/gas development and other land use development would not produce any noticeable effect on vegetation and wetlands. Therefore, cumulative effects of the past, current, and reasonably foreseeable future activities would negligible.

5.3.6 Land Use

The Cumulative Impact Analysis (CIA) area for land use is the WRPA plus areas within a few miles of the WRPA. In addition to the Proposed Action or Alternatives A, B and C (No Action), the land use in the CIA area includes the current gas well development within the WRPA and the following reasonably foreseeable future actions that may occur within and/or adjacent to the WRPA: gravel/sand mining operations, residential development, casino/retail development, and other oil and gas exploration and development.

In addition to the gas development within the WRPA, it is reasonable to foresee future oil and gas development occurring on lands within the WRIR. The cumulative impact of further gas development in the region may influence land use within the WRPA as perceptions of the region may reflect the gradual industrialization of the landscape character. The land-use type that would most likely reflect this change in public perception would be residential. As the WRPA becomes more industrial in character, landowners within and adjacent to the WRPA may find it more difficult to develop their property for residential use. In addition, potential buyers may be discouraged from purchasing land or residences in these areas due to the shifting character of the surrounding lands.

Agricultural and ranching land use within the WRPA may be also be affected by the cumulative long-term disturbance. If gas development interferes with normal farm or ranching operations, farmers and ranchers may cease operations on those portions of land that are most affected.

Gravel/sand mining operations within the WRPA on tribal and/or BOR lands may displace some rangeland uses, but it is likely that cattle grazing would continue on lands immediately adjacent to the gravel/sand mines.

Therefore, cumulative impacts of oil and gas development, residential development, gravel mining and other reasonably foreseeable future activities would be minor.

5.3.7 Wildlife

The analysis of the area of cumulative impacts to wildlife varies by species, since each species has a different home range. The cumulative impact analysis evaluates all known past and present activities, as well as foreseeable future activities that are reasonably likely to occur within the WRPA, WRIR, and Boysen Reservoir watershed, including Muddy Creek, Fivemile Creek, and Cottonwood Creek sub-basins.

The major activity that occurs within and near the WRPA is oil and gas development. Other activities that occur in the area include residential and commercial development, agriculture and livestock grazing, and sand and gravel mining. These activities are not expected to increase substantially from the current levels. The residual disturbance resulting from the existing oil and gas development in the WRPA is shown in Table 5.3-32. However, the specific locations of the proposed wells, access roads, and ancillary facilities, have not been determined. The locations and acreage of disturbance from activities outside the WRPA have also not been determined, so that the cumulative impacts of the RFFAs cannot be estimated quantitatively.

Table 5.3-32. Residual Disturbance by Field within the WRPA[1].

	Alternatives				
Fields	**Existing Development (ac)**	**Proposed Action (ac)**	**Alternative A (ac)**	**Alternative B (ac)**	**Alternative C (No Action) (ac)**
Pavillion	159	159.4	215.5	113.7	79.4
Muddy Ridge	182	119.4	158.4	96.3	0
Sand Mesa	33	121.5	159.6	96.4	0
Sand Mesa South	0	16.7	59.4	13.5	0
Coastal Extension	0	5.7	18.7	5.2	0
Other wells within WRPA	36	-	-	-	-
TOTAL	**410**	**422.7**	**611.6**	**325.1**	**79.4**

[1] See Appendix C for details.

5.3.7.1 Big Game

Five big game species have been observed in the general vicinity of the WRPA. They include pronghorn antelope (*Antilocapra americana)*, mule deer (*Odocoileus hermionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and moose (*Alces alces*). Yearlong habitat exists in the WRPA for the pronghorn antelope and the mule deer. The elk use the northern portion of the WRPA on a limited basis. Incidental observations have been recorded for the white-tailed deer and moose. The ranges of these three species are based on maps provided by the WGFD (1999) (see Figures 3.8-1 to 3.8-5). Data on the specific ranges of game species within the WRIR are not available. Cumulative impacts to the game animals, including pronghorn antelope, mule deer, and elk; would include habitat disturbance, reduction in reproductive success, impacts on movement throughout the range, and increased mortality from vehicle collisions, and predation.

Pronghorn Antelope

There are an estimated 110,247 acres of yearlong pronghorn antelope habitat within the WRPA and east to Boysen Reservoir (see Figure 3.8-1). "Limited use" pronghorn antelope habitat also exists on BOR land within and near the WRPA. The residual disturbance estimates for the existing development, Proposed Action and Alternatives are shown in Table 5.3-33. However, the range of pronghorn antelope within the WRIR has not been determined.

Based on the small area of impact from the Wind River Gas Field Development Project within the pronghorn antelope's yearlong range, the cumulative effects of existing development and the Proposed Action or Alternatives would be negligible. Although the extent of disturbance from other types of reasonably foreseeable future activities near the WRPA has not been quantitatively determined, it is anticipated that the cumulative impacts of the current and proposed development and reasonably foreseeable future activities would be minor.

Table 5.3-33. Estimated Residual Disturbance from Existing and Proposed Development in the WRPA and in the Pronghorn Antelope Yearlong Range[1].

Alternative	Disturbance (ac.)	% of WRPA	% of Yearlong Habitat
Proposed Action	833.2	0.91	0.76
Alternative A	1022.4	1.11	0.93
Alternative B	735.6	0.80	0.67
Alternative C	489.8	0.53	0.44

[1] See Appendix C

Mule Deer

There are 258,993 acres of yearlong mule deer habitat within the WRPA and east to Boysen Reservoir (see Figure 3.8-2). The residual disturbance estimates for the existing development and Proposed Action and Alternatives within the WRPA are shown in Table 5.3-34. However, the extent of the mule deer habitat within the WRIR has not been determined.

Based on the small area of impact within the mule deer's yearlong range, from the Wind River Gas Field Development Project the cumulative effects of existing and proposed development would be negligible. Although the extent of disturbance from other types of reasonably foreseeable future activities near the WRPA has not been quantitatively determined, it is anticipated that the cumulative impacts of the current and proposed development and reasonably foreseeable future activities would be minor.

Table 5.3-34. Estimated Disturbance from the Existing and Proposed Development within the WRPA and in the Mule Deer Yearlong Range[1].

Alternative	Disturbance (acres)	% of WRPA	% of Year-Long Habitat
Proposed Action	8333.2	0.91	0.32
Alternative A	1022.4	1.11	0.39
Alternative B	735.6	0.80	0.28
Alternative C	489.8	0.53	0.19

[1] See Appendix C

Elk

There are 30,354 acres of "limited use" elk habitat within the WRPA and east to Boysen Reservoir (see Figure 3.8-4). The residual disturbance estimates for the existing development, Proposed Action, and Alternatives within the WRPA are shown in Table 5.3-35. However, the extent of elk habitat within the WRIR has not been determined.

Based on the small area of impact from the Wind River Gas Field Development Project the elk's limited-use habitat, the cumulative effects of existing and proposed development would be negligible. Although the extent of disturbance from other types of reasonably foreseeable future activities near the WRPA has not been quantitatively determined, it is anticipated that the cumulative impacts of current and proposed development and reasonably foreseeable future activities would be minor.

Table 5.3-35. Estimated Residual Disturbance from Existing and Proposed Development in the WRPA and in the Elk Limited-Use Area[1].

Alternative	Disturbance (acres)	WRPA (%)	Limited-Use Area (%)
Proposed Action	833.2	0.91	2.75
Alternative A	1022.4	1.11	3.37
Alternative B	735.6	0.80	2.42
Alternative C	489.8	0.53	1.61

[1]See Appendix C

5.3.7.2 Raptors

Several species of raptors, including golden eagles, have been reported in the WRPA, and nests of raptors have also been observed within and adjacent to the WRPA (see Figure 3.8-6 and Appendix I). The home range of raptors varies based on the species and size. The home range of the northern goshawk is approximately 5,900 acres (rrc.boisestate.edu, accessed January 16, 2004); the home range of Swainson's hawk is approximately 1,280 acres [(www.id.blm.gov/bopnca/swainson.htm) accessed January 16, 2004]; and the home range of the red-tailed hawk varies from 292-1,150 acres. The residual impact in the Muddy Ridge and Pavillion fields, where the red-tailed hawks and nests have been observed (Buys & Associates 2003a), is estimated to be 619.8.8 acres (341.0 acres of disturbance from current operations and 278.8 acres under the Proposed Action). Raptors could potentially be impacted by destruction of habitat, noise from construction activities, and reduction in prey species. Since there are few trees or rocky ledges in the Sand Mesa, Sand Mesa South, and Coastal Extension fields, the impacts to raptors in these fields are expected to be negligible. Implementation of the mitigation measures described in Chapter 2, such as no drilling within one mile of raptor nests, would further reduce potential cumulative impacts. There could be a reduction in prey species from disturbance of prey habitat. The disturbance to prey habitat attributed to the current oil and gas operations and the Proposed Action is 833.2 acres or 0.91 percent of the WRPA. Even with additional habitat disturbance from other oil and gas development projects, residential and commercial development, and gravel mining, the cumulative impacts to raptors are expected to be minor.

5.3.7.3 Game Birds

Several species of game birds, including ring-necked pheasant, Canada goose, waterfowl (e.g., western grebe, cinnamon teal, northern pintail), sage-grouse, and gray partridge, have been reported for the WRPA, WRIR, and other areas in the vicinity of the Wind River Gas Field Development Project (see Appendix I). Cumulative impacts would occur to these species due to the increased human activity, noise, and traffic associated with the various development activities expected to occur within and near the WRPA in the reasonably foreseeable future. With the implementation of the mitigation measures described in Chapter 2, the cumulative impacts to game birds are anticipated to be minor.

5.3.7.4 Fish

Several fish species were reported from Muddy, Fivemile, and Cottonwood Creeks within WRPA (See Appendix I). Sport fish are stocked in Middle Reservoir, Boysen Reservoir and Ocean Lake. Since no oil and gas activities are allowed within 500 feet of a stream or other waterbody, the impacts from gas development are expected to be negligible. Other activities, such as residential development, agriculture, and grazing, and sand and gravel extraction, which may occur adjacent to creeks, lakes and reservoirs, may have a greater impact on the fish than oil and gas operations. Overall the cumulative impacts from the proposed gas development and other reasonably foreseeable future activities are likely to be minor. With implementation of the mitigation measures described in Chapter 2 impacts to native and sport fish would be further reduced.

5.3.8 Threatened, Endangered, and-Sensitive Species

Cumulative effects on threatened, endangered, and state-sensitive species were determined by combining the effects of each development alternative with other past, present, and reasonably foreseeable future actions.

The area analyzed for cumulative impacts on threatened, endangered or state-sensitive species consists of terrestrial and aquatic habitats, streams, ponds, and reservoirs in the northern portion of the Boysen Reservoir watershed, and includes the Muddy, Fivemile and Cottonwood Creek sub-basins within and adjacent to the WRPA. Cumulative effects that could occur both within and outside of these areas are evaluated.

Oil/gas development under the Proposed Action or Alternatives would be a negligible contributor to the cumulative impacts to federally listed, or state-sensitive species and their habitats within the WRPA. Even when these effects are combined with the incremental effects resulting from future residential and commercial development, gravel and sand mining, and increased vehicle use; the cumulative impacts would be minor. Reclamation and mitigation actions would further reduce cumulative impacts. The potential cumulative impacts on individual threatened, endangered and sensitive species are discussed below.

Bald Eagle

There would be negligible cumulative impacts from the gradual modification or incremental loss of bald eagle foraging habitat from oil and gas development within the WRPA and the Muddy, Fivemile and Cottonwood Creek sub-basins. Since this species is known to winter in the area, there could be sporadic disturbance of individual eagles by construction, oil/gas development, or gravel mining. Recreational boating and hunting activities would continue within and adjacent to the WRPA could also contribute to cumulative impacts. However, the moderate level of these activities in bald eagle foraging habitat would have little impact on the available prey base. Therefore, the cumulative effects of these activities to the bald eagle wintering habitat would be minor.

Black-footed Ferret

There could potentially be direct, minor cumulative effects from incremental loss of black-footed ferret habitat (i.e., white-tailed prairie dog colonies) from oil/gas development within the WRPA, WRIR and the Boysen Reservoir watershed. The oil and gas activities, combined with reasonably foreseeable future grazing, agricultural, and residential development, could also cause a reduction in ferret habitat. However, the requirement by the U.S. FWS to survey all white-tailed prairie dog colonies for the presence of black-footed ferrets prior to any development would prevent cumulative impacts from occurring.

Canada Lynx

Due to the lack of forested habitat and the primary prey species, (i.e., snow shoe hare) within and adjacent to the WRPA, there would be no cumulative effects from past, present, and reasonably foreseeable future activities to the Canada lynx.

Grizzly Bear and Gray Wolf

There have been incidental observations of grizzly bears and gray wolves in the WRPA and WRIR. Although there could be some effects to grizzly bear and gray wolf habitat, they would be temporary and localized. The degree of habitat displacement would be related to the impacts to oil/gas development and other types of development occurring at any one time. As construction and is completed and abandoned well sites reclaimed, the amount of grizzly bear and gray wolf habitat would be reduced. Thus, implementation of the Proposed Action or alternatives, in conjunction with other reasonably foreseeable future development, would result in negligible cumulative impacts to these species.

Greater Sage-Grouse

The greater sage grouse is considered to be a species of concern by the USFWS an WGFD. Continued conversion of native sagebrush to cropland, and residential and commercial development would reduce sage grouse habitat at a greater rate than oil/gas development. Past grazing practices within the sagebrush habitat, that encourage taller grasses and forbs, have increased the non-native grasses and altered wildfire regimes. Altered fire regimes are believed to be the single, most important, negative influence on sage-grouse habitat since sagebrush does not re-establish under frequent fire cycles (BLM 2003a). Conversion of sagebrush or mixed-grass prairie to cropland is likely to continue, resulting in moderate cumulative effects on this species, due to the incremental habitat loss from conversion to agriculture (USFWS 2002a).

Accidental oil/gas spills and exposure to agricultural insecticides and herbicides used on adjacent croplands, would result in cumulative impacts to sage grouse (Blus et al. 1989). However, most sage grouse nest sites and foraging areas are in sagebrush or rangelands, where the use of these chemicals is limited.

Mountain Plover

The mountain plover was recently removed from the list of proposed threatened species (USFWS 2003b). Nevertheless, this species is considered a species of special concern by the WGFD and USFWS. The mountain plover is commonly associated with prairie dog colonies. Since a large number of prairie dogs colonies have been eliminated throughout their range, mountain plover habitat has also been greatly reduced. According to the USFWS, habitat loss, as a result of changes in vegetative communities, has resulted in moderate impacts to the mountain plover (USFWS 2003b). Therefore, loss of mountain plover habitat from the various development activities within and adjacent to the WRPA may result in moderate cumulative impacts. Oil and gas development will contribute only in minor amount.

5.3.9 RECREATION

Cumulative impacts to recreation have been analyzed for the WRPA, the WRIR, and the WHMAs adjacent to WRPA. Reasonably foreseeable future development includes other oil and gas development in the WRIR, agriculture and grazing, and residential development in and near the WRPA. These activities in addition to gas development in the WRPA, could potentially cumulatively impact recreation.

5.3.9.1 Oil and Gas Development

To date, oil and gas development within and near the WRPA has had a minor impact on recreation resources. As analyzed in Chapter 4, Environmental Consequences, the Proposed Action or Alternatives could increase impacts somewhat, but have a minor impact overall on recreation resources.

In the reasonably foreseeable future, the cumulative impact of oil and gas development would be the sum of the residual disturbance from past and existing gas development plus residual disturbance from new gas development from the Proposed Action or Alternatives, as well as any additional potential impacts of other oil and gas development in the WRIR.

The cumulative impacts of past oil and gas development plus potential impacts of the Proposed Action or Alternatives could range from 0.53 percent of the total acreage of the WRPA for Alternative C to 0.1.11 percent for Alternative A. This is based on estimates of cumulative residual disturbance for each alternative:

- **Proposed Action – 325 Wells.** The Proposed Action could add approximately 422.7 acres of residual disturbance to the existing residual disturbance of 410.5 acres, for a cumulative residual disturbance of 833.2 acres, or 0.91 percent of the WRPA,

- **Alternative A – 485 Wells.** Alternative A could add approximately 611.9 acres of residual disturbance to the existing residual disturbance, for a cumulative residual disturbance of 1022.4 acres, or 1.11 percent of the WRPA.

- **Alternative B – 233 Wells.** Alternative B could add approximately 325.1 acres of residual disturbance to the existing residual disturbance, for a cumulative residual disturbance of 735.6 acres, or 0.80 percent of the WRPA.

- **Alternative C (No Action) – 100 Wells, Pavillion Field Only.** Alternative C could add approximately 79.3 acres of residual disturbance to the total, for a cumulative residual disturbance of 489.8 acres, or 0.53 percent of the WRPA.

The effect of residual disturbance would be concentrated within the five fields, increasing the percentage of disturbed lands in those areas. However, even at within-field disturbance percentages, it is unlikely that the cumulative impacts of existing and proposed oil and gas development within the WRPA could be higher than the incremental impacts of the alternatives. In other words, the cumulative impact of oil and gas development is likely to be about the same as the incremental impact of the proposed project itself, regardless of alternative.

5.3.9.2 Oil and Gas Development Outside the WRPA

Other foreseeable future activities include oil and gas exploration and development that is planned for north and west of the WRPA in the WRIR. Development in this general area would probably have a negligible impact on the resources already affected in the WRPA because of their distance from existing fields, probably five miles or more, assuming that new oil and gas development takes place adjacent to the northwest corner of the WRPA.

However, reasonably foreseeable future oil and gas exploration and development in that area could potentially impact recreation resources in the northwest corner of the WRPA that may not have been affected to date. These would probably be lands that Tribal members may use for hunting in the vicinity of Muddy Ridge. Foreseeable future exploration and development nearby could potentially change patterns of game use, affect the density of game populations and potentially displace hunters or impact the quality of the hunting experience. The locations of future oil and gas activity on WRIR land are not known at this time. The impacts to tribal hunting resources within the WRPA would likely be minor and would not change the level of cumulative impacts to the recreation resources of various kinds in the WRPA.

5.3.9.3 Other Reasonably Foreseeable Future Development (RFFD)

Irrigated agriculture began with private and public water development projects in the early 20th century. Original game habitat lost in the conversion to cropland was replaced by new game habitat supported by water development. Agricultural areas support the levels of recreational hunting and fishing that exist today and provide hunting, fishing and other recreation activity—including pheasant and waterfowl hunting and water-based, non-consumptive recreation—that are regionally important in an otherwise dry part of the state.

Recreational access to lakes, streams and related facilities that were originally developed or improved by the BOR, is now maintained by Wyoming state agencies, (e.g. Boysen State Park, Sand Mesa WHMA, and Ocean Lake WHMA). On a smaller scale, the state promotes public access to private habitat through the leasing of "walk-in" hunting areas. Recreation opportunities are greater today because of water development and irrigated agriculture, which have jointly had a major beneficial impact on recreation in the WRPA.

Residential development can impact recreation resources by absorbing or fragmenting habitat, changing game populations and distribution, and increasing demand for recreation. However, impacts to recreation from residential development in and near the WRPA have been minimal.

As noted in Section 4.7 (Land Use), the nearest residential area is the Town of Pavillion, one mile west of the WRPA. Most of the residences in and near the WRPA are isolated homes that are part of larger agricultural areas. Tribal land in and near the WRPA has no residential development. These Tribal lands are devoted to rangeland and resource extraction, and most are in more remote area of the WRIR that is not served by a federal or state highways.

These characteristics suggest that Reasonably Foreseeable Future Development (RFFD) is unlikely to include more than limited residential development on private land and on Tribal land. Given that scenario, residential development in the future would make a minor contribution to cumulative impacts to recreation resources in and near the WRPA.

5.3.10 Visual Resources

The Cumulative Impacts Analysis (CIA) area for visual resources is the WRPA plus the vicinity around the WRPA, where people can see the wells and facilities (assumed to be within a few miles of the WRPA boundaries). In addition to the Proposed Action or Alternatives A, B and C (No Action), the visual resource CIA area includes the following reasonably foreseeable future activities actions that may occur within and/or adjacent to the

WRPA: gravel/sand mining operations, residential development, casino/retail development, and oil and gas exploration and development.

The Proposed Action and Alternatives A, B and C (No Action) would add to the existing impact to visual resources associated with natural gas development in the WRPA. Impacts to visual resources within the WRPA under the Proposed Action and Alternatives A and B would shift the character of the landscape in some areas from farming and ranching to a more industrial nature. Alternative C (No Action) would result in similar cumulative impacts over a smaller geographic area, as development would be limited to the Pavillion field. However, because Pavillion field is located within the most densely populated area of the WRPA, the limited geographic influence on cumulative impacts has the potential to affect a large number of people, when compared to the entire population within the WRPA. Reasonably foreseeable future development of one or multiple gravel/sand extraction operations within the WRPA would contribute to the change in landscape character by creating additional contrasts in the line, color, form and texture with the surrounding landscape.

The cumulative effects of these visual impacts would create the appearance of a highly modified landscape and alter the visual experience for those traveling through or residing in the WRPA. This change in overall landscape character may affect property values within the WRPA, which may influence future residential development. Visitation to recreation areas within and adjacent to the WRPA may also be affected by this change in landscape character and visual experience. One has to remember these are not public lands. Non-Indians are “guests” on the Reservation.

5.3.11 Cultural Resources

The CIA area for cultural resources is the WRPA and adjacent areas within the Wind River Indian Reservation in Fremont County. The WRPA and surrounding areas are known to contain archaeological sites associated with nearly all of the prehistoric phases and complexes dating to about 11,000 years ago. Only about 20 percent of the WRPA has been surveyed for cultural resources, and no major excavations have been completed in the area. It is therefore possible that the WRPA contains archaeological sites that would contribute substantially to our understanding of prehistory. Development of natural gas fields in this area has been accomplished since 1960 without reported adverse impacts to significant archaeological sites, and the limited extent of the proposed gas development (in terms of percentage of total land area) indicates that proposed development under the Proposed Action or Alternatives A, B or C could be accomplished without substantial impacts to significant archaeological resources. If significant archaeological sites cannot be avoided, impacts to the sites can be mitigated through data recovery, which would add to the body of knowledge about the prehistory of the region.

Available cultural resources records and literature sources have not indicated that outstanding cultural resources exist within the WRPA that might be visually affected by natural gas development. Elders of the Eastern Shoshone and Northern Arapaho Tribes have indicated that potential Traditional Cultural Properties do not exist within the WRPA. Execution of the proposed natural gas development in conjunction with other reasonably foreseeable future activity in the WRIR is, therefore, unlikely to have substantial cumulative impacts to cultural resources under the Proposed Action or Alternatives A, B, and C.

5.3.12 Socioeconomics

5.3.12.1 Introduction

Potential cumulative socioeconomic effects are assessed for the following areas:

- Wind River Indian Reservation
- Fremont County
- WRPA portion of the Midvale Irrigation District

Cumulative socioeconomic effects would be associated with past, current and reasonably foreseeable future activities that affect economic, employment and population conditions on the WRIR and within Fremont County. Past natural gas development and future residential, commercial and industrial development in the WRPA portion of the MID could also result in cumulative socioeconomic impacts.

5.3.12.2 Reasonably Foreseeable Future Activities on the Wind River Indian Reservation

The Northern Arapaho Tribe has announced plans to build a casino on the WRIR south of Riverton. Current plans are to begin construction in the spring of 2004. Some US Department of Interior approvals are still pending, however (Casper Star Tribune 2003, Thorsen 2004). Under the most optimistic schedule, it is likely to be several years before the casino would be operational. While the casino could require some non-local employees, most of the workforce is anticipated to come from the WRIR and Fremont County. The small non-local workforce would not appreciably add to county population or housing demand in the early years of operation. Depending on the scale and success of the casino, the effects on indirect employment in retail, wholesale, service and other sectors of the local economy could be substantial. However, many of these jobs would also be filled from the local labor pool. Therefore, population increases associated with the casino would be anticipated to be negligible to minor.

5.3.12.3 Reasonably Foreseeable Future Activities in Fremont County

The Town of Riverton has recently decided to pursue location of a Wyoming Department of Corrections prison facility in the Riverton area. The site selection process is in the early stages, therefore it is not yet known if Riverton will be successful in its efforts (Riverton Ranger 2003b, Thorsen 2004). Consequently the potential prison facility was not considered in this cumulative assessment.

There are considerable oil and gas reserves in Fremont County. In 2001, Fremont County produced six percent of all oil produced in Wyoming and nine percent of all gas. Exploration and production of oil and gas resources is driven in large part by price. Substantial increases in the price of oil and gas could accelerate oil and gas exploration and development in the county and elsewhere in the state, resulting in increases in employment and, potentially, population. As described in Section 4.13, the regional oil and gas service industry could accommodate a substantial increase in activity with existing capacity and by hiring or in some cases re-hiring currently unemployed or underemployed workers in the region. Moreover, community infrastructure in Riverton has capacity to accommodate population levels that are higher than currently exist. Consequently, moderate increases in oil and gas exploration and development could be accommodated by the existing oil and gas service industry, local labor pool and community infrastructure.

5.3.12.4 Past, Present and Reasonably Foreseeable Future Activities in the WRPA

Currently, there are 178 producing wells in the WRPA, including 100 in the Pavillion field, 75 in the Muddy Ridge field and 3 in the Sand Mesa field. These wells, ancillary facilities and the associated development and production activity have affected socioeconomic conditions in the WRPA, and these effects are described as part of the characterization of the affected environment contained in Section 3.13.6. Currently the existing WRPA wells are in the production stage, and generate lower levels of activity than during development. But, when combined with the development associated with the Proposed Action or alternatives, the existing development would contribute to cumulative impacts on certain elements of the socioeconomic environment. Cumulative economic, employment, and fiscal effects would be positive. Cumulative effects on split estate, the rural character of certain areas within the WRPA and associated property values could be negative.

Most cumulative socioeconomic effects would occur in the Pavillion and Muddy Ridge fields; the Sand Mesa field has only three producing wells, there has been no development in the Sand Mesa South field and no recent development in the Coastal Extension field. Under Alternative C – No Action, cumulative socioeconomic effects would occur only in the Pavillion field.

Cumulative gas field activities would increase demand for law enforcement and emergency response services under all alternatives, but the increment of demand associated with proposed production activities is minor.

The existing natural gas-related disturbance on irrigated land would result in losses in MID assessment revenues, if the BOR were to reclassify agricultural land within the district (see Section 3.13.6.1). The Operators anticipate drilling wells on irrigated land only in the Pavillion field. For wells on irrigated lands, where well heads and access roads have been reclaimed to an approximate 8 foot by 8 foot disturbance area, the total amount of residual disturbance for all wells would be substantially less than 1 acre, for any alternative, which would result in losses of less than $15.00/year to the MID, if the BOR reclassified the land. Residual disturbance for production facilities associated with wells on irrigated land would total an estimated 20.7 acres under the Proposed Action, although many of these facilities would be located along roads and off irrigated lands. Total Proposed Action-related residual disturbance for wells and production facilities in the Pavillion field would be about 21 acres which would result in losses in $315/year to the MID if the BOR were to reclassify the land. The amount of existing residual disturbance associated with older wells and facilities on all lands is 145 acres. Although most is on dry land, some portion of those wells and facilities are located on irrigated lands. The portion of older wells and facilities on irrigated land has not been identified for this assessment; however, it is substantially less than 100 acres. For illustration purposes, if all 100 acres were reclassified by the BOR, the MID would lose $1,500/year in assessment revenues, which, when added to the potential lost revenue amounts associated with existing new wells on irrigated lands and proposed wells on irrigated lands, the total lost revenue would be less than $2,000 a year under any alternative.

Although the potential for conflict on split-estate lands is diminished during the production phase, conflict still could occur, particularly during reentry on surface lands for re-completion and other well maintenance activities. As with the Proposed Action and alternatives, the mitigation measures listed in Section 4.13.7 would reduce the potential for conflict.

Although natural gas development has been ongoing in the Pavillion field for over 40 years, the recent acceleration in the pace of development, and the resultant cumulative disturbance and increased development and production activity has accelerated the pace of change in rural character toward a mixture of rural and resource extraction land uses.

The combined existing and proposed gas development would remove some agricultural land from production and potentially disrupt irrigation systems and cultivation practices, affecting net income of agricultural operations. This loss in agricultural income would be offset by surface use agreement payments and Operator-committed mitigation measures.=

Potential future commercial and industrial activities which may affect socioeconomic conditions in the WRPA include sand and gravel mining on Tribal lands within the WRPA and sand and gravel mining, oil and gas exploration and development, and timber harvesting on the WRIR lands north and west of the WRPA. At present, the location, timing, size and other characteristics of these activities are unspecified, so the cumulative effects of these activities on socioeconomic conditions within the WRPA cannot be assessed.

5.3.13 TRANSPORTATION

The cumulative impacts analysis area for transportation includes the WRPA and the adjacent segments of the federal and state highways and county roads that provide access to the WRPA. Traffic generating activities within the WRIR and Fremont County were also considered for the cumulative assessment.

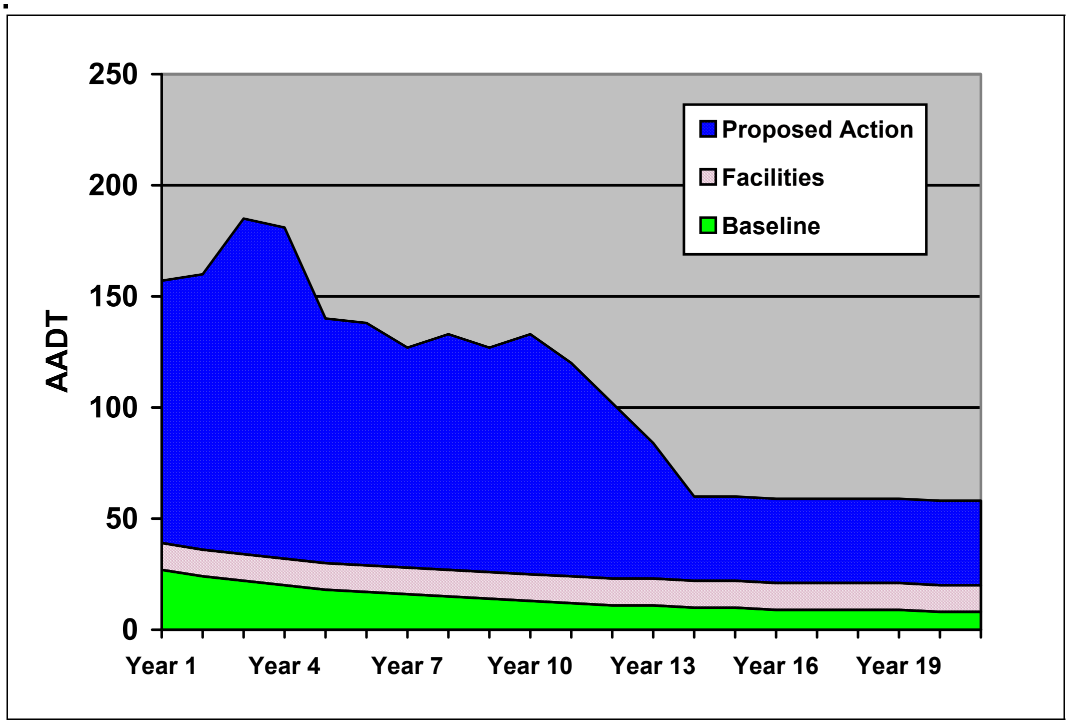
5.3.13.1 Reasonably Foreseeable Future Activities Potentially Affecting Transportation Conditions in the WRPA

Potential cumulative transportation impacts would be associated with existing and future natural gas development and production operations in the WRPA, existing and potential increases in residential, agricultural, recreational and Midvale Irrigation District (MID) traffic within the WRPA, potential increases in commercial and industrial traffic in and near the WRPA, and increases in thru-traffic on the adjacent segments of the federal and state highways providing access to the WRPA.

Existing Natural Gas Operations within the WRPA

Figure 5-2 displays projected total average annual daily traffic (AADT) to and from the WRPA for traffic associated with existing production operations, traffic associated with compression and production facilities within the WRPA, and traffic associated with the Proposed Action.

Figure 5-2.Cumulative WRPA AADT including Baseline, Facilities and Proposed Action.



As shown by Figure 5-2, baseline AADT, associated with existing gas production operations, would decline over time as existing wells cease production and are plugged and abandoned, but compression and production facilities AADT would remain relatively constant as new production replaces production from existing wells. Cumulative gas operations AADT would peak at an estimated 158 in the third year of the Proposed Action and decline to about 58 after the development phase of the Proposed Action is completed. Cumulative gas production AADT would continue to decline over time as wells are plugged and abandoned.

Residential, Agricultural and Recreational Activities within the WRPA

In addition to the natural gas-related activities discussed above, existing traffic within the WRPA is generated by residential, agricultural and recreational land uses, and by the activities of the MID.

Residential land uses in the WRPA may increase in the near term as larger parcels of farm land are subdivided, sold and developed into low-density residential housing. This trend is currently occurring in parts of the WRPA, but at current levels would not increase traffic appreciably across the entire WRPA over the next several decades. Agricultural activities and related traffic are anticipated to remain relatively constant.

Recreational use within the WRPA may also increase over time. Recreational use data for Boysen Reservoir, Bass Lake, and Ocean Lake all show generally flat or slightly upward trends, with seasonal variations and changes in use in response to fluctuations in reservoir levels. This is especially true at Boysen Reservoir's west side and at Bass Lake. Boysen Reservoir has excess day and overnight recreation use capacity throughout the park, so in the future, increases on the west side (potentially affecting Bass Lake Road) would be slightly upward, but not disproportionate to the rest of the park. It is likely that the features of the Sand Mesa WHMA will be maintained rather than expanded, and no improvements are planned which would drive increases in recreational use of tribal and private lands (see Section 4.10.6).

The MID has an ongoing program of maintenance of water distribution and drainage systems within the WRPA and elsewhere in the district, which generates fluctuating volumes of truck and heavy equipment traffic on a short-term basis. In addition, the MID is emphasizing conversion from open conduits to pipelines and sprinklers. Conversion of water distribution and delivery systems may generate additional construction traffic, but this traffic would be short-term in nature.

Commercial and Industrial Activities in and near the WRPA

Potential future commercial and industrial activities, which may affect traffic conditions, include sand and gravel mining on Tribal lands within the WRPA and sand and gravel mining, oil and gas exploration and development, and timber harvesting on the WRIR lands north and west of the WRPA. At present, the location, timing, size and other characteristics of these activities are unspecified, so the cumulative effects of these activities on highways and roads providing access to and within the WRPA cannot be assessed.

The Northern Arapaho Tribe is planning to build a casino on tribal land located south of Riverton, and has hired an architectural firm and a construction contractor (Casper Star Tribune 2003). This development would likely increase thru-traffic on US 26 north and west of Riverton, but the cumulative effect of casino and WRPA traffic is likely to be relatively small when compared to peak summer-time traffic volumes that already occur on this highway. Development of the casino would be unlikely to have a measurable effect on other highways and roads providing access to and within the WRPA.

The Riverton City Council has decided to actively pursue the construction and operations of a new medium security state prison in Riverton (Riverton Ranger 2003b). At present, it is not known when or whether the State of Wyoming will decide to locate a prison in the Riverton area, so the effects of the prison on area highways cannot be assessed.

5.3.13.2 Federal and State Highways Providing Access to the WRPA

Table 5.3-36 displays percentage increases and decreases in total and truck AADT on highways proving access to the WRPA between 1991 and 2001.

Table 5.3-36: Percentage Increase (Decrease) in Average Annual Daily Traffic on Highways Providing Access to the WRPA: 1991 – 2001.

Highway	Segment	Total Increase in Overall AADT: 1991 - 2001	Total Increase in Truck AADT: 1991 - 2001
US 26/789	Shoshoni west corporate limits	8%	-8%
	Junction WYO 134	27%	-23%
	Riverton north corporate limits	32%	-8%
US 26	Riverton west corporate limits	35%	-9%
	Junction WYO 133	28%	-14%
WYO 134	Junction US 26	59%	47%
	Midvale	40%	23%
WYO 133	Junction US 26	44%	20%
	Junction WYO 134	41%	-23%
	Pavillion west corporate limits	37%	-23%

As shown by the table, AADT increased on every affected segment between 1991 and 2001. Increases ranged from 8 percent at the west corporate limits of Shoshoni (or less than one percent per year) to 59 percent at the junction of US 26 and WYO 134 (almost 6 percent per year). In contrast, truck traffic decreased on most segments, the notable exception being on WYO 134, which had a 47 percent increase at the junction with US 26 and a 20 percent increase at Midvale, and the junction of WYO 133 and US 26, which had a 20 percent increase. Although the percentage increase in truck traffic at these locations was substantial, the numerical increase was modest, ranging from 35 more trucks per day at the junction of WYO 134 and US 26, to 15 more trucks per day at both WYO 134 at Midvale and the junction of WYO 133 and US 26.

WYDOT has not prepared forecasts of future traffic conditions on the highways which provide access to the WRPA, but the agency generally assumes that traffic increases on highways across the state will average from 3 to 5 percent annually (Steele 2003), which is consistent with average annual increases on most of the affected segments between 1991 and 2001. If this assumption holds in the future, traffic on the affected segments would double in 15 to 25 years. As traffic from other sources on affected highway segments increases over time, the traffic associated with the Proposed Action or alternatives would become a smaller portion of the total traffic on these highways. Consequently, the contribution of the Proposed Action or other alternatives to cumulative traffic volume on highways providing access to the WRPA would be negligible to minor on most segments, except where gas related traffic converges on WYO 134 in the Midvale area, where impacts and particularly truck impacts could be minor to moderate.

5.3.13.3 Fremont County Roads Providing Access to and within the WRPA

As noted above, residential, and recreational traffic within the WRPA may increase modestly over the next several decades. Traffic associated with agricultural activities is anticipated to remain relatively stable and traffic associated with the MID may show short term increases during facility construction and reconstruction. Traffic associated with existing natural gas operations would decline over time. Although there may be some traffic associated with natural resource extraction activities within the WRPA (sand and gravel mining) and outside the WRPA to the north and west (sand and gravel mining, oil and gas exploration and development, timber harvesting) schedules and locations for these activities have not been specified and have not been considered for this assessment. Therefore, the only activities which would have a substantial impact on county roads within the WRPA would be the Proposed Action and alternatives.

5.3.13.4 Private and Operator-Maintained Roads within the WRPA

Estimates of the total length of new private and Operator maintained resource roads are provided in Section 4.14 (Transportation) for each alternative. It is anticipated that resource roads may also be used for agricultural and recreational activities, but because these roads would not be thoroughfares or provide access to key developed recreation facilities and use areas, use by other than the Operators is anticipated to be minor. Use of resource roads on private lands would be controlled by the landowners.

5.3.14 Health and Safety

For cumulative impacts to human health and safety, the various project-related activities were considered along with other reasonably foreseeable future projects that may occur in the region. These other projects include oil and gas activities in the WRIR outside of the WRPA, gravel mining, timber harvesting in the Owl Creek Mountains, a planned casino/commercial development, and modest levels of residential growth in and around Riverton, Pavillion, Fort Washakie, Ethete, and Arapaho.

The Proposed Action and Alternatives, when considered with other projects, would result in a slight increase in occupational accidents in the region above and beyond those identified for the Proposed Action alone, resulting in a minor impact.

Human health and safety effects to the residents of properties adjacent to the major access roads within the WRPA would be minor. These minor risks would result from generation of increased traffic, noise, air emissions, and fugitive dust from project-related vehicles associated with any of the alternatives. Truck trips and related hazards to public safety associated with increased accident risks, dust, and noise emissions from the multiple activities would be slightly greater than described for the Proposed Action or alternatives alone. The cumulative impact associated with traffic increases would be experienced over a broader geographic area than just in and around the WRPA. Given the broad geographic area affected and the rural charter of the region, the cumulative impacts to health and safety would be minor.

The cumulative increase in fire hazards associated with the Proposed Action or Alternatives and all other projects considered in the overall region would be similar to those described for the Proposed Action, but would be distributed over a larger geographic area and are rated as negligible.

Pipeline ruptures and accidents could potentially occur anywhere in the region where pipelines would be located. Given the relatively infrequent incidence of pipeline accidents, the rural character of the region, and modest level of overall construction and utility installation activity, pipeline–related ruptures and accidents would result in minor cumulative impacts to health and safety.

Other projects and construction activities in the region that would utilize, store or transport hazardous materials, and/or generate hazardous wastes would be subject to regulations that would minimize the potential for accidental spills or releases into the environment. Assuming that the Proposed Action or Alternatives and all other projects comply with applicable regulations, the cumulative human health and safety impacts within and near the WRPA are rated as negligible.

5.3.15 Noise

Sources of noise within the WRPA would result from:

- Construction, drilling, and completion of wells.
- Compressor stations.
- Project-related traffic along access roads.

However, cumulative noise effects within the WRPA would be minor for two reasons. First, no additional noise sources other than natural gas development are anticipated within or immediately adjacent to the WRPA. In addition, there would be sufficient distance between project construction sites, facilities, and compressor stations, and residences within the WRPA and WRIR.

Under all alternatives, there would be minor increases in the cumulative noise resulting from increases in AADT along roads leading into the WRPA. The noise would be greatest during the development phase (well pad construction, drilling, and completion) of the Wind River Gas Development Project. Additionally, the traffic noise would generally be the greatest during morning and evening when workers and equipment would be arriving and departing the construction sites. After all the wells are operational, traffic noise would decrease.

Cumulative noise increases would be the highest along Gables Road and Eight Mile Road because approximately 70 percent of project traffic would use these routes to enter the

WRPA from U.S. Highway 134. The other 30 percent would use Wyoming Highways 133 and 134 from U.S. Highway 26, resulting in a smaller increase of traffic noise along these roads.

These minor increases would be similar for each alternative. However, he length of the construction phase of each alternative would vary, so that the cumulative noise effects would last the longest time under Alternative A, followed by the Proposed Action, then Alternative B, and finally Alternative C.

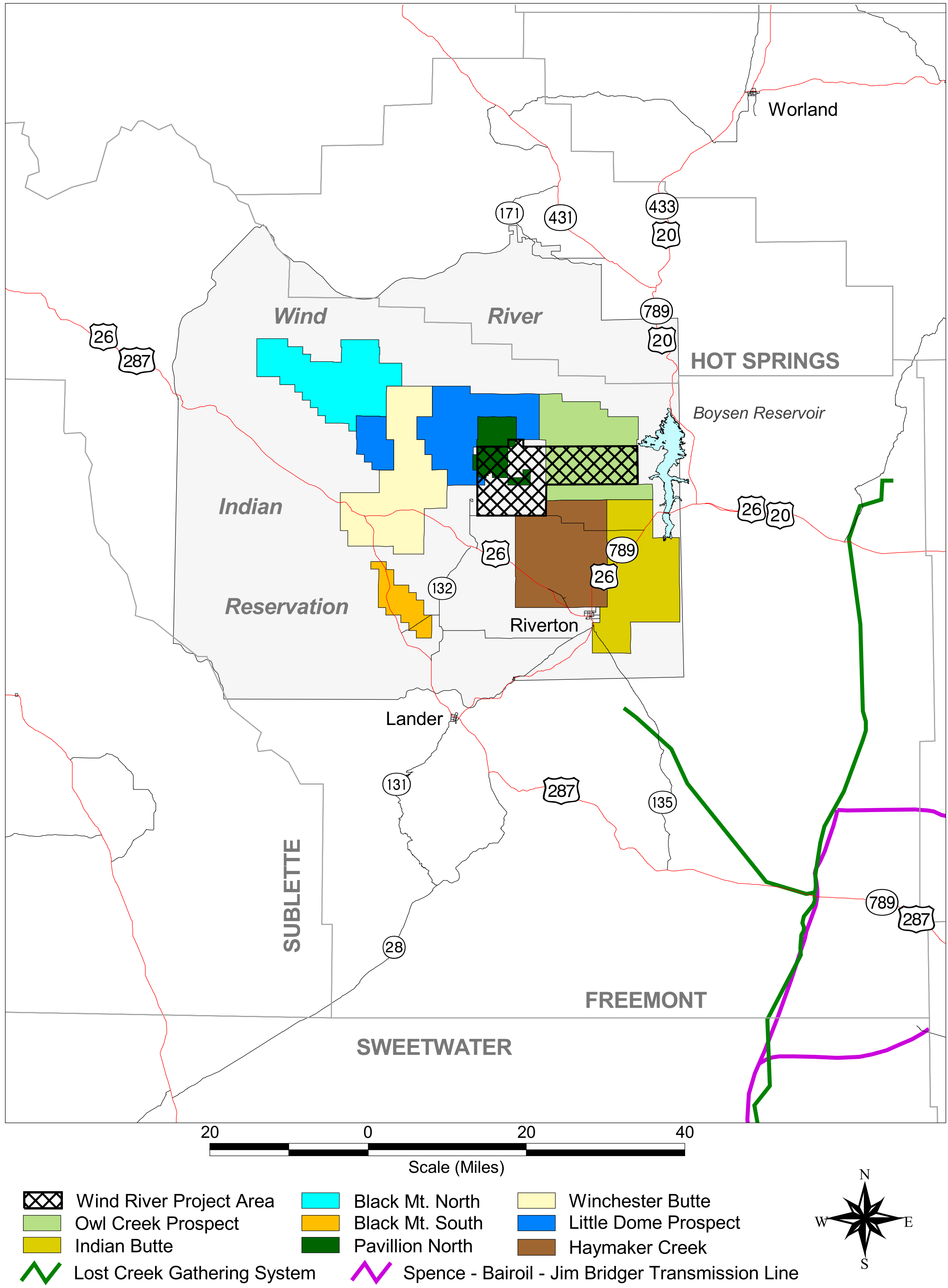


Figure 5-1. Location of NEPA Projects within Fremont County, Wyoming.

6.0 CONSULTATION AND COORDINATION

6.1 INTRODUCTION

An Environmental Impact Statement (EIS) is required under the National Environmental Policy Act (NEPA) when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. The EIS aids a federal agency in making decisions on such an action by presenting information on the physical, biological, and social environment of a Proposed Action and alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of alternatives that will be considered, and the potential impacts of the Proposed Action.

The Council on Environmental Quality (CEQ) regulations (40 CFR, Parts 1500 -1508) require that an early scoping process be conducted to determine the issues related to the Proposed Action and the alternatives that the EIS should address. The purpose of the scoping process is to identify important issues and potential issues that need to be addressed in the EIS.

The EIS for the Wind River Natural Gas Field Development Project was prepared by a third party contractor working under the direction of and in cooperation with the lead agency for the project, which is the Bureau of Indian Affairs (BIA), Wind River Agency, Fort Washakie, Wyoming.

6.2 PUBLIC PARTICIPATION

A Scoping Notice was prepared and submitted to the public by the BIA on September 30, 2002, requesting input into the proposed Wind River Natural Gas Field Development Project. The scoping notice was mailed to the public listed on the BIA mailing list, as well as organizations, groups, and individuals requesting a copy of the scoping notice. A public meeting to discuss the proposed project was conducted in Pavillion, Wyoming on October 22, 2002 at the Wind River Recreation Center. A second public meeting was held in Fort Washakie, Wyoming on October 23, 2002 at the Shoshone Rocky Mountain Hall.

A total of 42 written responses were received during the scoping period in response to the proposed Wind River Gas Field Development Project. The issues raised by the written and oral responses made during the scoping period are summarized in Chapter 1, Section 1.6.

During the preparation of this EIS the BIA and the members of the project team have communicated with representatives from various federal, state, county, and local agencies, elected officials, environmental and citizens groups, industries and individuals concerned with the proposed development project.

The key individuals that represented the BIA, BLM, Shoshone-Arapaho Joint Business Council, and the prime Operator (Tom Brown, Inc.) at the public hearings are the following:

Ray Nation, Environmental Coordinator
Bureau of Indian Affairs
Wind River Agency
Fort Washakie, WY

Stuart Cerovski
Bureau of Land Management
Lander Field Office
Lander, WY

Wesley Martel
Shoshone-Arapaho Joint Business Council
Fort Washakie, WY

David Petrie, Manager-Government Affairs & Regulations
Tom Brown, Inc.
Denver, CO

The following agencies, organizations and individuals received the scoping notice and provided comments or were provided the opportunity to comment on the Proposed Action during the public scoping period.

FEDERAL OFFICES

U.S. Army Corps of Engineers
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Department of Agriculture, Forest Service, Bridger-Teton National Forest
U.S. Department of Agriculture, Forest Service, Rocky Mountain Region
U.S. Department of Energy Western Area Power Administration
U.S. Department of the Interior, Office of the Solicitor
U.S Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. EPA, Office of Ecosystem Protection and Remediation, Region 8
U.S. Forest Service, Pinedale Ranger District
U.S. Forest Service, Shoshone National Forest
U.S. Natural Resource Conservation Service

POLITICAL OFFICES

U.S. Representative Barbara Cubin
U.S. Senator Mike Enzi
U.S. Senator Craig Thomas
Governor Jim Geringer
State Representatives
State Senators

STATE & LOCAL AGENCIES

Midvale Irrigation District
Bureau of Land Management, Reservoir Management Group
Bureau of Land Management Wyoming State Office
Wyoming Office of Federal Land Policy
Wyoming Office of State Land & Investments
Riverton Chamber of Commerce
Wyoming State Engineers Office
Wyoming Business Council
Wyoming Department of Agriculture
Wyoming Department of Environmental Quality
Wyoming Department of Transportation
Wyoming Department of State Parks & Cultural Resources, Division of State Parks & Historic Sites
Fremont County Solid Waste Disposal
Fremont County Commissioners
Division of State Parks & Historic Sites
Wyoming Game and Fish Department
Wyoming Oil and Gas Conservation Commission
Wyoming State Historic Preservation Office
Wyoming Information, Planning and Coordination Office
Warren Ulmer, University of Wyoming Department of Atmospheric Science Laramie

NATIVE AMERICAN ORGANIZATIONS

Eastern Shoshone Business Council
Northern Arapaho Business Council
Shoshone-Arapaho Joint Business Council
Shoshone Oil and Gas Commission
Shoshone Tribal Water Engineer
Wind River Environmental Quality Commission
Shoshone-Arapaho Tribes Fish & Game Department

LAND OWNERS

All private landowners within the WRPA received the Scoping Notice

LOCAL MEDIA

Casper Star-Tribune
Dubois Frontier
KGWC TV-Casper
KOVE/KDLY-Lander
KTRZ-Riverton
KWRR-Ethete
Lander Journal
The Riverton Ranger
Wind River News

COMPANIES

Barnes Consulting
Blair Hotels
Directional LLC
High Plains Power
Knight Oil Tools
M&M Well Service, L.L.C
Newpark Drilling Fluids, LLC
Pacific Power & Light
SWACO Geolograph Limited
Wood Group Pressure Control
Wrangler Well Service, Inc.
Wyoming Atmospheric Research
Tom Brown, Inc.
New'e Development Corp

ORGANIZATIONS

Independent Petroleum Association of Mountain States
National Wildlife Federation
The Nature Conservancy
Petroleum Association of Wyoming
Public Lands Advocacy
Sierra Club, Wyoming Chapter
Wilderness Society
Wind River Multiple Use Advocates
Wyoming Audubon Society
Wyoming Farm Bureau Federation
Wyoming Outdoor Council
Wyoming Public Lands Council
Wyoming State Grazing Board
Wyoming Stock Growers Association
Wyoming Wildlife Federation
Wyoming Wool Growers Association

INDIVIDUALS/LANDOWNERS

Individuals and landowners that responded to the scoping notice in writing or orally during the public meeting are listed below.

Keith Blankenship, Landowner
Lucille Borushko, Landowner
Dwight Mayland, Landowner
Joe Dennis, Landowner
Bill Garland, Landowner
Alfred & Velva Baldes, Landowner
Laurie D. Goodman, Environmental Consultant

Stan Horton, Landowner
Jerry Huelle, Landowner
Ron W. Kidder, Landowner
Daniel Johnson, Landowner
Jeff Locke, Landowner
Hamon Wise, Landowner
Mark & Kim Lambert, Landowner
Lee Arrington, Landowner
Willie Wagon, Landowner
Pat Drerak & Jim Geottemon, Landowner
Dave McDonald, Landowner
Chawn Duncan, Landowner
Bob Vogel, Landowner
Lynn Middleston, Landowner
Dan Heilig, Landowner
Brian Randall, Landowner
Vince Dolbow, Landowner
Louis & Donna Meeks, Landowner
Bruce & Gail Johnson, Landowner

Table 6-1. List of Preparers of the Wind River EIS

Project Team		
Name	**Affiliation**	**Responsibility**
Martin Buys	Buys & Associates	Program Manager
Marion Fischel	Buys & Associates	Project Manager; T/E Species
George Blankenship	Blankenship Consulting	Socioeconomics; Transportation
Phil Brown	Buys & Associates	Water Resources
Kirby Carroll	Buys & Associates	Wildlife Resources
Connie Chitwood	Buys & Associates	Vegetation/Wetlands; Wildlife; T/E Species
Don Douglas	Buys & Associates	Air Quality, Noise
Ron Dutton	Blankenship Consulting	Economics
Russ Erbes	Buys & Associates	Air Modeling
Jon Fredericks	Otak	Visual Resources; Land Use
Chris Freeman	Buys & Associates	Health & Safety; Scoping Issues
Doug Henderer	Buys & Associates	Air Quality
Gary Holsan	Gary Holsan Environmental Planning	Chapter 1, Chapter 2 & Peer Review
Lloyd Levy	Blankenship Consulting	Recreation
Kurt Schweigert	Associated Cultural Resource Experts	Cultural Resources
Jon Torizzo	Buys & Associates	Air Quality; Noise
Louis Wilsher	Otak	Visual Resources
Gustav Winterfeld	Erathem-Vanir Geological Consultants	Geology/Paleontology, Mineral Resources, Soils
Technical Support Team		
Andy Dworak	Buys & Associates	Wildlife Resources
Roger Melick	Buys & Associates	GIS/Figures/Maps
David Nicholson	Buys & Associates	Geology; Water Resources
Melissa Wood	Buys & Associates	Document Editing & Production
Suzanne Tyler	Buys & Associates	Document Editing & Production

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- A -

ADAPTATION. Adjustment to environmental conditions.

AERIAL COVERAGE. The ground area circumscribed by the perimeter of the branches and leaves of a given plant or group of plants.

AESTHETICS. Relates to the pleasurable characteristics of a physical environment as perceived through the five senses of sight, sound, smell, taste, and touch.

ALLUVIUM. Unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that had been deposited by water.

AMBIENT. The environment as it exists at the point of measurement and used as a basis to measure changes or impacts. Synonymous with background.

AMBIENT NOISE LEVEL. Cumulative effect from all noise generating sources in the area.

ANGLE OF OBSERVATION. The angle, both vertical and horizontal, between a viewer's line of sight and the landscape being viewed.

ANGLER DAY. A standard measure of fishing pressure equal to one person fishing at a site for 12 hours.

ANION. An ion with a negative electrical charge. That is, an atom that has gained one or more electrons.

ANNELIDS. Segmented worms.

ARTHROPODS. Insects, mites, scuds and crayfish.

ANTICLINAL. Pertaining to anticline which is a convex upward rock fold in which strata have been bent into an arch; the strata on each side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

AQUIFER. A body of rock or unconsolidated sediments that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN (ACEC's) FOR SCENIC VALUES. Areas within the public lands where special management attention is required to protect or prevent irreparable damage to important scenic values.

ARKOSIC. A variety of sandstone containing abundant feldspar and quartz, frequently in angular, poorly sorted grains.

ARROYO. A watercourse (as a creek) in an arid region, or a water-carved gully or channel.

ARTESIAN AQUIFER. A confined aquifer that is fully charged and under hydrostatic pressure.

ARTESIAN WELL. A well deriving its water from an artesian or confined aquifer, in which the water level stands above the top of the aquifer.

ASSOCIATION. Organisms living together in any given combination of environmental conditions.

ATMOSPHERIC DEPOSITION. Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and is reported as the mass of material deposited on an area (kilograms per hectare or kg ha^{-1}). Air pollutants are deposited by wet deposition (precipitation) and by dry deposition (gravitational settling of particles and adherence of gaseous pollutants).

ATMOSPHERIC DISPERSION. The complex process by which pollutants are transported and chemically transformed in the atmosphere.

ATMOSPHERIC STABILITY. A measure of turbulence in the atmosphere. Three general classes of stability include neutral, unstable, and stable. Influenced by vertical temperature gradients and wind profiles.

- B -

BACKGROUND. The environment as it exists at the point of measurement and used as a basis to measure changes or impacts. Synonymous with ambient.

BACKGROUND DISTANCE ZONE. The visible area of a landscape which lies beyond the foreground middle ground. Usually from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route, use area, or other observer point. Atmospheric conditions in some areas may limit the maximum to about 8 miles or less.

BANKFULL WIDTH. The width of a stream or river at the highest point on a bank before the stream over flows.

BASIC ELEMENTS. The four design elements (form, line, color, and texture), which determine how the character of a landscape is perceived.

BENTHOS. Organisms living in or on the bottom of a lake, pond, stream, ocean, etc.

BENTONITE. Absorbent aluminum silicate clay formed from volcanic ash.

BERM. A barrier constructed to confine water or other substances.

BEST MANAGEMENT PRACTICES (BMP). Common-sense actions required, by law, to keep soil and other pollutants out of streams and lakes. BMPs are designed to protect water quality and to prevent new pollution.

BIO-GEOGRAPHIC PROVINCE. A spatial classification based on composites of homogenous, hierarchical systems forming a regional scale. They are generally applied by mapping geographic entities of similar character (such as land systems or ecological districts) at national, regional and district scales.

BIOTA. The plant and animal life in an area.

BRECCIA. A clastic rock in which the gravel-sized particles are angular in shape and make up an appreciable volume of the rock.

BROOD. Hatchlings in a given nest or being raised by a given female bird.

BROWSER. An animal, which feeds on leaves, wigs, and young shoots of trees or shrubs; i.e., deer.

- C -

CALICHE HARDPAN. A crust of calcium carbonate that forms on the stony soil of arid regions.

CANAL. A manmade watercourse carrying water for delivery to irrigation facilities.

CARBONACEOUS. Sedimentary rocks that contain high percentages of coal or carbon.

CARNIVORE. An organism, which acquires life-sustaining nutrients by using animals as food.

CATION. An ion that has a positive electrical charge. That is, an atom that has lost one or more electrons.

CHARACTERISTIC LANDSCAPE. The established landscape within an area being viewed. This does not necessarily mean a naturalistic character. It could refer to an agricultural setting, an urban landscape, a primarily natural environment, or a combination of these types.

CHERT. A sedimentary form of amorphous or extremely fine-grained siliceous, partially hydrous, found in concretions and beds.

CHIRONOMIDS – Midges or midge larvae

CLAYSTONE. A consolidated rock that consists of any mineral fragments smaller than 1/255 mm in diameter.

CLEAN AIR ACT (CAA). Public Law 84-159, established July 14, 1955, and amended numerous times since. The Clean Air Act establishes federal standards for air pollutants emitted from stationary and mobile sources; authorizes states, tribes, and local agencies to regulate polluting emissions; requires the agencies to improve air quality in areas of the country which do not meet federal standards; and to prevent significant deterioration in areas where air quality is cleaner than the standards.

CLIMATOLOGY. Science of climate and its causes.

CLUTCH. The eggs of birds, reptiles, or amphibians of a given nest.

COLLUVIUM. An unconsolidated terrestrial sediment composed of sorted or unsorted sand, S.H, gravel, and clay that had been deposited due to the action of gravity.

COMMERCIAL WATER USE. Water for motels, hotels, restaurants, office buildings, other commercial facilities, and institutions. The water may be obtained from a public supply or may be self-supplied.

COMMUNITY. A group of plants and animals, which occupy a given locale.

COMPRESSOR BUILDING. A building, or cluster of buildings, that house the required equipment to pressurize underground gas lines for the purposes of gas transport.

COMPRESSOR PLANT (STATION). A facility consisting of one or more compressors, auxiliary treatment equipment, and pipeline installations to pump natural gas under pressure over long distances.

CONDENSATE. A low-density liquid hydrocarbon phase that generally occurs in association with natural gas. Its presence as a liquid phase depends on temperature and pressure conditions in the reservoir allowing condensation of liquid from vapor.

CONFINED AQUIFER. An aquifer bounded above and below by impermeable beds or by beds of distinctly lower permeability than that of the aquifer itself; an aquifer containing confined groundwater.

CONFINING BED. A body of impermeable or distinctly less permeable material stratigaphically adjacent to one or more aquifers.

CONGLOMERATE. A clastic sedimentary rock composed of lithified beds of rounded gravel mixed with sand.

CONSUMPTIVE USE. Recreational activities, such as hunting, fishing and trapping, that involve the taking of wild animals.

CONTRAST. Opposition or unlikeness of different forms, lines, colors, or textures in a landscape.

CONTRAST RATING. A method of analyzing the potential visual impacts of proposed management activities.

CONVEYANCE LOSS. Water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a ground water source and be available for further use.

COVER. That part of the environment, living or dead, utilized y animals for resting, feeding, nesting, and protection.

COVER-TYPE. The part of the environment or landscape characterized by a predominant plant community.

CRITERIA POLLUTANTS. Six common air pollutants for which the Environmental Protection Agency (EPA) has established national air quality standards, including (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter ($PM_{2.5}$), and lead.

CROSS-BEDDED. A arrangement of laminations of strata transverse to the main planes of stratification.

CRUCIAL RANGE. Any particular seasonal range or habitat component, that is documented as the determining factor in a big games species' ability to sustain a viable population. A viable population is defined as the species' capability to maintain and reproduce itself at a certain population level specific to that species.

CULTURAL MODIFICATION. Any man-caused change in the landform, water form, vegetation, or the addition of a structure, which creates a visual contrast in the basic elements (form, line, color, texture) of the naturalistic character of a landscape.

CUMULATIVE IMPACT. The impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taken place over a period of time (40 CFR 1508.7).

- D -

DECIBEL (dB). The measurement unit commonly used to describe sound levels. The A-weighted decibel (dBA) scale is a logarithmic function that emphasizes the audio frequency response curve audible to the human ear and thus more closely describes how one perceives sound.

DECIVIEW (dv). A unit of measure for visibility. The deciview index was developed as a linear perceived visual change.

DENDRITIC. Branching like a tree, a dendritic drainage system.

DIRECT IMPACTS. Effects that are caused by the action and occur at the same time and place (40 CFR 1508.8).

DIRECTIONAL DRILLING. The intentional deviation of a wellbore from vertical to reach subsurface areas some distance from the well pad.

DISSOLVED SOLIDS. The portion of solids in water that can pass through a 0.45-micron filter.

DISTANCE ZONES. A subdivision of the landscape as viewed from an observer position. The subdivision (zones) includes foreground-middle ground, background, and seldom seen.

DOLOMITE. A mineral, calcium-magnesium carbonate ($Ca,Mg[CO_3]_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

DOMESTIC WATER USE. Water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Also called residential water use. The water may be obtained from a public supply or may be self-supplied.

DOWNSLOPE WINDS. Wind patterns that are common along the eastern slopes of the Rocky Mountains. Typically a warm, dry air flow which travels down-terrain, from higher to lower elevations. Also referred to as a “Chinook”.

DRAIN. A ditch that removes surplus water from irrigated land and returns it to the surface watershed.

- E -

EASEMENT. An interest in land owned by another that entitles its holder to to a specific limited use or enjoyment.

ECOSYSTEM. A system of biological communities interacting with each other and with their nonliving surroundings

ECOSYSTEM INTEGRITY. A measure of the health of an entire area or community based on how much of the original physical, biological and chemical components of the area remain intact.

ENHANCEMENT. A management action designed to improve visual quality.

EPHEMERAL. A stream that flows only in direct response to a runoff event.

EPIFAUNA. Part of the benthos living on the sediment surface.

EPT RICHNESS. EPT demotes the total number of species of mayflies (*Ephemeroptera*), stoneflies (*Pleoptera*), and caddisflies (*Trichopera*) found in a 100-organism sub-sample. These are considered to be mostly clean-water organisms and their presence generally is correlated with good water quality.

EVAPOTRANSPIRATION. Water withdrawn by evaporation from water surfaces, moist soil, and by plant transpiration.

EVAPORATION POND (PIT) OR RESERVE PIT. A pit dug to contain drilling fluids, drill cuttings, and other wastes from drilling operations that disposes of the liquids by evaporation. Some evaporation ponds are lines with plastic or asphalt to keep water from filtering through and contaminating nearby aquifers.

EXTIRPATION. To eliminate or cause to be eliminated.

- F -

FAMILY. In taxonomy, a category containing one or more genera which have similar characteristics.

FAUNA. All animal life associated with a given habitat.

FLORISTIC. All plant life associated with a given habitat.

FORAGE. Vegetation utilized by animals as food.

FORB. Flowering herbaceous plants.

FOREGROUND-MIDDLEGROUND DISTANCE ZONES. The area visible from a travel route, use area, or other observation point to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape. Vegetation is apparent only in patterns or outline.

FORM. The mass or shape of an object or objects which appear unified, such as a vegetative opening in a forest, a cliff formation, or a water tank.

FRY. Juvenile fish between the egg and fingerling stages.

FUGITIVE DUST. Dust that escapes the general vicinity of an area where activity is occurring. Dust can be generated by construction traffic, surface clearing operations etc., and can then by carried by wind into the air, creating a plume that may be visible from greater distances than the activity directly causing the dust.

- G -

GEOMORPHOLOGY. The study of landforms.

GREASEWOOD. A low stiff shrub *(Sarcobatus vermiculatus)* of the goosefoot family common in alkaline soils in the western U.S.

GROUNDWATER, CONFINED. Confined groundwater is under pressure substantially greater than atmospheric throughout, and its upper limit is the bottom of a bed of distinctly lower permeability than that of the material in which the confined water occurs.

GROUNDWATER, UNCONFINED. Unconfined groundwater is water in an aquifer that is under atmospheric pressure and is considered under water table conditions.

GYPSUM. An evaporate mineral consisting of $CaSO_4 \cdot H_2O$.

- H -

HABITAT. A place where a plant or an animal lives.

HARMONY. A combination of parts into a pleasing or orderly whole: congruity; a state of agreement of proportionate arrangement of form, line, color, and texture.

HAZARDOUS AIR POLLUTANTS (HAPs). Pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental impacts. The Environmental Protection Agency (EPA) has classified 189 air pollutants as HAPs.

HERBACEOUS. Having little or no woody tissue and persisting usually for a single growing season.

HERBIVORE. An organism, which acquires life-sustaining nutrients by feeding on vegetation.

HYDROCARBONS. An organic compound containing only carbon and hydrogen and often occurring in petroleum, natural gas, and coal.

HYDROGRAPH. A graph showing fluctuations in stream flow, stream level, or water levels in wells over time.

- I -

IMPULSIVE NOISE. Impulsive noise is very short in duration and is often very loud. An example of impulsive noise would be noise from a gunshot.

INDIRECT IMPACTS. Effects, which are caused by the action bit occur later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include reduced reproduction, population density or growth rate in wildlife. Other effects may be related to induced changes in the patterns of land use and effects on air, water, and other natural systems, including ecosystems (40 CFR 1508.8).

INDUSTRIAL WATER USE. Water used for industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. The water may be obtained from a public supply or may be self-supplied.

INSTREAM WATER USE. Water that is used, but not withdrawn from a groundwater or surface water source for such purposes as hydroelectric power-generation, navigations, water-quality improvement, fish propagations, and recreation. Sometimes called non-withdrawal use or in-channel use.

INTERBEDDED. Rock beds that lie within rock beds of different material.

INTERDISCIPLINARY TEAM. A group of individuals with different training, representing the physical sciences, social sciences, and environmental design arts, assembled to solve a problem or perform a task. The members of the team proceed to a solution with frequent interaction so that each discipline may provide insights to any stage of the problem and disciplines may combine to provide new solutions.

INTERMITTENT. A stream that flows only part of a year along which the bed intercepts the groundwater table.

INVERTEBRATES. All animals without vertebrae.

IRRIGATION WATER USE. Artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands, such as parks and golf courses.

- K -

KEY OBSERVATION POINT (KOP). One or a series of points on a travel route or at a use area or a potential use area, where the view of a management activity would be most revealing.

- L -

LANDSCAPE CHARACTER. The arrangement of a particular landscape as formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give the area a distinctive quality, which distinguishes it from its immediate surroundings.

LANDSCAPE FEATURES. The land and water form, vegetation, and structures which compose the characteristic landscape.

LEKS. A place where males of some species of birds, such as grouse gather and perform courtship displays in a group.

LINE. The path, real or imagined, that the eye follows when perceived abrupt differences in form, color, or texture. Within landscapes, line may be found as ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

LITHOLOGY. The systematic description of rocks, in terms of mineral composition and texture.

LIMESTONE. A sedimentary rock composed principally of calcium carbonate ($CaCO2$), usually as the mineral calcite.

LIVESTOCK WATER USE. Water for livestock watering, feedlots, dairy operations, fish farming, and other on-farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are animal specialties.

LONG TERM IMPACTS. Effects that persist beyond the construction, drilling and reclamation phases, or continue for the life of the project.

LOWER ATMOSPHERE. The layer of air next to the Earth's surface, also referred to as the planetary boundary layer. Typically a few hundred meters deep.

- M -

MAJOR IMPACTS. Changes in resource condition, quality, or quantity that are measurable, have substantial consequences at a regional level.

MANAGEMENT ACTIVITY. A surface disturbing activity undertaken on the landscape for the purpose of harvesting, traversing, transporting, protecting, changing, replenishing, or otherwise using resources.

MASSIVE. Sandstone rock without any distinctive bedding planes.

MESA. Land formation with steep walls and a relatively flat top.

MINING WATER USE. Water used for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, well operations (dewatering), milling (crushing, screening, washing, and flotation), and other preparations customarily done at the mine site or as part of a mining activity. Does not include water used in processing, such as smelting, reining petroleum, or slurry pipeline operations. These uses are include in industrial water use.

MITIGATION. Avoiding, minimizing, reducing, rectifying, or compensating for impacts to resources from an action. The complete definition is provided in 40 CFR 1508.8.

MITIGATION MEASURES. Methods or procedures designed to reduce or lessen the adverse impacts caused by management activities.

MINOR IMPACTS. Changes in resource condition, quality, or quantity that are measurable, but small and localized.

MODERATE IMPACTS. Changes in the resource condition, quality, or quantity that are measurable, and result in consequences that would be relatively localized.

MOLLUSCS. Snails, limpets, mussels, and clams.

MULTIDISCIPLINARY TEAM. A group specialists with different backgrounds, assembled to solve a problem. The problem is broken into pieces and each specialist works on a portion of the problem. Partial solutions are then linked together to provide the final solutions.

- N -

NATIONAL AND WYOMING AMBIENT AIR QUALITY STANDARDS (NAAQS and WAAQS). The allowable concentrations of air pollutants in the air specified by the federal government (and the State of Wyoming). The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

NATURALISTIC CHARACTER. A landscape setting where the basic elements are displayed in a composition that appears unaltered by man.

NEGLEABLE IMPACTS. Changes in resource condition, quality, or quantity are slightly above the level of detection.

NEMATODES. A group of animals referred to as round worms.

NIGHT-LIGHTING. Lights used to illuminate facilities for work or safety. These lights can be mounted on poles, buildings, other equipment and fences. The lighting can consist of two types: area and accent. Area lighting provides general illumination over a broad zone for safety, while accent lighting provides concentrated illumination for work areas, doorways, pathways, stairs and other areas that require distinction.

NODULAR. A general term used to describe rounded concretionary bodies.

NON-CONSUMPTIVE USES. Recreational activities, such as wildlife observation and wildlife photography, where wild animals are not taken.

- O -

OFFSTREAM WATER USE. Water withdrawn or diverted from ground or surface water source for public water supply, industry, irrigation, livestock, thermoelectric power generation, and other users. Sometimes called off-channel use or withdrawal use.

ORDINARY HIGH WATER MARK (OHWM). A line on the shore of a water body established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

OUTCROP. Rock strata exposed at the surface.

- P -

PALUSTRINE. A marsh, swamp, or wetland environment.

PALIOSOL. An ancient soil horizon contained in sedimentary rocks.

PARTURITION AREAS. Documented birthing areas commonly used by females. These areas may be used as nursery areas by some big game species.

PERENNIAL. A stream or river that flows all year.

PERIODIC NOISE. Periodic noise consists of short durations of relatively high noise levels followed by steady state or no noise, repeated over time. Examples of periodic noise include that from pile drivers and industrial stamping machines.

PERMEABILITY. The capacity of material to transmit water or other fluids. Primary permeability is the capacity of interconnected pores to transmit fluids and Secondary permeability is the capacity of interconnected fractures, bedding planes, solution voids, etc. to transmit fluids.

pH. A measure of the acidity or alkalinity of water. It is defined as the negative logarithm of the hydrogen-ion concentration. This parameter is dimensionless and generally has a range from 0 to 14, with a pH of 7 representing neutral water. A pH of greater than 7 indicates the water is alkaline, whereas a pH value of less than 7 indicates an acidic water.

PHOSPHATIC. A rock containing phosphorous.

PHOTO-MONTAGE. The technique of combining in a single photographic composition, parts of different photographs by superimposition.

PHYSIOGRAPHIC PROVINCE. An extensive portion of the landscape normally encompassing many hundreds of square miles, which portrays similar qualities of soil, rock, slope, and vegetation of the same geomorphic origin (Fenneman 1946, Sahrhaftig 1975).

PHYSIOGRAPHY. The study and classification of the surface features of the Earth.

PLANT ASSOCIATION. The basic unit of vegetation classification representing a plant community containing a defined flora, composition, and uniform habitat conditions (Reid et al. 2002).

PLANT COMMUNITY. A group of plants that occupy a given locale.

PLATYHELMINTHES. Comprised of flatworms.

POROUS. A rock that has a high percentage of void space.

POTENTIOMETRIC SURFACE. A groundwater surface that describes the static head, as related to an aquifer, it is defined by the levels to which water will rise in tightly cased wells. A water table is a particular potentiometric surface.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD). A regulatory program under the Clean Air Act (Public Law 84-159, as amended) to limit degradation of air quality in areas that currently achieve the National Ambient Air Quality Standards. The PSD program established air quality classes that allow differing amounts of additional air pollution above a legally defined baseline level. Almost any additional air pollution would be considered significant in PSD Class I areas (certain large national parks and wilderness areas in existence on August 7, 1977, and specific tribal lands redesignated since then.) PSD Class II areas allow deterioration associated with moderate, well-controlled growth (most of the country).

PRIMARY COVER-TYPE. Land cover type occupying the largest area within the polygon (WYNDD 2003).

PUBLIC LAND. Land within the exterior boundary of the Wind River Indian Reservation not restored to Tribal ownership in 1939 and retained by the U.S. for the Riverton Irrigation Project. Now managed by the Department of the Interior's Bureau of Reclamation.

PUBLIC SUPPLY WATER USE. Water withdrawn by public and private water suppliers and delivered to users. Public suppliers provide water for a variety of uses, such as domestic, commercial, thermoelectric power, industrial, and public water use.

PUT-AND-TAKE. A wildlife management strategy that annually releases captive animals, in this case pheasants, into existing habitat to augment a natural population for seasonal hunting.

- Q -

QUARTZITIC. Rocks, most often sandstone, that contains quartz.

- R -

RANGELANDS. Typically non-irrigated lands managed primarily for raising cattle, sheep, goats, horses etc.

REHABILITATION. A management alternative and/or practice, which restores landscapes to a desired scenic quality.

RELIEF. The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

RIPARIAN. Relating to, or living or located, on the bank of a natural watercourse (as a river) or sometimes of a lake.

- S -

SANDSTONE. A sedimentary rock composed of mineral grains from 1/16 to 2 millimeters in diameter, bound together by a cement of silica, carbonate, or other minerals or a matrix of clay minerals.

SCALE. The proportionate size relationship between an object and the surroundings in which the object is placed.

SCENERY. The aggregate of features that give character to a landscape.

SCENIC AREA. An area whose landscape character exhibits a high degree of variety and harmony among the basic elements, which results in a pleasant landscape to view.

SCENIC QUALITY. The relative worth of a landscape from a visual perception point of view.

SCENIC QUALITY EVALUATION KEY FACTORS. The seven factors (land form, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications) used to evaluate the scenic quality of a landscape.

SCENIC QUALITY RATINGS. The relative scenic quality (A, B, or C) assigned a landscape by applying the scenic quality evaluation key factors; scenic quality A being the highest rating, B a moderate rating, and C the lowest rating.

SCENIC QUALITY RATING UNIT (SQRU). A portion of the landscape which displays primarily homogenous visual characteristics of the basic landscape features (land and water form, vegetation, and structures).

SCENIC VALUES. (Refer to scenic quality and scenic quality ratings).

SECONDARY COVER-TYPE. Land cover type occupying the second largest area within the polygon (WYNDD 2003).

SEDGE. Any of a family (Cyperaceae, the sedge family) of usually tufted marsh plants differing from the related grasses in having achenes and solid stems.

SEDIMENTARY ROCK. A rock formed by the accumulation and cementation of mineral grains transported by wind, water, or ice to the site of deposition or chemically precipitated at the depositional site.

SEEN AREA. That portion of the landscape which is visible from roads, trails, rivers, campgrounds, communities, or other key observation positions.

SELDOM SEEN DISTANCE ZONE. Portions of the landscape which are generally not visible from key observation points, or portions which are visible but more than 15 miles distance.

SENSITIVITY LEVELS. Measures (e.g., high, medium, and low) of public concern for the maintenance of scenic quality.

SENSITIVITY LEVEL RATING UNIT (SLRU). A measure of public concern for scenic quality. Lands are assigned high, medium or low sensitivity levels by analyzing the various indicators of public concern. The indicators are: type of users, amount of use, public interest, adjacent land uses, special areas, and other factors including research or studies that include indicators of visual sensitivity.

SHALE. A fine-grained sedimentary rock formed by the consolidation (esp. by compression) of clay, silt, or mud. It is characterized by finely laminated structure, approximately parallel to the bedding, along which the rock breaks readily into thin layers.

SHORT-TERM IMPACT. Effects of short duration that occur during construction, drilling, completion and reclamation of a well.

SIDE-SLOPES. The rising area of land that forms the transition between a relatively flat condition and a hilltop, mesa top or ridgeline.

SILICEOUS. Rock containing silica.

SILO. A trench, pit, or especially a tall cylinder (as of wood or concrete) usually sealed to exclude air and used for making and storing silage, or a deep bin for storing material.

SILTSTONE. A rock composed of silt having the texture and composition of shale but lacking its fine lamination or fissility.

SLIMACIDES – Chemical substance used to control slime forming bacteria

SODIUM-ADSORPTION RATIO (SAR). A measure of irrigation water sodium hazard. It is the ratio of sodium to calcium plus magnesium concentrations in milliequivalents per liter. The SAR value of water is considered along with specific conductance in determining suitability for irrigation.

SPECIES. The basic category of biological classification intended to designate a single kind of animal or plant.

SPECIAL AREAS. Natural Areas, Wilderness Areas or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Roads or Trails and Areas of Critical Environmental Concern.

SPECIES RICHNESS. This is he total number of species or taxa found in a sample. Higher species richness values are mostly associated with clean-water conditions.

SPECIFIC CAPACITY. The rate of discharge of water form a well divided by the drawdown of the water level within the well.

SPECIFIC CONDUCTANCE. A measure of the water's ability to conduct an electrical current. Specific conductance is expressed in microsiemens per centimeter (µS/cm) at 25 degrees Centigrade (25^{o} C). For water containing between 100 and 5,000 mg/L of dissolved solids, specific conductance in µS/cm at 25^{o} C multiplied by a factor between 0.55 and 0.71 will approximate the dissolved solids concentration in mg/L. For most water, reasonable estimates can be obtained by multiplying the specific conductance value by 0.44 to obtain dissolved solid concentrations.

STEADY-STATE NOISE. Steady-state noise levels are relatively constant over time. A good example is an idling automobile.

STRATIGRAPHIC UNIT. A body of rocks recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

STRATIGRAPHY. The science of the description, correlation, and classification of rock strata, including the interpretation of the depositional environments of those strata.

STRUCTURAL BASIN. A subsidence feature surrounded by structural uplifts.

SUCCULENT PLANTS. Full of juice or juicy.

SUMMER or SPRING-SUMMER-FALL RANGE. A documented survival range, which is used primarily in the summer season or spring, summer, and fall. Occasional use may occur during the winter. It may lack habitat characteristics that would make it attractive or capable of supporting major portions of the population during normal years, but is used by and allows at least a sufficient portion of the population to survive the occasional severe winter.

SURFACE WATER. An open body of water, such as a stream or lake.

SYNOPTIC SCALE. The scale of the high- and low-pressure systems of the lower atmosphere. Typical dimensions range approximately from 1000 to 2500 kilometers (synoptic-scale circulation).

- T -

TEMPERATURE INVERSION. An atmospheric condition in which warmer air lies above colder air and is said to have an ``inverted'' temperature gradient, where temperature increases with altitude.

TERRITORY. An area defended by a male, both members of a pair or an unmated species.

TEXTURE. The visual manifestations of the interplay of light and shadow created by the variations in the surface of an object or landscape.

TOTAL DEPOSITION. Total deposition refers to the sum of airborne material transferred to the Earth's surface by both wet and dry deposition.

TRANSIENT VIEWERS. Viewers that are traveling through the area and do not reside or work within the WRPA. It is assumed that these viewers would see the project area for a limited period of time with limited frequency.

TRIBAL LAND. Lands on the Wind River Indian Reservation held in trust by the U.S. for the Eastern Shoshone and Northern Arapaho. Administered by the Department of Interior's Bureau of Indian Affairs.

TRUST LAND. A property held by one entity for the benefit of another. Land committed or entrusted to an entity to be used or cared for in the interest of another.

TUFF. A consolidated rock composed of pyroclastic fragments and fine ash. If particles are melted slightly together from their own heat, it is a "welded tuff."

- U -

UNCONFINED AQUIFER. An aquifer that has a water table.

UPLAND BIRDS. Game birds such as sage grouse, chukar and partridge.

USE VOLUME. The total volume of visitor use each segment of a travel route or use area receives.

- V -

VARIABLES. Factors influencing visual perception including distance, angle of observation, time, size or scale, season of the year, light, and atmospheric conditions.

VIEWSHED. The landscape that can be directly seen under favorable atmospheric conditions, from a viewpoint or along a transportation corridor.

VISIBILITY. The ability or inability to view scenic vistas. It is usually characterized by two parameters, visual range (VR) and the light-extinction coefficient (b_{ext}). The visual range parameter represents the greatest distance that a large dark object can be seen. The light extinction coefficient represents the attenuation of light per unit distance due to scattering and absorption by gases and particulate matter in the atmosphere.

VISITOR DAY. A standard measure of visitor use equal to one person visiting a site for 12 hours.

VISUAL CONTRAST. (See contrast).

VISUAL IMPACT. Any modification in landform, water bodies, or vegetation, or any introduction of structures, which negatively interrupts the visual character of the landscape and disrupts the harmony of the basic elements (i.e., form, line, color, and texture).

VISUAL QUALITY. (See scenic quality).

VISUAL RESOURCE. The visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features).

VISUAL RESOURCE INVENTORY (VRI). An inventory of an area of land that determines visual values. The inventory consists of a scenic quality evaluation, sensitivity level analysis and a delineation of distance zones. Based on these three factors, lands are placed into one of four visual resource inventory classes.

VISUAL RESOURCE MANAGEMENT (VRM). The inventory and planning actions taken to identify visual values and to establish objectives for managing those values; and the management actions taken to achieve the visual management objectives.

VISUAL RESOURCE MANAGEMENT CLASSES. Categories assigned to public lands based on scenic quality, sensitivity level, and distance zones. There are four classes. Each class has an objective, which prescribes the amount of change allowed in the characteristic landscape.

VISUAL VALUES. (See scenic quality).

VOLCANOCLASTIC. Rock fragments of volcanic origin.

- W -

WALK-IN AREA. Private land leased for public hunting access by the Wyoming Game and Fish Department.

WATERS OF THE UNITED STATES. Includes 1) all waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; 2) all interstate waters including wetlands; 3) all other waters, such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce……..; 4) all impoundments of waters otherwise defined as waters of the United States under the definition; 5) tributaries of waters identified in paragraphs (a) (1)-(4) of this section; 6) territorial seas; 7) Wetlands adjacent to waters (other than waters that are themselves wetlands); 8) Waters of the United States do not include prior converted cropland (33 CFR Part 328).

WATERSHED. The line of division between two adjacent rivers or lakes with respect to the flow of water by natural channels into them; the natural boundary of a basin.

WATER TABLE. The water table is that surface in an unconfined water aquifer at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water.

WETLANDS. Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR Part 328).

WILDLIFE. In this summary, the term "wildlife" refers to any wild plant, mammal, bird, reptile, amphibian, or other aquatic or terrestrial organism.

WINTER RANGE. The range that large game animals use in substantial numbers only during winter periods.

WINTER / YEARLONG RANGE. A population (or a portion of a population) of animals makes general use of the documented suitable habitat sites within this range on a year-round basis. During the winter months there is a significant influx of additional animals into the area from other seasonal ranges.

- X -

XERIC HABITAT. An arid system almost totally lacking water.

- Y -

YEARLONG RANGE. A population (or substantial portion of a population) of animals makes general use of the suitable documented habitat sites within the range on a year-round basis. However, the animals may leave the area under severe conditions.

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APPENDIX A
HISTORY OF THE WIND RIVER INDIAN RESERVATION

History of Land Ownership within the WRPA and WRIR[1]

The Treaty of July 3, 1868 fixed the boundaries of the Shoshone Indian Reservation at 3,054,182 acres in the Wind River Valley. The Reservation boundaries at that time were from the mouth of the Owl Creek north of Thermopolis, to the divide between the Sweetwater and Popo Agie rivers, and along the Wind River Mountains to the North Fork of the Wind River. (Treaty with Eastern Band Shoshone, 15 Stat. 673). In 1878, the Northern Arapaho Tribe was placed on the Reservation by the United States.

The act of March 3, 1905 (“1905 Act”) ratified an agreement with Tribes which opened the portions of the Reservation north and east of the Big Wind and Popo Agie Rivers, including the WRPA, to settlement by non-Indians under the homestead, townsite, and mineral land laws. The 1905 Act preserved the right of Tribal members to acquire and retain allotments in the opened area. Congress hoped that 150,000 might be settled within 2 years, another 150,000 within 4 years, and the remainder would not be settled, if ever, until after six years. By 1914, only the 128,987 acres were settled, leaving over 90% of the opened lands unsettled. In 1915, the Secretary of Interior postponed further sale of lands to protect the Indians. Article II provided that there was to be no immediate acquisition by the United States of the area opened. Article IX of the 1905 Act provided that the United States shall act as trustee for said Indians to dispose of said lands and to expend for said Indians and pay over to them the proceeds received from the sale thereof. The language of Article IX has been held to mean that the Indians only (i) released their possessory right so that the government, as trustee could, convey fee title to a purchaser, (ii) the unsold lands remained in Indian ownership, and (iii) the lands never became “public lands” in the sense of being subject to sale, or other disposition under the General Land Laws.

In 1916, Congress authorized oil and gas leasing on the lands covered by the 1905 Act [Act of August 21, 1916 (39 Stat. 519)]. In connection with the 1916 Act, Congress engaged in an extended debate concerning whether unpurchased lands opened by the 1905 Act were held in Indian or federal title. Congress resolved the issue by enacting legislation, which established that the unpurchased lands retained their Indian character.

In 1918, the portions of the Reservation, including the WRPA, were withdrawn for reclamation purposes. The Bureau of Reclamation became the federal agency responsible for management of the surface estate for reclamation purposes and formed the Midvale Irrigation District (MID).

The next time Congress dealt with the lands within the Reservation was in 1939. The Act of July 27, 1939, (53 Stat.1128), paid the Shoshone Tribe for locating the Arapaho Tribe on the Reservation, In addition, the Act permanently withdrew the authority under the 1905 Act to sell Reservation lands. Pursuant to Supreme Court decision, each tribe has an undivided ½ interest in the Reservation. Governance of the Reservation is by the Business Councils of each Tribe meeting as the Join Business Council to govern the Reservation as a whole. Two subsequent agreements altered the boundaries and size of the Reservation. These agreements were the Lander Purchase and the Thermopolis Purchase. In the Lander Purchase (Bruno Cession), the Tribes sold 710,642 acres in the southern portion of the Reservation to the federal government for the sum of $25,000. The purpose of this land transfer was to resolve difficulties from the trespassing on the

[1] Prepared by John Schumacher, Attorney for the Eastern Shoshone Tribe

Reservation of persons in the Sweetwater Mining district near South Pass. The Lander Purchase specifically changed the southern boundary of the Reservation and the lands covered by the Lander Purchase are no longer a part of the Reservation. Likewise, in 1897, the United States purchased 10 square miles in the northeast corner of the Reservation from the Tribes.

Lands for the Boysen Reservoir were acquired from the Tribes in 1952. The United States acquired the surface estate of various lands within the WRPA as part of the Boysen Purchase.

In 1953, the United States acquired from the Tribes the surface estate of lands within the Riverton Reclamation Project, which has not been previously patented and clarified that in the Act of August 27, 1958 (72 Stat. 953), that all the minerals covered by the 1953 Act were held in trust for the Tribes. Some of these mineral rights are within the WRPA.

APPENDIX B
AGENCY MITIGATION GUIDLINES

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STANDARD PROTECTION REQUIREMENTS FOR SURFACE-DISTURBANCE ACTIVITIES (BLM 1987)

1.0 SURFACE DISTURBANCE MITIGATION GUIDELINES

Surface disturbance will be prohibited in any of the following areas or conditions. Exception, waiver, or modification of this limitation may be approved in writing, including documented supporting analysis, by the AO.

a. Slopes in excess of 25 percent.

b. Within important scenic areas (Class I and II Visual Resource Management Areas).

c. Within 500 feet of surface water and/or riparian areas.

d. Within either one-quarter mile or the visual horizon (whichever is closer) of historic trails.

e. Construction with frozen material or during periods when the soil material is saturated or when watershed damage is likely to occur.

GUIDANCE

The intent of the SURFACE DISTURBANCE MITIGATION GUIDELINE is to inform interested parties (potential lessees, permittees, or operators) that when one or more of the five (1a through 1e) conditions exist, surface-disturbing activities will be prohibited unless or until a permittee or his designated representative and the surface management agency (SMA) arrive at an acceptable plan for mitigation of anticipated impacts. This negotiation will occur prior to development. Specific criteria (e.g., 500 feet from water) have been established based upon the best information available. However, such items as geographical areas and seasons must be delineated at the field level. Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, and application for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

2.0 WILDLIFE MITIGATION GUIDELINES

a. To protect important big game winter habitat, activities or surface use will not be allowed from November 15 to April 30 within certain areas encompassed by the authorization. The same criteria apply to defined big game birthing areas from May 1 to June 30.

Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects.

Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the AO.

b. To protect important raptor and/or sage and sharp-tailed grouse nesting habitat, activities or surface use will not be allowed from February 1 to July 31 within certain areas encompassed by the authorization. The same criteria apply to defined raptor and game bird winter concentration areas from November 15 to April 30.

Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operation or production aspects.

Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the AO.

c. No activities or surface use will be allowed on that portion of the authorization area identified within (*legal description*) for the purpose of protecting (e.g., sage/sharp-tailed grouse breeding grounds, and/or other species/activities) habitat.

Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the AO.

d. Portions of the authorized use area legally described as (*legal description*), are known or suspected to be essential habitat for (*name*) which is a threatened or endangered species. Prior to conducting any onsite activities, the lessee/permittee will be required to conduct inventories or studies in accordance with BLM and U.S. Fish and Wildlife Service guidelines to verify the presence or absence of this species. In the event that (*name*) occurrence is identified, the lessee/permittee will be required to modify operational plans to include the protection requirements of this species and its habitat (e.g., *seasonal use restrictions, occupancy limitations, facility design modifications that apply*).

GUIDANCE

The WILDLIFE MITIGATION GUIDELINE is intended to provide two basic types of protection: 1) seasonal restriction (2a and 2b), and 2) prohibition of activities or surface use (2c). Item 2d is specific to situations involving threatened or endangered species. Legal descriptions will ultimately be required and should be measurable and legally definable. There are no minimum subdivision requirements at this time. The area delineated can and should be defined as necessary, based upon current biological data, prior to the time of processing an application and issuing the use authorization. The legal description must eventually become a part of the condition for approval of the permit, plan of development, and/or other use authorization.

The seasonal restriction section identifies three example groups of species and delineates three similar time frame restrictions. The big game species including elk, moose, deer, antelope, and bighorn sheep, all require protection of crucial winter range between November 15 and April 30. Elk and bighorn sheep also require protection from disturbance from May 1 to June 30, when they typically occupy distinct calving and lambing areas. Raptors include eagles, accipiters, falcons, (peregrine, prairie, and merlin), kestrels, buteos (ferruginous and Swainson's hawks), osprey, burrowing owls, and short-eared owls. The raptors and sage and sharp-tailed grouse require nesting protection between February 1 and July 31. The same birds often require protection from disturbance from November 15 through April 30 while they occupy winter concentration areas.

Item 2c, the prohibition of activity or surface use, is intended for the protection of specific wildlife habitat areas or values within the use area that cannot be protected by using seasonal restrictions. These areas or values must be factors that limit life-cycle activities (e.g., *sage grouse strutting grounds, known threatened and endangered species habitat*).

Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, applications for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

3.0 CULTURAL RESOURCE MITIGATION GUIDELINES

When a proposed discretionary land use has potential for affecting the characteristics, which qualify a cultural property for the National Register of Historic Places (National Register), mitigation will be considered. In accordance with Section 106 of the Historic Preservation Act, procedures specified in 36 CFR 800 will be used in consultation with the Wyoming State Historic Preservation Officer and the Advisory Council on Historic Preservation in arriving at determinations regarding the need and type of mitigation required.

GUIDANCE

The preferred strategy for treating potential adverse effects on cultural properties is "avoidance." If avoidance involves project relocation, the new project area may also require cultural resource inventory. If avoidance is imprudent or unfeasible, appropriate mitigation may include excavation (data recovery), stabilization, monitoring, protection barriers and signs, or other physical and administrative measures.

Reports documenting results of cultural resource inventory, evaluation, and the establishment of mitigation alternatives (if necessary) shall be written according to standards contained in BLM Manuals, the cultural resource permit stipulations, and in other policies issued by the BLM. These reports must provide sufficient information for Section 106 consultation. The appropriate BLM cultural resource specialist shall review reports for adequacy. If cultural properties on, or eligible for, the National Register are located within these areas of potential impact and cannot be avoided, the AO shall begin the Section 106 consultation process in accordance with the procedures contained in 36 CFR 800.

Mitigation measures shall be implemented according to the mitigation plan approved by the BLM AO. Such plans are usually prepared by the land use applicant according to BLM specifications. Mitigation plans will be reviewed as part of Section 106 consultation for National Register eligible or listed properties. The extent and nature of recommended mitigation shall be commensurate with the significance of the cultural resource involved and the anticipated extent of damage. Reasonable costs for mitigation will be borne by the land use applicant. Mitigation must be cost effective and realistic. It must consider project requirements and limitations, input from concerned parties, and be BLM-approved or BLM-formulated.

Mitigation of paleontological and natural history sites will be treated on a case-by-case basis. Factors such as site significance, economics, safety, and project urgency must be taken into account when making a decision to mitigate. Authority to protect (through mitigation) such values is provided for in Federal Land Policy Management Act (FLPMA) (1976), Section 102(a) (8). When avoidance is not possible, appropriate mitigation may include excavation (date recovery), stabilization, monitoring, protection barriers and signs, or other physical and administrative protection measures.

4.0 SPECIAL RESOURCE MITIGATION GUIDELINES

To protect (*resource value*), activities or surface use will not be allowed (i.e., *within a specific distance of the resource value or between date to date*) in (*legal description*).

Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects.

Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the AO.

EXAMPLE RESOURCE CATIGORIES (*Select or identify category and specific resource value*):

a. Recreation areas.

b. Special natural history or paleontological features.

c. Special management areas.

d. Sections of major rivers.

e. Prior existing rights-of-way.

f. Occupied dwellings.

f. Other (specify).

GUIDANCE

The SPECIAL RESOURCE MITIGATION GUIDELINE is intended for use only in site-specific situations where one of the first three general mitigation guidelines will not adequately address the concern. The resource value, location, and specific restrictions must be clearly identified. A detailed plan addressing specific mitigation and special restrictions will be required prior to disturbance or development and will become a condition for approval of the permit, plan of development, or other use authorization.

Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, applications for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

5.0 NO SURFACE OCCUPANCY GUIDELINES

No Surface Occupancy (NSO) will be allowed on the following described lands (*legal description*) because of (*resource value*).

EXAMPLE RESOUCE CATAGORIES (*Select or identify category and specific resource value*):

a. Recreation areas (e.g., campgrounds, historic trails, national, monuments).

b. Major reservoirs/dams.

c. Special management areas (e.g., areas of critical environmental concern, known threatened or endangered species habitat, wild and scenic rivers).

d. Other (specify).

GUIDANCE

The NO SURFACE OCCUPANCY (NSO) MITIGATION GUIDELINE is intended for use only when other mitigation is determined insufficient to adequately protect the public interest and is the only alternative to "no development" or "no leasing." The legal description and resource value of concern must be identified and be tied to an NSO land use planning decision.

Waiver of, or exception(s) to, the NSO requirement will be subject to the same test used to initially justify its imposition. If, upon evaluation of a site-specific proposal, it is found that less restrictive mitigation would adequately protect the public interest or value of concern, then a waiver or exception to the NSO requirement is possible. The record must show that because conditions or uses have changed, less restrictive requirements will protect the public interest. An environmental analysis must be conducted and documented (e.g., environmental assessment, environmental impact statement, etc., as necessary) in order to provide the basis for a waiver or exception to an NSO planning decision. Modification of the NSO requirement will pertain only to refinement or correction of the location(s) to which it applied. If the waiver, exception, or modification is found to be consistent with the intent of the planning decision, it may be granted. If found inconsistent with the intent of the planning decision, a plan amendment would be required before the waiver, exception, or modification could be granted.

When considering the "no development" or "no leasing" option, a rigorous test must be met and fully documented in the record. This test must be based upon stringent standards described in the land use-planning document. Since rejection of all development rights is more severe than the most restrictive mitigation requirement, the record must show that consideration was given to development subject to reasonable mitigation, including "no surface occupancy." The record must also show that other mitigation was determined to be insufficient to adequately protect the public interest, a "no development" or "no leasing" decision should not be made solely because it appears that conventional methods of development would be unfeasible, especially where an NSO restriction may be acceptable to a potential permittee. In such cases, the potential permittee should have the opportunity to decide whether or not to go ahead with the proposal (or accept the use authorization), recognizing that an NSO restriction is involved.

MEMO OF BIA MITGATION REQUIREMENTS FOR OIL AND GAS DEVELOPMENT (BIA 2004)

UNITED STATES GOVERNMENT
MEMORANDUM

DATE: 21-Jan-04

REPLY TO: Laura E. Austin, Realty Officer
ATTN.: BIA. Wind River Agency, Ft. Washakie, WY

SUBJECT: Tom Brown Inc.'s proposal to drill well Tribal Juniper # 28-11

TO: Area Manager, Bureau of Land Management, Lander Resource Area

We have reviewed Tom Brown's surface use plan to drill as well described Tribal Juniper #28-11 located in the NW¼NW¼ of section 28, Township 1 North, Range 1 West, WRM, Fremont County Wyoming.

Dr. Charles Reher, Archeologist and Director of WRCRPP, conducted a survey with no significant cultural resources located. Therefore, archeological clearance is grated for the project.

The U.S. Fish & Wildlife have conducted a T&E survey of the area with no major impacts to the threatened and endangered species therefore we recommend approval.

All disturbed areas shall be reseeded with the following seed mixture.

Crintana Thickspike Wheatgrass	3 lbs./acre
Rosanna Western Wheatgrass	3 lbs./acre
Green Needlegrass	3 lbs./acre
Indian Ricegrass	3 lbs./acre

Seed is to be planted to a depth not to exceed ½ inch using a seed drill. Where hand broadcast method be utilized, seed mixture shall be doubles and the area raked or chained to cover seed. Fall planting is recommended for September through November before the ground freezes and spring planting is after ground frost and prior to May 15th.

Any questions may be directed to Floyd Phillips of the Branch of Realty, Minerals section at (307) 332-5605.

U.S. FISH AND WILDLIFE SERVICE MITIGATION REQUIREMENTS FOR THREATENED AND ENDANGERED SPECIES IN THE WIND RIVER PROJECT AREA (U.S. FWS 2002)

Black-footed Ferret

If white-tailed prairie dog colonies or complexes, greater than 200 acres, may be disturbed, surveys for black-footed ferrets are recommended in order to determine if the action will result in an adverse effect to the species.

Bald Eagle

In order to reduce adverse effects to the bald eagle a disturbance-free buffer zone of one mile should be maintained around their nests. Activity within one mile of an eagle nest may disturb the eagles and result in incidental “take.”

Grizzly Bear

Grizzly bears are attracted to carrion, waste products of construction camps, recreational camps and sprawling residential areas that have encroached into their habitat and consequently increased human-bear interactions (Grizzly Bear Recovery Plan, 1993).

Gray Wolf

All gray wolves within Wyoming are now considered part of the nonessential experimental population. The protective measures in the final rule and special regulations, promulgated for the nonessential populations of the gray wolf, should be followed (59 FR 60252). Wolves designated as nonessential experimental populations are treated as proposed, rather than listed.

Canada Lynx

In Wyoming, the Canada lynx lives in subalpine/coniferous forests of mixed age and structural classes. The home range of the lynx can be 5 to 94 miles. They are capable of moving extremely long distances in search for food. The FWS cautions you when making a “no effect” ruling based on the fact that there are no recent records of their occurrence in an area, since Canada lynx have been observed in every mountain range in Wyoming.

Mountain Plover

The mountain plover occupies its breeding habitat from late March through July. Surveys are recommended for plovers following the Mountain Plover Survey Guidelines (US FWS, March 2002) in all suitable habitat as well as avoidance of nesting areas to minimize adverse impacts to plovers within a project site. In some cases project activities can be conducted between August 15 and March 15 to avoid affecting this species.

Sage Grouse

The sage grouse population has been declining. All necessary measures should be taken to protect the sages grouse in the project area to ensure that this project does not exacerbate factors contributing to this species' decline.

Avoidance of any activity that would disrupt brood rearing during the nesting period from June 1 to July 31 is recommended. Crucial wintering habitat of the sage grouse should also be protected.

Eagles, Raptors, and Migratory Bird Species

The Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act require the protection of many species of migratory birds, including eagles and other raptors, which may occur within a project area. The Migratory Bird Treaty Act prohibits the taking of any migratory birds, their parts, nests, or eggs, except as permitted by regulations, and does not require intent to be proven. The Bald and Golden Eagle Protection Act prohibits knowingly taking or taking with wanton disregard for the consequences of an activity, any bald or golden eagles or their body parts, nests, or eggs, which includes collection, molestation, disturbance, or killing. No nest manipulation is allowed without a permit.

Wetlands/Riparian Areas

Wetlands and riparian areas are valuable natural resources and impacts to these areas should be avoided, whenever possible. If wetlands may be destroyed or degraded by the Proposed Action, those wetlands in the project area should be inventories and fully described in terms of functions and values. Acreage of wetlands, by type, should be disclosed and specific actions outlined to minimize impacts and compensate for all unavoidable wetland impacts. Measures should be taken to avoid any wetland losses, in accordance with Section 404 of the Clean Water Act, Executive Order 11990, as well as the goal of "no net loss of wetlands."

APPENDIX C
SURFACE DISTURBANCE CALCULATIONS

Table C-1. Disturbance Estimates for the Existing TBI Operations in the Wind River Project Area.

Field	Structure	Dimensions (lxw)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance (lxw)	Total Residual Disturbance (acres)
Pavillion (Separate Wellhead)	Wellpad	250'x350'	87,500	2.01	24	48.21	8'x8'	0.04
	Temporary Well Access Roads	800'x16'	12,800	0.29	24	7.05	0	0.00
	Production Facility	100'x125'	12,500	0.29	24	6.89	100'x125'	6.89
Pavillion (Wellhead w/Facility)	Wellpad / Production Facility	250'x350'	87,500	2.01	75	150.65	163'x270'	75.77
Pavillion (all)	TBI Existing Roads	77,917'x35'	2,727,095	62.61	-	62.61	77,917x35'	62.61
TOTAL PAVILLION					**99**	**275**		**145**
Muddy Ridge	Wellpad/ Facility	460'x475'	218,960	5.03	70	351.86	222'x327'	116.66
	TBI Existing Roads	15.3mi.x35'	2,827,440	64.91		64.91	15.3mi.x35'	64.91
TOTAL MUDDY RIDGE					**70**	**417**		**182**
Sand Mesa	Wellpad/Facility	460'x475'	218,960	5.03	3	15.08	222'x327'	5.00
	TBI Existing Roads	6.2mi.x35'	1,145,760	26.30		26.30	6.2mi.x35'	26.30
TOTAL SAND MESA					**3**	**41**		**31**
Other Wells w/in WRPA	Wellpad/Facility	460'x475'	218,960	5.03	6	30.16	222'x327'	10.00
	Other Existing Roads	6.2mi.x35'	1,145,760	26.30	-	26.30	6.2mi.x35'	26.30
TOTAL OTHER WELLS					**6**	**56**		**36**
WELL TOTAL					**178**	**790**		**394**
Pipelines / Compressors	3" Gathering Line	48,120'x50'	2,406,000	55.23	-	55.2	0	0
	4" Gathering Line	212,338'x50'	10,616,900	243.73	-	243.7	0	0
	6" Gathering Line	108,652'x50'	5,432,600	124.72	-	124.7	0	0
	8" Gathering Line	121,100'x50'	6,055,000	139.00	-	139.0	0	0
	10" Gathering Line	20,500'x50'	1,025,000	23.53	-	23.5	0	0
	Kinder Morgan 2" Distribution Line	21,120'x50'	1,056,000	24.24	-	24.2	0	0
	Pavillion Plant (8212 HP)			10.00		10.0		10.0
	West Pavillion Compressor (3340 HP)			4.00		4.0		4.0
	Sand Mesa Compressor Station (360HP)/			2.00		2.00		2.00
TOTAL PIPELINES/ COMPRESSORS						**626**		**16.0**
TOTAL DISTURBANCE					**178**	**1,416**		**410**
Total Disturbance by Area	Pavillion				**99**	**606**		**159**
	Muddy Ridge				**70**	**573**		**182**
	Sand Mesa				**3**	**73**		**33**
	Other				**6**	**164**		**36**
TOTAL DISTURBANCE ALL AREAS					**178**	**1,416**		**410**

Note: Existing road distances estimated by Apex Surveying, Inc. in a letter addressed to Steve Mansur, TBI, June 24, 2003
Existing pipeline and compressor station distrubance provided by TBI in a facility summary
Drilling pad and production pad dimensions provided by TBI and based upon surveys completed by Apex Surveying Inc.
Division of pipeline disturbance by development area estimated from pipeline maps provided by TBI and number of wells.
The majority of the larger diameter pipelines are located outside of the five development areas.

Table C-2. Disturbance Estimates for the Proposed Action in the WRPA.

Field	Structure	Length (ft.)	Width (ft.)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance Length, ft.	Residual Disturbance Width, ft.	Percent success	Residual Disturbance (acres)[1]
Pavillion (Irrigated)	Access Road to/from well	800	16	12,800	0.29	72	21.2	0	0		0.0
	Pipeline from well	1,000	8	8,000	0.18	72	13.2	0	0		0.0
	Wellpad	350	250	87,500	2.01	72	144.6	8	8	100%	0.1
	Production Facility	125	100	12,500	0.29	72	20.7	125	100	100%	20.7
Pavillion (Dry Land)	Access Road to/from well	800	35	28,000	0.64	83	53.4	800	35	100%	53.4
	Pipeline from well	1,000	8	8,000	0.18	83	15.2	0	0		0.0
	Wellpad	350	250	87,500	2.01	83	166.7	270	163	100%	83.9
Pavillion	8" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	6" Line Loop	10,000	50	500,000	11.48	-	11.5	0	0		0.0
	South Pavillion Compressor Station	200	300	60,000	1.38	-	1.4	200	300		1.4
TOTAL PAVILLION						**155**	**472.1**				**159.4**
Muddy Ridge	Access Road to/from well	800	35	28,000	0.64	50	32.1	800	35	100%	32.1
	Pipeline from well	1,000	8	8,000	0.18	50	9.2	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	50	250.8	327	222	100%	83.3
	8"Line Loop	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	6" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 6" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	New 4" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	Muddy Ridge Compressor Station	415	415	172,225	3.95	-	4.0	415	415		4.0
TOTAL MUDDY RIDGE						**50**	**411.2**				**119.4**
Sand Mesa	Access road to/from well	800	35	28,000	0.64	100	64.3	800	35	50%	32.1
	Pipeline from well	1,000	30	30,000	0.69	100	68.9	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	100	501.6	327	222	50%	83.3
	8" Line Loop	42,240	50	2,112,000	48.48	-	48.5	0	0		0.0
	New 8" Line	15,900	50	795,000	18.25	-	18.3	0	0		0.0
	New 6" Line	32,000	50	1,600,000	36.73	-	36.7	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66	-	20.7	0	0		0.0
	Sand Mesa Compressor Station	415	630	261,450	6.00	-	6.0	415	630		6.0
TOTAL SAND MESA						**100**	**764.9**				**121.5**

Table C-2. Disturbance Estimates for the Proposed Action in the WRPA.

Field	Structure	Length (ft.)	Width (ft.)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance Length, ft.	Residual Disturbance Width, ft.	Percent success	Residual Disturbance (acres)[1]
Sand Mesa South	Access road to/from well	800	35	28,000	0.64	12	7.7	800	35	50%	3.9
	Pipeline from well	1,000	30	30,000	0.69	12	8.3	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	12	60.2	327	222	50%	10.0
	8" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 8" Line	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 6" Line	18,480	50	924,000	21.21	-	21.2	0	0		0.0
	New 4" Line	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	Sand Mesa South Compressor Station	300	415	124,500	2.86	-	2.9	300	415		2.9
TOTAL SAND MESA SOUTH						**12**	**173.0**				**16.7**
Coastal Extension	Access road to/from well	800	35	28,000	0.64	8	5.1	800	35	20%	1.0
	Pipeline to/from well	1,000	30	30,000	0.69	8	5.5	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	8	40.1	327	222	20%	2.7
	New 8" Line	43,850	50	2,192,500	50.33	-	50.3	0	0		0.0
	New 6" Line	32,210	50	1,610,500	36.97	-	37.0	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66	-	20.7	0	0		0.0
	Coastal Extension Compressor Station	210	415	87,150	2.00	-	2.0	210	415		2.0
TOTAL COASTAL EXTENSION						**8**	**160.7**				**5.7**
TOTAL DISTURBANCE ALL FIELDS						**325**	**1,981.9**				**422.6**

DISTURBANCE SUMMARY		LENGTH, FT.	LENGTH, MI.				ACRES				ACRES
Wellpads							1,164.1				263.3
Pipelines		740,480	140				597.2				0.0
Roads		260,000	49				183.8				122.5
Ancillaries							36.9				36.9
Total							**1,981.9**				**422.6**

Table C-3. Disturbance Estimates for Alternative A (485 New Wells) in the WRPA

Field	Structure	Length (ft.)	Width (ft.)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance Length, ft.	Residual Disturbance Width, ft.	Percent success	Residual Disturbance (acres)[1]
Pavillion (Irrigated)	Access Road to/from well	800	16	12,800	0.29	96	28.2	0	0		0.0
	Pipeline from well	1,000	8	8,000	0.18	96	17.6	0	0		0.0
	Wellpad	350	250	87,500	2.01	96	192.8	8	8	100%	0.1
	Production Facility	125	100	12,500	0.29	96	27.5	125	100	100%	27.5
Pavillion (Dry Land)	Access Road to/from well	800	35	28,000	0.64	110	70.7	800	35	100%	70.7
	Pipeline from well	1,000	8	8,000	0.18	110	20.2	0	0		0.0
	Wellpad	350	250	87,500	2.01	110	221.0	270	163	100%	111.1
Pavillion	8" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	6" Line Loop	10,000	50	500,000	11.48	-	11.5	0	0		0.0
	South Pavillion Compressor Station	415	630	261,450	6.00	-	6.0	415	630		6.0
TOTAL PAVILLION						**206**	**619.8**				**215.5**
Muddy Ridge	Access Road to/from well	800	35	28,000	0.64	66	42.4	800	35	100%	42.4
	Pipeline from well	1,000	8	8,000	0.18	66	12.1	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	66	331.1	327	222	100%	110.0
	8"Line Loop	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	6" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 6" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	New 4" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	Muddy Ridge Compressor Station	415	630	261,450	6.00	-	6.0	415	630		6.0
TOTAL MUDDY RIDGE						**66**	**506.8**				**158.4**
Sand Mesa	Access road to/from well	800	35	28,000	0.64	133	85.5	800	35	50%	42.7
	Pipeline from well	1,000	30	30,000	0.69	133	91.6	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	133	667.1	327	222	50%	110.8
	8" Line Loop	42,240	50	2,112,000	48.48	-	48.5	0	0		0.0
	New 8" Line	15,900	50	795,000	18.25	-	18.3	0	0		0.0
	New 6" Line	32,000	50	1,600,000	36.73	-	36.7	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66	-	20.7	0	0		0.0
	Sand Mesa Compressor Station	415	630	261,450	6.00	-	6.0	415	630		6.0
TOTAL SAND MESA						**133**	**974.4**				**159.6**

Table C-3. Disturbance Estimates for Alternative A (485 New Wells) in the WRPA

Field	Structure	Length (ft.)	Width (ft.)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance Length, ft.	Residual Disturbance Width, ft.	Percent success	Residual Disturbance (acres)[1]
Sand Mesa South	Access road to/from well	800	35	28,000	0.64	48	30.9	800	35	50%	15.4
	Pipeline from well	1,000	30	30,000	0.69	48	33.1	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	48	240.8	327	222	50%	40.0
	8" Line Loop	21,120	50	1,056,000	24.24		24.2	0	0		0.0
	New 8" Line	21,120	50	1,056,000	24.24		24.2	0	0		0.0
	New 6" Line	18,480	50	924,000	21.21		21.2	0	0		0.0
	New 4" Line	21,120	50	1,056,000	24.24		24.2	0	0		0.0
	Sand Mesa South Compressor Station	415	415	172,225	3.95		4.0	415	415		4.0
TOTAL SAND MESA SOUTH						**48**	**402.6**				**59.4**
Coastal Extension	Access road to/from well	800	35	28,000	0.64	32	20.6	800	35	20%	4.1
	Pipeline to/from well	1,000	30	30,000	0.69	32	22.0	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	32	160.5	327	222	20%	10.7
	New 8" Line	43,850	50	2,192,500	50.33		50.3	0	0		0.0
	New 6" Line	32,210	50	1,610,500	36.97		37.0	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66		20.7	0	0		0.0
	Coastal Extension Compressor Station	415	415	172,225	3.95		4.0	415	415		4.0
TOTAL COASTAL EXTENSION						**32**	**315.0**				**18.7**
TOTAL DISTURBANCE ALL FIELDS						**485**	**2,818.6**				**611.6**

DISTURBANCE SUMMARY		**LENGTH, FT.**	**LENGTH, MI.**				**ACRES**				**ACRES**
Wellpads							1,813.3				382.8
Pipelines		900,480	171				673.6				0.0
Roads		388,000	73				278.3				175.4
Ancillaries							53.5				53.5
Total							**2,818.6**				**611.6**

[1] Access roads to wells will be removed in irrigated fields.

Table C-4. Disturbance Estimates for Alternative B (233 new wells) in the WRPA.

Field	Structure	Length (ft.)	Width (ft.)	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance Length, ft.	Residual Disturbance Width, ft.	Percent success	Residual Disturbance (acres)[1]
Pavillion (Irrigated)	Access Road to/from well	800	16	12,800	0.29	34	10.0	0	0		0.0
	Pipeline from well	1,000	8	8,000	0.18	34	6.2	0	0		0.0
	Wellpad	350	250	87,500	2.01	34	68.3	8	8	100%	0.0
	Production Facility	125	100	12,500	0.29	34	9.8	125	100	100%	9.8
Pavillion (Dry Land)	Access Road to/from well	800	35	28,000	0.64	62	39.9	800	35	100%	39.9
	Pipeline from well	1,000	8	8,000	0.18	62	11.4	0	0		0.0
	Wellpad	350	250	87,500	2.01	62	124.5	270	163	100%	62.6
Pavillion	8" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	6" Line Loop	10,000	50	500,000	11.48	-	11.5	0	0		0.0
	South Pavillion Compressor Station	200	300	60,000	1.38		1.4	200	300		1.4
TOTAL PAVILLION						**96**	**307.2**				**113.7**
Muddy Ridge	Access Road to/from well	800	35	28,000	0.64	40	25.7	800	35	100%	25.7
	Pipeline from well	1,000	8	8,000	0.18	40	7.3	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	40	200.6	327	222	100%	66.7
	8"Line Loop	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	6" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 6" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	New 4" Line	26,400	50	1,320,000	30.30	-	30.3	0	0		0.0
	Muddy Ridge Compressor Station	415	415	172,225	3.95	-	4.0	415	415		4.0
TOTAL MUDDY RIDGE						**40**	**352.8**				**96.3**
Sand Mesa	Access road to/from well	800	35	28,000	0.64	80	51.4	800	35	50%	25.7
	Pipeline from well	1,000	30	30,000	0.69	80	55.1	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	80	401.3	327	222	50%	66.7
	8" Line Loop	42,240	50	2,112,000	48.48	-	48.5	0	0		0.0
	New 8" Line	15,900	50	795,000	18.25	-	18.3	0	0		0.0
	New 6" Line	32,000	50	1,600,000	36.73	-	36.7	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66	-	20.7	0	0		0.0
	Sand Mesa Compressor Station	415	415	172,225	3.95	-	4.0	415	415		4.0
TOTAL SAND MESA						**80**	**635.9**				**96.4**

Table C-4. Disturbance Estimates for Alternative B (233 new wells) in the WRPA.

Sand Mesa South	Access road to/from well	800	35	28,000	0.64	10	6.4	800	35	50%	3.2
	Pipeline from well	1,000	30	30,000	0.69	10	6.9	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	10	50.2	327	222	50%	8.3
	8" Line Loop	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 8" Line	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	New 6" Line	18,480	50	924,000	21.21	-	21.2	0	0		0.0
	New 4" Line	21,120	50	1,056,000	24.24	-	24.2	0	0		0.0
	Sand Mesa South Compressor Station	210	415	87,150	2.00	-	2.0	210	415		2.0
TOTAL SAND MESA SOUTH						**10**	**159.4**				**13.5**
Coastal Extension	Access road to/from well	800	35	28,000	0.64	7	4.5	800	35	20%	0.9
	Pipeline to/from well	1,000	30	30,000	0.69	7	4.8	0	0		0.0
	Wellpad/Facility	475	460	218,500	5.02	7	35.1	327	222	20%	2.3
	New 8" Line	43,850	50	2,192,500	50.33	-	50.3	0	0		0.0
	New 6" Line	32,210	50	1,610,500	36.97	-	37.0	0	0		0.0
	New 4" Line	18,000	50	900,000	20.66	-	20.7	0	0		0.0
	Coastal Extension Compressor Station	210	415	87,150	2.00	-	2.0	210	415		2.0
TOTAL COASTAL EXTENSION						**7**	**154.4**				**5.2**
TOTAL DISTURBANCE ALL FIELDS						**233**	**1,609.7**				**325.2**

DISTURBANCE SUMMARY		**LENGTH, FT.**	**LENGTH, MI.**				**ACRES**				**ACRES**
Wellpads							880.0				206.7
Pipelines		648,480	123				568.7				0.0
Roads		186,400	35				137.9				95.4
Ancillaries							23.0				23.1
Total							**1,609.7**				**325.2**

[1] Access roads to wells will be removed in irrigated fields.

Table C-5. Disturbance Estimates for the No Action Alternative (Alternative C) in the WRPA.

Field	Structure	Length, Ft.	Width, Ft.	Disturbance (ft^2)	Disturbance (acres)	Total No. Wells	Total Disturbance (acres)	Residual Disturbance length (ft.)	Residual Disturbance width (ft)	Percent Success	Residual Disturbance (acres)[1]
Pavillion (Fee, Irrigated)	Access Road to/from well	800	16	12,800	0.29	64	18.8	0	0		0.0
	Pipeline to/from well	1,000	8	8,000	0.18	64	11.8	0	0		0.0
	Wellpad	350	250	87,500	2.01	64	128.6	8	8	100%	0.1
	Production Facility	125	100	12,500	0.29	64	18.4	125	100	100%	18.4
Offset Drainage Tribal Protection Wells	Access Road to/from well	800	35	28,000	0.64	36	23.1	800	35	100%	23.1
	Pipeline to/from well	1,000	8	8,000	0.18	36	6.6	0	0		0.0
	Wellpad	350	250	87,500	2.01	36	72.3	270	163	100%	36.4
	8" Line Loop Pavillion	21,120	50	1,056,000	24.24	100	24.2	0	0		0.0
	6" Line Loop Pavillion	10,000	50	500,000	11.48	100	11.5	0	0		0.0
	South Pavillion Compressor Station	200	300	60,000	1.38	-	1.4	200	300		1.4
						100	**316.6**				**79.35**
Muddy Ridge	No wells will be drilled in this area under a No Action Alternative.										
Sand Mesa	No wells will be drilled in this area under a No Action Alternative.										
Sand Mesa South	No wells will be drilled in this area under a No Action Alternative.										
Coastal Extension	No wells will be drilled in this area under a No Action Alternative.										

DISTURBANCE SUMMARY		LENGTH, FT.	LENGTH, MI.				ACRES				ACRES
Wellpads							200.9				36.5
Roads		80,000.0	15.2				41.9				23.1
Pipelines		32,120.0	6.1				54.1				0.0
Ancillaries							19.7				19.7
Total							**316.6**				**79.3**

APPENDIX D
RECLAMATION PLAN

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RECLAMATION PLAN

1.0 INTRODUCTION

The following erosion control, revegetation, mitigation measures, and management measures are designed to attain successful rehabilitation of areas disturbed within the Wind River Project Area (WRPA) as a result of the Proposed Action or Alternatives A, B, and C. These measures are designed to establish the feasibility of reclaiming disturbances associated with this project. The extent of possible disturbed areas to be reclaimed includes drill sites, access roads and pipeline ROW's, staging areas, and other ancillary facilities. The following measures apply to the Proposed Action and Alternatives A, B, and C unless identified for a specific alternative.

The measures presented in this plan are designed to allow the project to be constructed without significant impacts to natural resources. Because of the large geographic area covered by the project and the lack of site-specific locations of project facilities, these measures are presented in a general manner. Final selection of the measures to be applied at any given location, and modifications of these measures, will be identified by the agencies involved in coordination the Operators.

This reclamation plan outlines measures that will be taken to effectively reclaim areas disturbed during construction within the WRPA. These measures will be followed unless exceptions are granted or actions are modified by agreement between involved agencies and the Operators. These measures describe how natural gas development activities would be managed to assure compliance with the resource management goals and objectives for the general area, applicable lease and unit area stipulations, and resource limitations identified during interdisciplinary (ID) team analyses. Initial monitoring for compliance and successful implementation of the mitigation measures will be under the direction of the Operators. Final approval and release will be under the direction of the agencies involved.

Reclamation measures covered in this plan fall into two general categories: temporary and final reclamation. Temporary reclamation refers to measures applied to stabilize disturbed areas and to control runoff and erosion during time periods when application of final reclamation measures is not feasible or practicable. Final reclamation refers to measures that would be applied concurrently with completion of drilling and pipeline installation.

Reclamation potential may be limited by salinity, alkalinity, steep slopes, shallow soils, depth to bedrock, low precipitation, stoniness, high wind and water erosion, periodic flooding, short growing season, seasonably high water tables, and strong winds. Special intensive land-use practices may be necessary to mitigate salt and sediment loading caused by surface-disturbing activities within the WRPA. Activity plans (e.g., applications for permit to drill [APD's]) would address site-specific problems, including monitoring for salt and sediment loading (USDI-BLM 1990).

In general, temporary reclamation measures would be applied to all areas not promptly reclaimed to final conditions within a specified time period whether due to adverse weather conditions, inability to secure needed materials, and/or seasonal constraints. Temporary reclamation measures would be applied only as needed. In most cases, final reclamation measures would be applied concurrently as sections of the project are completed. Temporary reclamation measures may be applied more rigorously to sensitive areas such as drainage channel crossings, steep slopes, and areas prone to high wind and water erosion. Temporary reclamation measures would include returning the disturbed area to near pre-disturbance contour, re-spreading salvaged topsoil, mulching, and placing runoff and erosion control structures.

Final reclamation measures, in general, involve returning the disturbed area to near pre-disturbance contour, re-spreading salvaged topsoil, applying soil amendments (if necessary), applying a prescribed seed mixture, mulching, and placing runoff and erosion control structures such as water bars and silt fences (Figure D-1). The duration of the resulting impacts to the various vegetation community types depends in part on the success of implementation of the reclamation measures prescribed in this appendix and the time required for natural succession to return disturbed areas to pre-disturbance conditions.

Because wetlands are "waters of the U.S." and are protected under the Federal Clean Water Act (CWA), discharge of dredge or fill material into, and/or excavation of wetlands could require administrative coordination with the U.S. Army Corps of Engineers (COE) pursuant to the CWA and may require a Section 404 permit. The COE, based on the exact nature of the disturbance activity, would determine the type of permit (Individual, Regional, or Nationwide) required according to the regulations presented in the Federal Register (1986). Avoidance of waters of the U.S. and wetlands would be the highest priority. A suitable wetland mitigation plan would be developed for the areas of wetlands directly impacted due to project activities where avoidance is not practicable. Impact minimization would include reducing the area of disturbance in wetland areas as well as utilizing procedures specified by authorizing agencies to cross intermittent and ephemeral drainage channels and wetland areas.

Although intermittent and ephemeral drainage channels are not considered wetlands, the same requirements apply to the discharge of dredge and fill into them as for discharge into wetlands. Residual wetland impacts that could occur, after maximum avoidance and/or impact minimization has been demonstrated, would be mitigated according to the following order of priority: 1) avoidance; 2) impact minimization; 3) mitigation in-kind, on-site; 4) mitigation in-kind, off-site; 5) mitigation out-of-kind, on-site; and 6) mitigation out-of-kind, off-site. In addition, the following modes of mitigation could be implemented for wetland mitigation if avoidance and impact minimization were not feasible: 1) wetlands restoration; 2) wetlands creation; and 3) wetlands enhancement. The wetlands mitigation plan would be designed to replace the area of impact and functional values associated with the disturbed area.

2.0 OBJECTIVES

This plan is designed to meet the following objectives for reclamation of the access road/pipeline ROW's and the drill sites:

Short-Term (Temporary) Reclamation:

- Immediately stabilize the disturbed areas by mulching (if needed), providing runoff and erosion control, and establishing new vegetation (required for problem areas; may be optional for other areas depending on consultation with the BIA).
- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures.

Long-Term (Final) Reclamation:

- Immediately stabilize the disturbed soil surface by mulching (if needed and as directed by the agencies involved), runoff and erosion control, and through the establishment of new vegetation. Adequate surface roughness would exist to reduce runoff and to capture rainfall and snow melt.
- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures.
- Restore primary productivity of the site and establish vegetation that will provide for natural plant and community succession.
- Establish a vigorous stand of desirable plant species that will limit or preclude invasion of undesirable species, including noxious weeds.
- Revegetate the disturbed areas with plant species useful to wildlife and livestock.
- Enhance aesthetic values. In the long-term, reclaimed landscapes would have characteristics that approximate the visual quality of adjacent areas, including location, scale, shape, color, and orientation of major landscape undisturbed features.

3.0 PERFORMANCE STANDARDS

The following performance standards would be used to determine the attainment of successful revegetation:

All Years:

- Protective cover. With the exception of active work areas, all disturbed highly erosive or sensitive areas to be left bare, unprotected, or unreclaimed for more than one month will have at least a 50 percent cover of protective material in the form of mulch, matting, or vegetative growth. All disturbed areas would have at least a 50 percent cover of protective material within six months after reclamation.

Second Year (Final Reclamation):

- Seedling density. The density and abundance of desirable species is at least three to four seedlings per linear foot of drill row (if drilled) or transect (if broadcast). Vegetative transects will be established on a permanent basis so that transects can be measured annually through the five-year monitoring period.

- Percent cover. Total vegetative cover will be at least 50 percent of predisturbance vegetative cover as measured along the reference transect for establishing baseline conditions.

By the Fifth Year (Final Reclamation):

- Percent cover. Total vegetation cover will be at least 80 percent of predisturbance vegetation cover as measured along the reference transect for establishing baseline conditions.

- Dominant species. Ninety percent of the revegetation consists of species included in the seed mix and/or occurs in the surrounding natural vegetation, or as deemed desirable by the BIA as measured along the reference transect for establishing baseline conditions.

- Erosion condition/soil surface factor. Erosion condition of the reclaimed areas is equal to or in better condition than that measured for the reference transect for establishing baseline conditions.

4.0 METHODS

4.1 Drill Site, Access Road, and Pipeline Right-of-Way Clearing and Topsoil Removal and Storage

Topsoil would be handled separately from subsoil materials. At all construction sites, topsoil would be stripped to provide for sufficient quantities to be respread to a depth of at least four to six inches over the disturbed areas to be reclaimed. In areas where deep soils exist (such as floodplains and drainage channel terraces), at least 12 inches of topsoil would be salvaged. Where soils are shallow or where subsoil is stony, as much topsoil would be salvaged as possible. Topsoil would be stockpiled separately from subsoil materials. Topsoil salvaged from drill sites and stored for more than one year would be bladed to a specified location at these areas, seeded with a prescribed seed mixture, and covered with mulch for protection from wind and water erosion and to discourage the invasion of weeds. Topsoil stockpiles would not exceed a depth of 2 feet. Topsoil would be stockpiled separately from other soil materials to preclude contamination or mixing and would be marked with signs and identified on construction and design plans. Runoff would be diverted around topsoil stockpiles to minimize erosion of topsoil materials. In most cases, disturbances will be reclaimed within one year. Therefore, it is unlikely that topsoil stockpiling for more than one year will be required. Salvaged topsoil from roads and drill sites will be respread over cut-and-fill surfaces not actively used during the production phase. Upon final reclamation at the end of the project life, topsoil spread on these surfaces will be used for the overall reclamation effort.

Operators are finding out that it is not always necessary to remove all vegetation and strip all topsoil within a pipeline ROW. In many areas, such as with deep soils on relatively flat smooth slopes with low gradients, it is possible to crush in-place rather than clear vegetation and leave topsoil in-place rather than blade and stockpile. This technique would reduce the magnitude and severity of disturbance impacts and hasten successful reclamation.

In federal jurisdictional wetland areas, vegetation would be cut off only to the ground level, leaving existing root systems intact. Cut vegetation would be removed from wetland areas for disposal. Grading activities would be limited to directly over pipeline trenches and access roads. At least 12 inches of topsoil would be salvaged and replaced except in areas with standing water or saturated soils. Use of construction equipment in wetland areas would be limited. Dirt, rock fill, or brush riprap would not be used to stabilize pipeline ROW’s. If standing water or saturated soils are present, wide-track or balloon-tire construction equipment would be used or normal construction equipment would be operated on equipment pads or geotextile fabric overlain with gravel fill. Equipment pads would be removed immediately upon completion of construction activities. Trench spoil would be placed at least 10 feet away from drainage channel banks for all minor and major drainage channel crossings.

4.2 Drill Site, Access Road, and Pipeline Right-of-Way Construction

4.2.1 Upland Areas

Uplands include all areas away from wetlands and alluvial bottomlands or other areas that have excess soil moisture for prolonged periods or have shallow water tables. Construction would be accomplished following site-specific construction and design plans and applicable agency specifications. At drill sites, and along the areas of access road or pipeline ROW traversing steep slopes, slope angles would be minimized to enhance retention of topsoil, and reduce erosion as well as facilitate revegetation, and subsequent reclamation success. Slope-stabilizing revetment structures may be necessary in areas where the subsurface materials are unconsolidated and loose and cannot be stabilized with revegetation and mulch.

Surface runoff would be controlled at all well sites through the use of interception ditches and berms. A berm approximately 18 inches high would be constructed around fill portions of these well sites to control and contain all surface runoff generated or fuel or petroleum product spills on the pad surface. Water contained on the drill pads would be treated in a retention pond prior to discharge into undisturbed areas in the same manner as discussed previously. This system would also serve to capture fuel and chemical spills, should they occur.

Erosion and sedimentation control measures and structures would be installed on all disturbed areas. Soil erosion control would be accomplished on sites in highly erosive soils and steep areas with mulching, netting, tackifiers, hydromulch, matting, and excelsior. The type of control measure would depend on slope gradients and the susceptibility of soil to wind and water erosion. Silt fences would be placed at the base of all steep fill slopes and sensitive disturbed areas. All runoff and erosion control structures would be inspected periodically, cleaned out, and maintained in functional condition throughout the duration of construction and drilling. Water bars would be constructed on cut-and-fill slopes exceeding 25 feet long and 10 percent gradient using the water bar spacing guidelines and procedures specified for access road and pipeline ROW runoff and erosion control (BLM Manual Section 9113).

Runoff and erosion control along access road/pipeline ROW'S would be accomplished by implementing standard cross drain, culvert, road ditch, and turnout design as well as timely mulching and revegetation of exposed cut, fill, and road shoulders. All culverts would be constructed with riprapped entrances and exits and with energy dissipaters or other scour-reducing techniques where appropriate. Water discharged from culverts, cross drains, road ditches, and turnouts would be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures would be installed across all cut-and-fill slopes within 100 feet of drainage channels. All runoff and erosion control structures would be inspected after major runoff events and at a regular schedule. If found to be sub-standard, these structures would be cleaned out and maintained in functional condition throughout the life of the project.

4.2.2 Drainage Channel Crossings

Construction of drainage channel crossings would minimize the disturbance to drainage channels and wetlands to the extent practicable and would occur during the low runoff period (June 15 through March 1). Staging areas would be limited in size to the minimum necessary and would be located at least 50 feet from drainage channel bottoms, where topographic conditions permit. Hazardous materials would not be stored and equipment would not be refueled within 100 feet of drainage channels. Drainage channel crossings would be constructed as perpendicular to the axis of the drainage channel and at the narrowest positions as engineering and routing conditions permit. Clean gravel would be used for the upper one foot of fill over the backfilled pipeline trenches within drainage channel crossings.

4.2.3 Wetlands

Access roads and pipelines would be rerouted, and drill sites located, to avoid wetland areas to the maximum practical extent. The size of staging areas would be limited to the minimum necessary and all staging areas would be located at least 50 feet from the edge of federally delineated wetland areas, where topographic conditions permit. The width of the access road and pipeline construction ROW would be limited to no more than 50 feet. Hazardous materials would not be stored and equipment would not be refueled within 100 feet of wetland boundaries.

Appropriate permits would be secured from the COE prior to any construction activities in federal jurisdictional wetland areas.

4.3 Surface Runoff and Erosion Control

4.3.1 Drill Site, Access Road, and Pipeline Right-of-Way

Temporary Reclamation

Temporary erosion control measures may include application of mulch and netting of biodegradable erosion control blankets stapled firmly to the soil surface, respreading scalped vegetation, or construction of water bars. Reclamation measures are further discussed in Chapter 4, Soils with specific information pertaining to mulching. The actual distance of a pipeline/road ROW requiring stabilization on each side of a drainage channel would be determined on a site-specific basis. To minimize sedimentation of drainage channels and wetlands during the interim period between construction activity and final reclamation, temporary erosion and sediment control measures would be applied. Silt fences or other sediment filtering devices, such as weed-free straw bales, would be installed along drainage channel banks where sedimentation is excessive and at the base of all slopes adjacent to wetlands. Figure D-1 presents schematics of water bar and silt fence construction. Sediment filtering devices would be cleaned out and maintained in functional condition throughout the life of the project. To avoid the possibility of mulching materials entering waterways, loose mulch (i.e., mulch not crimped into the soil surface, tackified, or incorporated into erosion control blankets) would not be applied to drainage channel banks.

If construction is completed more than 30 days prior to the specified seeding season for perennial vegetation, areas adjacent to the larger drainage channels would be covered with jute matting for a minimum of 50 feet on either side of the drainage channel. In addition, to protect soil from raindrop impact and subsequent erosion, 2.0 tons/acre of weed-free straw mulch would be applied to all slopes greater than 10 percent. Temporary erosion control measures may include leaving the ROW in a roughened condition, respreading scalped vegetation, or applying mulch. As indicated by several operators and the BLM, weed-free straw mulch is difficult to obtain in quantities and at costs suitable for all reclamation applications. Although this circumstance could reduce the application of the measure, the effectiveness of mulch in protecting the exposed soil from raindrop impact, erosion, and off-site sedimentation would not be ignored. In addition to its effectiveness in erosion control, mulching also benefits the soil as a plant growth medium in many cases. Therefore, effective mulching is fundamental to reducing soil erosion to acceptable, non-significant levels.

Trench breakers would be used for pipeline construction in certain areas to prevent the flow of water in a trench that has been backfilled or temporarily left open. Trench breakers are particularly important in wetland areas to minimize subsurface drainage. Trench breakers would be constructed such that the bottom of one breaker is at the same elevation as the top of the next breaker down slope, or every 50 feet, whichever is greater. Factors that control the application of trench breakers include: the proximity to drainage channels and wetland areas, slope gradient, proximity of areas to shallow groundwater, and surface runoff source areas that can discharge water into the trench. Topsoil would not be used to construct trench breakers.

If a pipeline crosses roads at the base of slopes, vegetative strips would be maintained. If vegetation is disturbed within these limits, temporary sediment barriers, such as silt fences and/or staked weed-free straw bales, would be installed at the base of the slope adjacent to the road crossing. Temporary sediment barriers would remain in-place until permanent revegetation measures have been judged successful.

Final Reclamation

Upland Areas

Control of runoff and erosion along all ROW'S would be accomplished by constructing sediment trapping devices (e.g., silt fences and straw bales) and water bars, as well as by timely mulching and revegetation of exposed disturbed areas. Runoff discharged from water bars would be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures would be installed across all cut-and-fill slopes. All runoff and erosion control structures would be inspected after major runoff events and on a regular schedule. If found to be substandard or ineffective, these structures would be cleaned out and maintained in functional condition until successful revegetation and soil stability is attained.

Water bars would be constructed across sideslopes at appropriate intervals, according to slope gradient, immediately following recontouring of the disturbed areas. The spacing would depend on whether mulching is applied in conjunction with placement of water bars. Water bars would be maintained in functional condition throughout the life of the project. If the integrity of the water bar system is disrupted during seeding, water bars would be repaired and broadcast seeded with the seed raked into the soil. Water bars would be constructed according to hillslope topography at the slope gradient intervals as shown in Table D-1.

Water bars would be constructed 12 to 18 inches deep by digging a small trench and casting the soil material to the downhill side in a row. Each water bar would initiate in undisturbed vegetation upslope, traverse the disturbed area perpendicular to the ROW at a gradient between one and two percent, and discharge water into undisturbed vegetation on the lower side of the disturbed area.

Table D-1. Water Bar Intervals According to Slope Gradient.

With Mulching		Without Mulching	
Slope Gradient (percent)	**Interval (feet)**	**Slope Gradient (percent)**	**Interval (feet)**
10	150	10	100
15	100	15	75
20	50	20	45
30	40	30	40
40	35	40	35
50	30	50	30
>50	30	>50	30

Source: Based on Grah (1989).

Wetlands and Drainage Channel Crossings

Disturbance to the ephemeral and intermittent drainage channels would be avoided and/or minimized. All channel crossings not maintained for access roads would be restored to near predisturbance conditions. Drainage channel bank slope gradients would be regraded to conform with adjacent slope gradients. Channel crossings would be designed to minimize changes in channel geometry and subsequent changes in flow hydraulics. Culverts would be installed for ephemeral and intermittent drainage channel crossings. All drainage channel-crossing structures would be designed to carry the 25- to 50-year discharge event as directed by the BLM. Silt fences would be constructed at the base of slopes at all drainage channel crossings. Minor routing variations would be implemented during access road, pipeline, and drill site layout to avoid washes. The area of disturbance in the vicinity of washes would be minimized. A 500-foot-wide buffer strip of natural vegetation would be maintained between all construction activities and drainage channels.

Trench plugs would be employed at non-flumed drainage crossings to prevent diversion of drainage channel flows into upland portions of pipeline trenches during construction. Application of riprap would be limited to areas where flow conditions prevent vegetative stabilization; riprap activities must comply with COE permit requirements. Pipeline trenches would be dewatered in such a manner that no silt-laden water flows into active drainage channels (i.e., prior to discharge the water would be filtered through a silt fence, weed-free straw bales, or allowed to settle in a sediment detention pond).

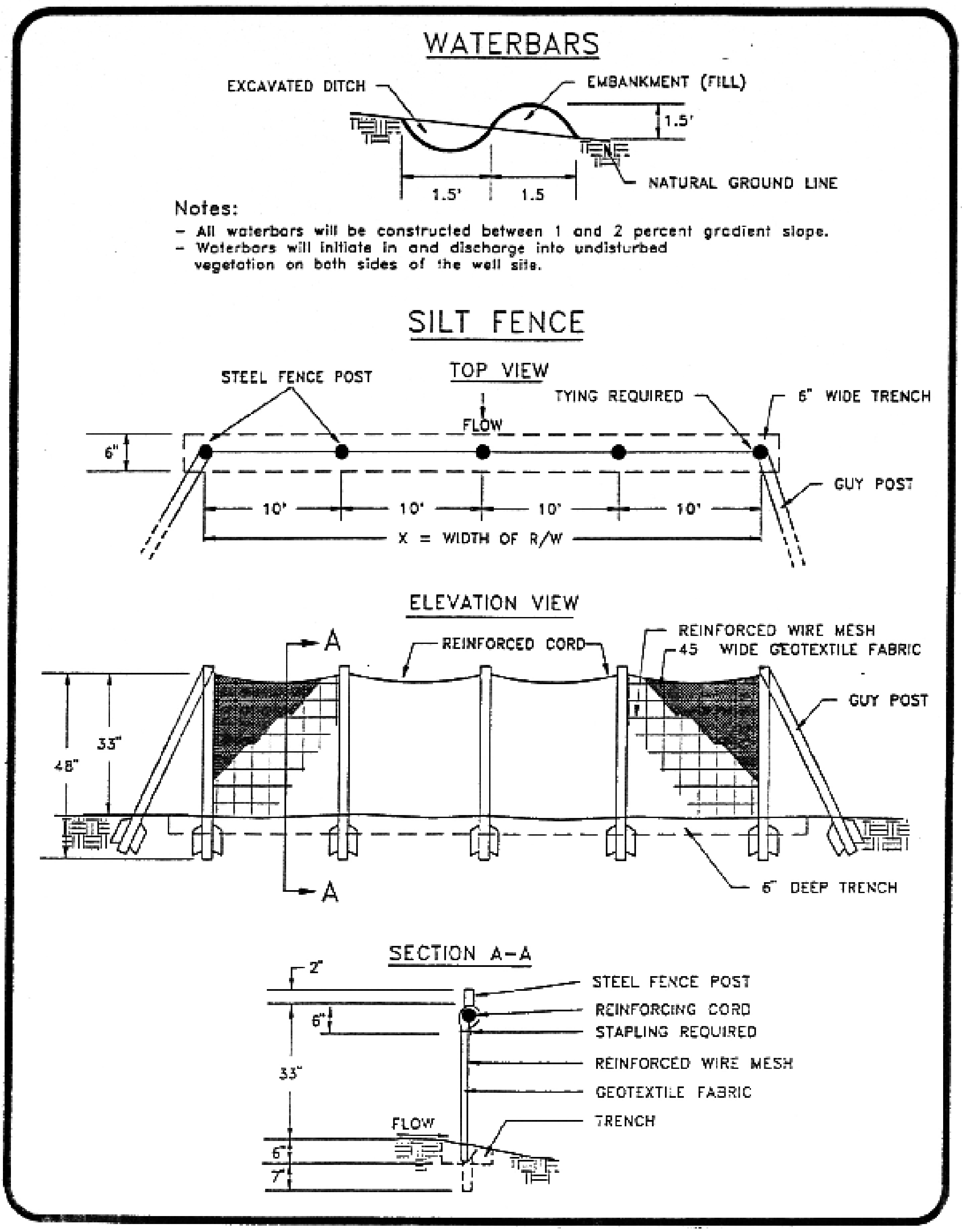

Figure D-1. Water Bar Construction and Silt Fence Construction.

4.4 Final Reclamation

4.4.1 Topsoil Re-spreading and Seedbed Preparation

In preparation for seeding, topsoil that was initially removed would be evenly spread over the pipeline ROW, staging areas, cut-and-fill surfaces, and all areas of other sites not required for production purposes.

Soil compaction could result from heavy equipment working on disturbed soils prior to revegetation. Therefore, compaction is likely to occur under most situations. Soil compaction can inhibit adequate revegetation of disturbance areas. Therefore, all disturbances to be revegetated will be ripped to reduce the adverse effect of compaction. All disturbed areas would be ripped on 18- to 26-inch spacing and 12 to 16 inches deep. A spring tooth harrow equipped with utility or seedbed teeth, or ripper-teeth equipment mounted behind a large crawler tractor or patrol would be used to loosen the subsoil. The subsoil surface would be left rough. After topsoil has been respread and if it is loose, it would be compacted with a cultipacker or similar implement to provide a firm seedbed. On steep slopes (greater than 40 percent and highly erosive), it may be difficult or impossible to replace topsoil and adequately prepare the seedbed. The disturbed areas on steep slopes would be ripped as described above. These areas would then be mulched with a hydromulch/seed/tackifier mix. Erosion control blankets with seed incorporated into the matting would be installed per manufacturer's specifications to enhance soil stabilization.

4.4.2 Seed Application

Upon completion of final grading, soil surfaces would either be seeded, or erosion control measures would be used until the site is seeded. Late fall is typically a good time of year to seed, however timing of seeding would be adjusted depending upon weather, soil moisture conditions, and the plant species being used. The seedbed would be prepared to a depth of three to four inches where possible to provide a firm seedbed. If hydroseeding or broadcast seeding is employed, the seedbed would be scarified to ensure good seed-soil contact. The seed mixtures presented in Tables D-2 through D-5, or a similar mix, would be applied according to the pure live seed (PLS) rates and drilling depths specified, to areas along the road and pipeline ROW, staging areas, and unused areas of drill sites that have been retopsoiled.

Seed would be used within 12 months of viability testing. Legume species purchased commercially must have been properly inoculated with nitrogen-fixing bacteria. Seed would be planted in the fall (after September 31) or no later than late fall (mid-November) prior to snow accumulation to avoid seed germination and breaking of dormancy and to prevent seedling frost damage; or in early spring (prior to May 15). Seed would preferably be planted with drill-type equipment such as a rangeland drill or brillion seeder. Where the microtopography of the disturbed areas does not allow drill-type equipment, seed would be broadcast applied at twice the application rate of drilled seed. A spike-toothed harrow or similar equipment would be used where ripping has been insufficient to provide cover for the broadcast seed.

Any soil disturbance that occurs outside the recommended permanent seeding season, or any bare soil left unstabilized by revegetation, would be treated as a winter-construction problem and mulching would be considered.

The seed mixtures presented in Tables D-2 through D-5, or similar mixtures, would be applied according to specific areas identified to be homogeneous in terms of overall ecosystem similarities such as precipitation zones, elevational zones, dominant species herbaceous cover, soil types, and inherent limitations in reclamation success potential. Specifically, Seed Mixture #1 (Table D-2) would be applied to disturbances in the sagebrush-dominated mixed desert shrub and juniper woodland community types. Seed Mixture #2 (Table D-3) would be applied to disturbances in the more moist alkaline mixed desert shrub community types. Seed Mixture #3 (Table D-4) would be applied to greasewood-dominated mixed desert shrub communities in alkaline valley bottoms and bluffs. Seed Mixture #4 (Table D-5) would be applied to disturbances in wet meadow community types. These seed mixes were developed based on the following criteria: 1) site-specific conditions of the analysis area; 2) usefulness of species in rapid site stabilization; 3) species' success in revegetation efforts; and 4) current seed costs and availability. Native plant species would be used, and final seed mixes applied in the revegetation effort would be designed in coordination with the agencies involved.

Final determination of the appropriate seed mixture would be developed on a site-specific basis at the time of field review of the facility. Seeding rates may be varied to enhance the probability for maintaining the natural balance of species. Watershed protection must be emphasized when reclaiming disturbed areas. The composition of rare and native species, if encountered, would be taken into consideration at the time of seeding. However, appropriate measures must be taken to ensure that an adequate protection of the soil surface is maintained. Areas not exhibiting successful revegetation throughout the area disturbed by the project would be re-seeded until an adequate cover of vegetation is established. Private and agricultural lands would be seeded with similar seed mixes unless the landowner requests different mixes.

4.4.3 Mulching

In sensitive sites where significant erosion (e.g., large areas of disturbance or areas with high erosion rates) is most likely to occur, the seeded access road/pipeline ROW, staging areas, and the portion of the drill pads not needed for production purposes would be mulched following seeding to protect the soil from wind and water erosion, raindrop impact, surface runoff, noxious weed invasion, and to hold the seed in place. The exposed surface of disturbed areas, including topsoil stockpiles, may be protected by placing crimped straw mulch, hydromulch, biodegradable plastic netting and matting, or biodegradable erosion control blankets.

Table D-2. Seed Mixture[1] #1 - Mixed Desert Shrub, Badlands, and Juniper Woodland Community Types.

Species	Cultivar or Variety	Seed Application Drilled Rate (pls[2] lbs/ac)	Planting Depth (if drilled) (inches)
Grasses			
Western wheatgrass (*Agropyron smithii*)	Rosanna	2.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	2.0	0.5
Bottlebrush squirreltail (*Sitanion hystrix*)	-	2.0	0.5
Indian ricegrass (*Oryzopsis hymenoides*)	Nezpar	2.0	0.5
Needle-and-Thread (*Stipa comata*)	-	2.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
Cicer milkvetch (*Astragalus cicer*)	Monarch	1.0	0.5
Shrubs			
Wyoming big sagebrush (*Artemisia tridentata*)	-	0.5	0.25
Antelope bitterbrush (*Purshia tridentata*)	-	1.0	0.5
Fourwing saltbush (*Atriplex canescens*)	-	1.0	0.5
TOTAL		**14.5**	

[1] Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.
[2] PLS = pure live seed.

Table D-3. Seed Mixture[1] #2 - Moist Alkaline Areas in the Mixed Desert Shrub Community Type.

Species	Cultivar or Variety	Seed Application Drilled Rate (pls[2] lbs/ac)	Planting Depth (if drilled) (inches)
Grasses			
Spike Muhly (*Muhlenbergia wrightii*)	El Vado	2.0	0.5
Alkaligrass (*Pucinellia distans*)	Fults	5.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	3.0	0.5
Forbs			
Strawberry clover (*Trifolium fragiferum*)	O'Connors, Salina	2.0	0.5
Shrubs			
Fourwing saltbush (*Atriplex canescens*)	-	1.0	0.5
Shadscale (*Atriplex confertifolia*)	-	1.0	0.5
TOTAL		**14.0**	

[1] Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.
[2] PLS = pure live seed.

Table D-4. Seed Mixture[1] #3 - Greasewood-Dominated Valley Bottoms and Bluffs.

Species	Cultivar or Variety	Seed Application Drilled Rate (pls[2] lbs/ac)	Planting Depth (if drilled) (inches)
Grasses			
Western wheatgrass (*Agropyron smithii*)	Rosanna	3.0	0.5
Pubescent wheatgrass (*Agropyron tricophorum*)	Luna	2.0	0.5
Alkali sacaton (*Sporobolus airoides*)	-	2.0	0.25
Russian wildrye (*Elymus junceus*)	Vinall	2.0	0.25
Forbs			
Cicer milkvetch (*Astragalus cicer*)	Monarch	3.0	0.5
Shrubs			
Fourwing saltbush (*Atriplex canescens*)	-	1.0	0.5
Gardner saltbush (*Atriplex gardneri*)	-	1.0	0.5
Winterfat (*Ceratoides lanata*)	-	1.0	0.5
TOTAL		**15.0**	

1 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.
2 PLS = pure live seed.

Table D-5. Seed Mixture[1] #4 - Wet Meadow Community Types.

Species	Cultivar or Variety	Seed Application Drilled Rate (pls[2] lbs/ac)	Planting Depth (if drilled) (inches)
Grasses			
Spike muhly (*Muhlenbergia wrightii*)	El Vado	2.0	0.5
Redtop (*Agrostis stolonifera*)	-	1.0	0.5
Tufted hairgrass (*Deschampsia cespitosa*)	-	4.0	0.25
Forbs			
Red clover (*Trifolium pratense*)	Kenland	2.0	0.5
Strawberry clover (*Trifolium fragiferum*)	O'Connors, Salina	2.0	0.5
TOTAL		**13.0**	

[1] Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.
[2] PLS = pure live seed.

All sensitive disturbed areas would be mulched immediately following seeding with 1.5 to 2.0 tons/acre of weed-free straw mulch. Mulching materials would be free of noxious and undesirable plant species, as defined by state or county lists. Hay mulch may be used, but it would be applied only if cost-competitive and if crimped into the soil. Straw mulch is more desirable than hay mulch because it is generally less palatable to wild horses, wildlife, and livestock. Additionally, there tends to be a higher risk of introducing undesirable species and noxious weeds with a hay mulch such as smooth brome, timothy, orchardgrass, and other minor species. The lessee would maintain all disturbances relatively weed-free for the life of the project through implementation of a noxious weed monitoring and eradication program.

Wherever utilized, mulch would be spread uniformly so that at least 75 percent of the soil surface is covered. If a mulch blower is used, the straw strands would not be shredded less than eight inches in length to allow effective anchoring. On slopes less than 30 percent, straw mulch would be applied by a mechanical mulch blower at a rate of 2.0 tons/acre after seeding. The mulch would be crimped into the soil surface using a serrated disc crimper. Where broadcast straw mulch is applied on windswept slopes, a biodegradable plastic netting would be staked firmly to the soil surface over the mulch following the manufacturer's specifications. On slopes in excess of 40 percent or on slopes exceeding the operating capabilities of machinery, hydromulch or biodegradable erosion control blankets with seed incorporated into the netting would be applied and staked firmly to the soil surface.

Where utilized, hydromulch and tackifier would be applied at a rate of 1,500 lbs/acre. In general, erosion control and soil stabilization are directly related to the amount of mulch applied. Under certain conditions where degradation processes are slow (e.g., in extremely hot or cold dry climates), a trade-off between the degree of effectiveness of mulch and long-term degradation would be considered. In extremely dry areas where mulch degradation may be slow, mulching rates would be reduced to 1.0 to 1.5 tons/acre. Special measures may need to be implemented in areas with sandy soils.

On steeper slopes with highly erodible, shallow, rocky soils, and/or on windswept areas with loose, unconsolidated materials, the above recommended measures may not be sufficient to reduce erosion to non-significant levels. Incorporating a custom blend of seed into erosion control blankets would be used for stabilizing these areas. This method has proven cost-effective in many cases, with 98 percent of the cost being the blanket itself. The additional cost of incorporating seed into the blanket will average $1.00 to $1.50 per blanket, depending upon current seed costs. In most cases, this additional cost would offset the repeated efforts of broadcast seeding, manual raking of seeds into the soil, and mobilizing a labor force. The final measure(s) to be implemented in such areas would be determined by agreement between the agencies involved and the Operators.

4.4.4 Livestock Control

Livestock grazing would be monitored on and along all drill sites, access roads, and pipeline ROWs. If grazing negatively impacts revegetation success, measures would be taken to immediately remove livestock from the newly reclaimed areas. Depending upon site-specific evaluations, it may be necessary to temporarily fence off certain riparian areas and wetlands to prevent excessive livestock grazing and trampling to enhance drainage channel bank stabilization and overall revegetation success. Existing livestock control structures, such as fences and cattle guards, would be maintained in functional condition during all phases of the project. Where access requires the disruption of an existing fence, a cattle guard would be installed at the junction.

4.4.5 Off-Road Vehicle Control

Off-road vehicle control measures would be installed and maintained following the completion of seeding. Examples of practicable measures include a locking, heavy steel gate with fencing extending a reasonable distance to prevent bypassing the gate, with appropriate signs posted; a slash and timber barrier; a pipe barrier; a line of boulders; or signs posted at all points of access at intervals not to exceed 2,000 feet indicating "This Area Seeded for Wildlife Benefits and Erosion Control."

4.4.6 Fugitive Dust Control

If fugitive dust is generated during construction of the drill sites, access road/pipeline ROWs, or staging areas become a problem, dust abatement measures would be implemented. Such procedures could include applying water or water with additives (e.g., magnesium chloride) to the construction area at regular intervals.

4.5 Monitoring and Maintenance

4.5.1 General

A designated official or responsible party would annually inspect and review the condition of all drill sites, access road/pipeline ROWs, and any other disturbed areas associated with the project. This official would assess the success of and prognosis for all runoff and erosion control and revegetation efforts, evaluate fugitive dust control needs, and recommend remediation measures, if necessary. In addition, monitoring would take place following each major runoff event. Photographs would be taken at drill sites and along access roads at specific areas each year to document the progress of the reclamation program at established photomonitoring points.

The following specific items would be monitored during inspections:

- Revegetation success
- Sheet and rill erosion, gullies, slumping, and subsidence
- Soundness and effectiveness of erosion control measures
- Sediment filtering devices along all active ephemeral and intermittent drainage channels
- Water quality and quantity
- Noxious weed invasion
- Degree of rodent damage on seed and seedlings
- Locations of unauthorized off-highway vehicle (OHV) access
- Soundness and effectiveness of OHV control structures
- Evidence of livestock or wildlife grazing
- Overgrazing/trampling of riparian and wetland areas

4.5.2 Reclamation Success Monitoring

Reclamation success would be based upon the objectives specified in this plan. Therefore, monitoring would be tied to these objectives. The actual monitoring procedures for quantitative and qualitative evaluations of reclamation success would be implemented as specified by the authorizing agencies.

Reclamation success would be monitored in the short-term (temporary reclamation) and in the long-term (final reclamation). Monitoring of temporary reclamation measures would include visual observations of soil stability, condition, and effectiveness of mulching and runoff and erosion control measures, and a quantitative and qualitative evaluation of revegetation success, where appropriate. Long-term reclamation monitoring would include visual observations of soil stability, condition of the effectiveness of mulching and runoff and erosion control measures, and a quantitative and qualitative evaluation of revegetation success.

Revegetation success would be determined through monitoring and evaluation of percent ground cover to include a measure of vegetation cover (by species), litter/mulch, rock/gravel, and bare ground. Ground cover would be documented at each 1-foot interval along a 100-foot line intercept transect. Seedling density and relative abundance would be determined by selection of plots at the 20-, 40-, 60-, and 80-foot marks on the transect. Grazing impacts would be assessed as an ocular estimate of the percent utilization along the transect.

Soil stability would be measured using an erosion condition class/soil surface factor rating method to numerically rate soil movement, surface litter, surface rock, pedestalling, flow patterns, and rill-gully formation. Information obtained through this rating system represents an expression of current erosion activity and can be used to reflect revegetation success as a function of soil stability.

The access road boundaries, pipelines, and unused portions of the drill sites would be monitored until attainment of 80 percent of predisturbance vegetative cover within five years of seeding. This standard would include 90 percent of the vegetative cover being comprised of desirable species and the erosion condition of the reclaimed area being equal to or in better condition than predisturbance conditions as described in Section 3.1.

4.5.3 Wetland and Drainage Channel Crossings

Wetland areas and natural drainage channel crossings would be monitored for a minimum of three years for noxious weed invasion and establishment of undesirable species. Noxious weeds and undesirable species would not be allowed to establish at any time. Noxious weeds would be removed if they were found in a reclaimed wetland or drainage channel crossing. At the third year of monitoring, presence of undesirable species would be negligible. The lessee would maintain wetland areas and drainage channel crossings according to this standard throughout the development of a noxious weed and undesirable species monitoring and eradication program.

4.5.3 Photomonitoring

Permanent photomonitoring points would be established at appropriate vantage locations that provide adequate visual access to drill sites, along pipeline and access road ROWs, and to ancillary facilities. Each photomonitoring point would be permanently marked with re-bar and identified on a topographic map of the area. The location of each point would be described in detail to assist in relocation from year to year. Photos would be taken at each photomonitoring point prior to initiation of construction. Photos, framing the same scene as previously taken, would be taken each year until reclamation standards have been met.

APPENDIX E
HAZARDOUS MATERIALS MANAGEMENT PLAN

HAZARDOUS MATERIALS MANAGEMENT PLAN

1.0 INTRODUCTION

The Wind River Project Area (WRPA) producing operators, including mainly Tom Brown, Inc., but also include Samson Resources Co. and Saba Energy of Texas (hereafter referred to as "the Operators"), propose to explore and develop oil and natural gas reserves in the Wind River Project Area of Fremont County, Wyoming. The Bureau of Indian Affairs (BIA) has prepared an Environmental Impact Statement (EIS) for the proposed project, and this Hazardous Material Management Summary (HMMS), which is included as an appendix to the EIS, provides further specific information regarding the types and quantities of hazardous and extremely hazardous materials that are expected to be produced or used for the proposed project. Detailed descriptions of the Proposed Action and alternatives, the potential environmental consequences, and proposed mitigation and monitoring measures are provided in the EIS.

This HMMS is provided pursuant to BLM Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all National Environmental Policy Act (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. Hazardous materials, as defined herein, are those substances listed in the Environmental Protection Agency's (EPA's) *Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986*, and extremely hazardous materials are those identified in the EPA's *List of Extremely Hazardous Substances* (40 Code of Federal Regulations [CFR] 355). Materials identified on either of these lists that are expected to be used or produced by the proposed project are discussed herein.

A list of hazardous and extremely hazardous materials that are expected to be produced, used, stored, transported, or disposed of as a result of the Wind River Gas Field Development Project was obtained from WRPA operators, along with Material Safety Data Sheets (MSDS) for all chemicals, compounds, and/or substances which may be used during the construction, drilling, completion, and production operations of the proposed project. The Operators have reviewed the aforementioned EPA lists, as amended, and all materials included on either of these two lists that would be used or produced by the proposed project were identified.

Some potentially hazardous materials that may be used in small, unquantifiable amounts have been excluded from this HMMS. These materials may include: wastes, as defined by the Solid Waste Disposal Act; wood products' manufactured items and articles which do not release or otherwise result in exposure to a hazardous material under normal conditions of use (i.e., steel structures, automobiles, tires, etc.); food, drugs, tobacco products, and other miscellaneous substances (i.e., WD-40, gasket sealants, glues, etc.). No unauthorized use or disposal of these materials by project personnel would occur during project implementation, and all project personnel would be directed to properly dispose of these materials in an appropriate manner. Solid wastes generated at well locations would be collected in approved waste facilities (e.g., dumpsters), and each well location would be provided with one or more such facilities during drilling and completion operations. Solid wastes would be regularly removed from well locations and transported off the WRPA to approved disposal facilities.

2.0 HAZARDOUS MATERIALS

A listing of all relevant known hazardous and extremely hazardous materials that are expected to be used, produced, stored, transported, or disposed of during project implementation is provided herein. Where possible, the quantities of these materials have been estimated on a per-well basis and their use, storage, transport, and disposal methods described.

2.1 PRODUCTION PRODUCTS

The purpose of the proposed project is to extract natural gas from the Fort Union, Lance, Meeteetse, Mesaverde and Wind River Formations and other formations underlying the WRPA. Water would also be produced as a by-product of gas and oil extraction operations. Table E-1 lists and quantifies, where possible, the hazardous and extremely hazardous materials that may be found in these production products.

2.1.1 Natural Gas

Natural gas, primarily containing methane, ethane, and carbon dioxide, would be produced from ***approximately 250*** wells at rates averaging ***0.4 million*** cubic feet per day (mmcfd) per well. No extremely hazardous materials are anticipated to be produced with the gas stream; however, the hazardous material hexane (CAS Number 110-54-3) would be present in the gas stream at volumes ranging from approximately ***4 to 24 thousand*** cubic feet per day (mcfd) per well (Table E-1). In addition, the gas would also likely contain small amounts of potentially hazardous polycyclic organic matter and polynuclear aromatic hydrocarbons. No other hazardous materials are known to occur within the natural gas stream.

The majority of gas produced from WRPA wells would be transported from each location through newly constructed pipelines linking well locations to existing or newly constructed gas processing facilities. The natural gas would eventually be delivered to consumers for combustion. Small quantities of natural gas may be vented or flared at certain well locations during well testing operations. During testing, produced gas would be vented or flared into a flare pit pursuant to BLM/BIA/Wyoming Oil and Gas Conservation Commission (WOGCC) rules and regulations (Notice to Lessees [NTL]-4A). BLM or WOGCC approval would be obtained prior to flaring or venting operations. No natural gas storage is anticipated under the proposed project.

Industry standard pipeline equipment, materials, techniques, and procedures in conformance with all applicable regulatory requirements would be employed during construction, testing, operation, and maintenance of the project to ensure pipeline safety and efficiency. All necessary authorizing actions for natural gas pipelines would be addressed prior to installation. These actions include:

- Fremont County special use permits,
- BIA rights-of-way (ROWs) applications,
- BOR (Bureau of Reclamation) special use permits,
- Conformance with U.S. Department of Transportation (DOT) pipeline regulations (49 CFR 191-192), and

- Wyoming Public Service Commission Certificates to act as common carrier for natural gas.

Table E-1. Hazardous and Extremely Hazardous Materials Potentially Produced by the WRPA Natural Gas Project, Fremont County, Wyoming, 2003.

Production Product	Hazardous Constituents[1]	Extremely Hazardous Constituents[2]	Approximate Qauntity Produced per Well[3]
Natural Gas	--	None	0.4 mmcfd
	Hexane		4-24 mcfd
	PAHs[4]		
	POM[5]		
Condensates	--	None	252 gpd
	PAHs		
	POM		
Produced Water	--	None	168 gpd
	Lead		
	Cadmium		
	Chromium		
	Radium 226		
	Uranium		

1 The hazardous constituents listed are, to the best of our present knowledge, those that are or may be present in the production products and are listed under the EPA's *Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986*, as amended.
2 Extremely hazardous materials are those defined in 40 CFR 355.
3 mmcfd = million cubic feet per day.
mcfd = thousand cubic feet per day.
gpd = gallons per day.
4 PAHs = polynuclear aromatic hydrocarbons.
5 POM = polycyclic organic matter.

2.1.2 Condensate

Condensate would be produced with the gas stream at most of the proposed wells. Condensates primarily consist of long chain hydrocarbon liquids (e.g., octanes), but may also contain variable quantities of the following hazardous materials: polycyclic organic matter and polynuclear aromatic hydrocarbons. No other hazardous or extremely hazardous materials are known to be present in the condensates. The volume of condensate produced from Wind River Area wells is anticipated to be approximately ***252*** gallons per day (gpd) from most wells (Table E-1).

Condensate would be stored in tanks at well locations and centralized facilities, and all tanks would be bermed to contain the entire storage capacity of the largest tank plus 10% as mandated by the EPA. Condensate would be periodically removed from storage tanks and transported by truck, in adherence to DOT rules and regulations, off the WRPA. All necessary authorizing actions for the production, storage, and transport of condensates, including the Oil Pollution Act of 1990 (storage of >1,000,000 gal) as necessary, would be addressed prior to the initiation of condensate production activities.

2.1.3 Produced Water

Produced water from The WRPA wells is anticipated to range in volume from ***0 to 630*** gpd, and would average approximately ***168*** gpd for most wells (Table E-1). Produced water quality from wells within the WRPA is variable and would be monitored periodically. Based on water quality analyses of produced water samples from several WRPA wells, no hazardous or extremely hazardous materials are known to occur.

Produced water would be stored in tanks at well locations and centralized facilities and would periodically be removed and transported by truck to the existing EPA permitted Class II Tribal disposal well. Where applicable, National Pollutant Discharge Elimination System (NPDES) permits would be obtained from the EPA, and produced water that meets applicable standards would be discharged to the surface at appropriate locations. All necessary authorizing actions would be met prior to the disposal of produced water including:

- BLM/BIA approval of disposal methodologies,
- RCRA compliance as necessary,
- EPA Water Quality Division approval of wastewater disposal,

2.2 CONSTRUCTION, DRILLING, PRODUCTION, AND RECLAMATION

Known hazardous and extremely hazardous materials planned for use during typical construction, drilling, production, and reclamation operations for the proposed project are listed in Table E-2 and are described in detail below. Hazardous and extremely hazardous materials planned for use during project implementation fall into the following categories:

- Fuels,
- Lubricants,
- Coolant/antifreeze and heat transfer agents,
- Drilling fluids,
- Fracturing fluids,
- Cement and additives, and
- Miscellaneous materials.

2.2.1 Fuels

Gasoline (CAS 8006-61-9), diesel fuel (CAS 68476-30-2), and natural gas are the fuels proposed for use on the project, and all contain materials classified as hazardous. Gasoline would be used to power vehicles providing transportation to and from Riverton; diesel fuel would be used to power transport vehicles, drilling rigs, and construction equipment, and as a component of fracturing fluids (see Section 2.2.5); and natural gas would be used to power pipeline compressor stations.

Table E-2. Hazardous and Extremely Hazardous Materials Potentially Utilized During Construction, Drilling, Production, and Reclamation Operations by the Wind River Project Area, Fremont County, Wyoming.

Source	Hazardous Constituents[1]	Extremely Hazardous Constituents[2]	Approximate Quantity Used Per Well[3]
Fuel			
Gasoline	-- Benzene Toluene Ethyl benzene p-xylene m-xylene PAHs[4] POM[5] Tetraethyl lead	-- Tetraethyl lead	24,940 gal
Diesel Fuel	-- Benzene Toluene Ethylbenzene p-xylene m-xylene o-xylene Naphthalene PAHs POM	None	27,400 gal
Natural Gas	-- Hexane PAHs POM	None	
Lubricants	-- PAHs POM Lead Cadmium Manganese Barium Zinc Lithium	None	8 gal

Coolant/Antifreeze and Heat Transfer Agents	--	None	
	Ehylene glycol		180 gal
	Triethylene glycol		330 gal
Drilling Fluid Additives			
Caustic Soda	-- Sodium hydroxide	None	650 lbs
Lime	-- Fine mineral fibers	None	3,500 lbs
Mica	-- Fine mineral fibers	None	600 lbs
Uni-Drill	-- Acrylamide	None	50 gal
Uni-Gel	-- Fine mineral fibers	None	43,500 lbs
UNIBAR	-- Barium compounds	None	8,200 lbs
Fracturing Fluid Additives			
LGC-VI w/diesel fuel	-- Benzene Toluene Ethylbenzene p-xylene m-xylene o-xylene Naphthalene PAHs POM	None	953 gal
OPTI-FLO III	-- Glycol ether	None	144 lbs
SSO-21	-- Methanol Glycol Ether	None	15 gal
CL-29	-- Formic acid Ammonium chloride Zirconium nitrate	None	59 gal

	Zirconium sulfate		
BA-20	-- Acetic acid	None	38 gal
Sand	-- Fine mineral fibers	None	2,994 lbs
Cement and Additives	-- Fine mineral fibers PAHs POM	None	>10,000 lbs
Miscellaneous Materials	-- Methanol Corrosion inhibitors	None	3,000 gal

1 The hazardous constituents listed are, to the best of our present knowledge, those that are or may be present in the production products and are listed under the EPA's *Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986*, as amended.
2 Extremely hazardous materials are those defined in 40 CFR 355.
3 lb = pounds
gal = gallons.
4 PAHs = polynuclear aromatic hydrocarbons.
5 POM = polycyclic organic matter.

2.2.1.1 Gasoline

Gasoline would be used to power vehicles traveling to and from the WRPA. The hazardous and extremely hazardous materials likely to be found in gasoline are listed in Table E-2. The hazardous materials present in gasoline include: benzene (CAS 71-43-2), toluene (CAS 108-88-3), ethylbenzene (CAS 100-41-4), p-xylene (CAS 106-42-3), m-xylene (CAS 108-38-3), o-xylene (CAS 95-47-6), (CAS 1634-04-4), polynuclear aromatic hydrocarbons, and polycyclic organic matter. Leaded gasoline contains tetraethyllead (CAS 78-00-2), which is listed as an extremely hazardous material (Table E-2).

2.2.1.2 Diesel Fuel

Diesel fuel would be used to power transport vehicles, drilling rigs, and construction equipment. The hazardous and extremely hazardous materials likely to be found in diesel fuel are listed in Table E-2. The hazardous materials present in diesel fuel include: benzene (CAS 71-43-2), toluene (CAS 108-88-3), ethylbenzene (CAS 100-41-4), p-xylene (CAS 106-42-3), m-xylene (CAS 108-38-3), o-xylene (CAS 95-47-6), (CAS 1634-04-4), naphthalene (CAS 91-20-3), polynuclear aromatic hydrocarbons, and polycyclic organic matter.

2.2.1.3 Natural Gas

An unknown volume of natural gas would be burned to provide power for the natural gas compressor stations required for efficient pipeline function. The natural gas used to power compressor stations would be produced by the proposed project, and hazardous materials contained in this natural gas are identified in Table E-2. Further detail on the transportation of natural gas as a result of the proposed project, and relevant authorizing actions for natural gas transportation, is provided in Section 2.1.1.

2.2.2 Lubricants

Various lubricants, including: motor oils, hydraulic oils, transmission oils, compressor lube oils (8 gal/well), and greases, would be utilized for project-required vehicles, rigs, compressors, and other machinery. Some of these lubricants would likely contain polynuclear aromatic hydrocarbons and polycyclic organic matter, and some may additionally contain compounds of lead, cadmium, nickel, copper, manganese, barium, zinc, and/or lithium. No extremely hazardous materials are known to be present in the lubricants required for the proposed project.

The quantity of each lubricant used, stored, transported, and disposed of is unknown; however, all lubricants would be used, stored, transported, and disposed of following manufacturer's guidelines. Disposal of rags contaminated with lubricants would be in accordance with local, State, and federal requirements. No unauthorized disposal of lubricants (e.g., disposal of used motor oil) would occur in the WRPA.

2.2.3 Coolant/Antifreeze and Heat Transfer Agents

Ethylene glycol (CAS 107-21-1) and triethylene glycol (CAS 112-27-6) would be utilized as coolant/antifreeze and heat transfer agents in association with this project (Table E-2). Ethylene glycol would be used as an engine coolant/antifreeze in automobiles, construction equipment, gas dehydrators, and drilling and workover rigs. An unspecified volume of this hazardous material would be stored and transported in engine radiators. In addition, both ethylene glycol and triethylene glycol would be used as heat transfer fluids during well completion and maintenance operations. The estimated quantity of ethylene glycol required per well for completion and maintenance operations is approximately 180 gallons for the life of the project. The quantity of triethylene glycol required would range from approximately 290 to 370 gallons/well. While the total volume of ethylene glycol to be used, stored, transported, and disposed of for the proposed project is unknown, any disposal of ethylene glycol and/or triethylene glycol would be conducted in accordance with all relevant federal and state rules and regulations.

2.2.4 Drilling Fluids

Water-based muds (drilling fluids) would be used for drilling each well. Drilling fluids consist of clays and other additives that are used in standard industry procedures. Drilling fluid additives to be utilized for the proposed project include: caustic soda (650 lbs/well), cedar fibers (200 lbs/well), lime (3,500 lbs/well), mica (600 lbs/well), Uni-Drill (50 gal/well), Uni-Gel (43,500 lbs/well), UNIBAR (8,200 lbs/well), and paper (400 lbs/well) (Table E-2). All drilling operations would be conducted in compliance with applicable BLM/BIA, WOGCC, and WDEQ rules and regulations.

All known hazardous materials present in the proposed drilling fluids and additives are listed in

Table E-2. These materials are: sodium hydroxide (CAS 1310-73-2), present in caustic soda; acrylamide (CAS 79-06-1), present in Uni-Drill (partially hydrolyzed polyacrylamide); barium compounds, present in UNIBAR (barium sulfate); and fine mineral fibers, present in lime, mica, and Uni-Gel (sodium montmorillonite or barite). No hazardous materials are known to occur in sawdust or paper, and no extremely hazardous materials are known to be present in any of the drilling fluids and additives.

Drilling fluid additives would be transported to well locations during drilling operations in appropriate sacks and containers in compliance with DOT regulations. Drilling fluids, cuttings, and water would be stored in reserve pits, and pits would be fenced to protect wildlife from exposure. Netting (1 inch mesh), to protect waterfowl, other birds and bats, and pit liners, to protect shallow groundwater aquifers, would be used on all reserve pits as deemed appropriate by the BLM.

When the reserve pit is no longer required, its contents would be evaporated or solidified in place, and the pit backfilled, as approved by the BLM. All reserve pit solidification procedures using flyash or other BLM/BIA approved materials would be approved by the BLM or WOGCC and/or WDEQ prior to implementation. If the pH of pit residue is very high following solidification, off-site disposal may be required. In this event, or if other unanticipated contamination circumstances arise, reserve pit contents would be removed and disposed of at an appropriate facility in a manner commensurate with all relevant state and federal regulations.

2.2.5 Fracturing Fluids

Hydraulic fracturing is expected to be performed at some Wind River wells to augment gas flow rates. Approximately 78,700 gallons of fracturing fluids, consisting primarily of fresh water, would be required per well for the proposed project. Fracturing fluid additives and their approximate volumes include: LGV-VI with diesel fuel (953 gal/well), GEL-STA (150 lbs/well), OPTI-FLO III (144 lbs/well), CLAYFIX II (157 lbs/well), SSO-21 (15 gal/well), CL-29 (59 gal/well), BA-20 (38 gal/well), SP BREAKER (27 lbs/well), GBW-30 (9 lbs/well), BE-5 microbiocide (36 lbs/well), and sand (299,400 lbs/well) (Table E-2).

The hazardous materials present in fracturing fluid components are listed in Table E-2 and include: benzene, toluene, ethylbenzene, p-xylene, m-xylene, o-xylene, naphthalene, polynuclear aromatic hydrocarbons, and polycyclic organic matter contained in LGC-VI with diesel fuel (hydrocarbon gel concentrate); glycol ether present in OPTI-FLO III and SSO-21; methanol (CAS 67-56-1) present in SSO-21; formic acid (CAS 64-18-6), ammonium chloride (CAS 12125-02-9), zirconium nitrate (CAS 13746-89-9), and zirconium sulfate (CAS 14644-61-2) present in CL-29; acetic acid (CAS 64-19-7) present in BA-20; and fine mineral fibers present in sand. No hazardous materials are known to be present in GEL-STA (sodium salt), CLAYFIX II (alkylated quaternary chloride), SP BREAKER (sodium persulfate), GBW-30 (cellulase enzyme carbohydrate), and BE-5 (5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, a microbiocide). No extremely hazardous materials are known to be present in any of the fracturing fluid additives.

Fracturing fluids and additives would be transported to well locations in bulk (e.g., LGC-VI with diesel fuel, sand) or in appropriately designed and labeled containers (e.g., OPTI-FLO III in 50 lb fiber drums; SSO-21, CL-29, and BA-20 in 55 gal drums). All transportation of fracturing fluids and additives would be in adherence with DOT rules and regulations.

During fracturing, fluids are pumped under pressure down the well bore and out through perforations in the casing into the formation. The pressurized fluid enters the formation and induces hydraulic fractures. When the pressure is released at the surface, a portion of the fracturing fluids would be forced to the well bore and up into a tank. The fracturing fluids would then be transferred to lined reserve pits and evaporated, or hauled away from the location and reused or disposed of at an authorized facility. Decisions regarding the appropriate disposal of fracturing fluids would be made by the BLM on a case-by-case basis.

2.2.6 Cement and Additives

Well completion and abandonment operations would entail cementing and plugging various segments of the well bore to protect freshwater aquifers and other down-hole resources. Materials potentially used for cementing operations include: cement, calcium hydroxide, calcium chloride, pozzlans, sodium bicarbonate, potassium chloride, and insulating oil. An unknown quantity of cement and additives, which may contain the hazardous material classes of fine mineral fibers, polycyclic organic matter, and polynuclear aromatic hydrocarbons, would be transported in bulk to each well site by a qualified cement supply company. Small quantities may be transported and stored on-site in 50-pound sacks. Wells would be cased and cemented as directed and approved by the BLM (for federal minerals) and WOGCC (for state and patented minerals). No extremely hazardous materials are known to be present in the cement and additives proposed for use in this project.

2.2.7 Miscellaneous Materials

Miscellaneous materials, potentially containing hazardous and/or extremely hazardous materials, that may be used for the proposed project include: methanol and corrosion inhibitors. The material would be transported to the site by qualified service and supply companies and would be used and disposed of following manufacturer's guidelines.

An unknown quantity of methanol would be used to de-ice well bores and as a hydrate deterrent during completion and natural gas transport operations. Methanol is a listed hazardous chemical and would be stored, transported, used, and disposed of in adherence with all applicable federal and state rules, regulations, and guidelines.

2.3 COMBUSTION EMISSIONS

Combustion emissions from gasoline and diesel engines, as well as flaring natural gas, will occur as a result of this project. The complete oxidation of hydrocarbon fuels yields only carbon dioxide and water as combustion products; however, complete combustion is seldom achieved. Unburned hydrocarbons, particulate matter (e.g., carbon, metallic ash), carbon monoxide, nitrogen oxides, and possibly sulfur oxides would be expected as direct exhaust contaminants. Secondary contaminants would likely include the formation of ozone from the photolysis of nitrogen oxides. A listing of the hazardous and extremely hazardous materials potentially present in combustion emissions is provided in Table E-3.

Unburned hydrocarbons may contain potentially hazardous polynuclear aromatic hydrocarbons, and particulate matter may contain metal-based particulates from lead anti-knock compounds in the fuel, metallic lubricating oil additives, and engine wear particulates (Table E-3). Hazardous materials in the particulate matter may therefore include compounds of lead, cadmium, nickel, copper, manganese, barium, zinc, and /or lithium.

Nitrogen dioxide (CAS 10102-44-0), sulfur dioxide (CAS 7446-09-5), sulfur trioxide (CAS 7446-11-9), and ozone (CAS 10028-15-6) are probable combustion emissions, all classified as extremely hazardous materials. These materials would be either directly released in minor quantities from internal combustion engines, or would be formed through photolysis (i.e. ozone). No releases of these or other materials would occur in excess of those allowed for Prevention of Significant Deterioration Class II areas, WDEQ-Air Quality Division Implementation Plan; nor would releases occur that jeopardize National Ambient Air Quality Standards for Wind River. Particulate matter emissions and larger unburned hydrocarbons would eventually settle out on the ground surface, whereas gaseous emissions would react with other air constituents as components of the nitrogen, sulfur, and carbon cycles.

Table E-3. Hazardous and Extremely Hazardous Materials Potentially Present in Combustion Emissions of the Wind River Project Area, Fremont County, Wyoming, 2003.

Emission	Hazardous Constituents[1]	Extremely Hazardous Constituents[2]
Hydrocarbons	-- PAHs[3]	None
Particulate Matter	-- Lead Cadmium Nickel Copper Manganese Barium Zinc Lithium	None
Gases	-- Nitrogen dioxide Sulfur dioxide Sulfur trioxide Ozone	-- Nitrogen dioxide Sulfur dioxide Sulfur trioxide Ozone

1 The hazardous constituents listed are, to the best of our present knowledge, those that are or may be present in the production products and are listed under the EPA's *Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986*, as amended.
2 Extremely hazardous materials are those defined in 40 CFR 355.
3 PAHs = plynuclear aromatic hydrocarbons.

3.0 MANAGEMENT POLICY AND PROCEDURE

WRPA Operators and their contractors would ensure that all production, use, storage, transport, and disposal of hazardous and extremely hazardous materials as a result of the proposed project would be in strict accordance with all applicable existing, or hereafter promulgated federal, state, and local government rules, regulations, and guidelines. All project-related activities involving the production, use, and/or disposal of hazardous or extremely hazardous materials would be conducted in such a manner as to minimize potential environmental impacts.

WRPA Operators would comply with emergency reporting requirements for releases of hazardous materials. Any release of hazardous or extremely hazardous substances in excess of the reportable quantity, as established in 40 CFR 117, would be reported as required by the *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980,* as amended. The materials for which such notification must be given are the extremely hazardous substances listed under the *Emergency Planning and Community Right to Know* Section 302 and the hazardous substances designated under Section 102 of CERCLA, as amended. If a reportable quantity of a hazardous or extremely hazardous substance is released, prompt notice of the release would be given to the BLM's Authorized Officer and all other appropriate federal and state agencies. Additionally, notice of any spill or leakage (i.e. undesirable event), as defined in BLM NTL-3A, would be given by DFPA Operators to the Authorized Officer and other such federal and state officials as required by law.

WRPA Operators have evaluated field operations in the WRPA and have or would prepare and implement multiple plans and/or policies to ensure environmental protection from hazardous and extremely hazardous materials. These plans/policies would be available for review at the Tom Brown Inc., Riverton, Wyoming field office. These plans/policies include, where applicable:

- Spill prevention and control countermeasure plans;
- Oil/condensate spill response plans;
- Inventories of hazardous chemical categories pursuant to Section 312 of the SARA, as amended; and
- Emergency response plans.

Development operations in the Wind River Area would be in compliance with regulations promulgated under the Resource Conservation and Recovery Act (RCRA), Federal Water Pollution Control Act (Clean Water Act), Safe Drinking Water Act (SWDA), Toxic Substances Control Act (TSCA), Occupational Safety and Health Act (OSHA), and the Federal Clean Air Act (CAA). In addition, project operations would also comply with all attendant state rules and regulations relating to hazardous material reporting, transportation, management, and disposal. Table E-4 provides a generic list of hazardous chemical categories for the oil and gas exploration and production industry.

Table E-4. Generic List of Hazardous Chemical Categories for the Oil and Gas Exploration and Production Industry.

Hazardous Chemical Category (With Examples of Representative Chemicals)	Physical and Health Hazards
Acetylene Gas (CAS#74-86-2)	Fire, sudden release of pressure
Acids Hydrochloric acid (<30%)(CAS#7647-01-0) Hydrofluoric acid (<12%)(CAS#7664-39-3) Sulfuric acid (CAS#7664-93-9)	Immediate (Acute)
Alkalinity and pH Control Materials Calcium hydroxide (CAS#1305-62-0) Potassium hydroxide (CAS#1310-58-3) Soda ash (CAS#497-19-8) Sodium bicarbonate (CAS#144-55-8) Sodium carbonate (CAS#497-19-8) Sodium hydroxide (CAS#1310-73-2)	Immediate (Acute)
Biocides Amines Glutaraldehyde (CAS#111-30-8) Isopropanol (CAS#67-63-0) Thiozolin	Immediate (Acute), Fire
Breakers Ammonium persulfate (CAS#7727-54-0) Benzoic acid (CAS#65-85-0) Enzyme Sodium acetate (CAS#127-09-3) Sodium persulfate (CAS#7772-27-1)	Immediate (Acute), Fire
Buffers Sodium acetate (CAS#127-09-3) Sodium bicarbonate (CAS#144-55-8) Sodium carbonate (CAS#497-119-8) Sodium deacetate	Immediate (Acute)
Calcium Compounds Calcium bromide (CAS#71626-99-8) Calcium hypochlorite (CAS#7778-54-3) Calcium oxide (CAS#1305-78-8) Gypsum (CAS#10101-41-4) Lime (CAS#1305-78-8)	Immediate (Acute)
Cement (CAS#65997-15-1)	Immediate (Acute)
Cement Additives - Accelerators Calcium chloride (CAS#10035-04-8) Gypsum (CAS#10101-41-4) Potassium chloride Sodium chloride (CAS#7647-14-5) Sodium metasilicate	Immediate (Acute)
Cement Additives - Fluid Loss Cellulose polymer Latex	Immediate (Acute)

Cement Additives - Miscellaneous Cellulose flakes (CAS#9004-34-6) Coated aluminum Gilsonite (CAS#12002-43-6) Lime (CAS#1305-78-8) Long chain alcohols	Immediate (Acute)
Cement Additives - Retarders Cellulose polymer Lignosulfonates	Immediate (Acute)
Cement Additves - Weight Modification Barite (CAS#7727-43-7) Bentonite Diatomaceous earth (CAS#68855-54-9) Fly ash Glass beads Hematite (CAS#1317-60-8) Ilmenite Pozzolans	Immediate (Acute)
Chloride Salts Calcium chloride Potassium chloride Sodium chloride (CAS#7647-14-5) Zinc chloride (CAS#7646-85-7)	Immediate (Acute)
Chlorine Gas (CAS#7782-50-5)	Immediate (Acute), Sudden release of pressure
Corrosion Inhibitors 4-4' Methylene dianiline (CAS#101-77-9) Acetylenic alcohols Amine formulations Ammonium bisulfite (CAS#10192-30-0) Basic zinc carbonate (CAS#3486-35-9) Gelatin Ironite sponge (CAS#1309-37-1) Sodium chromate (CAS#7775-11-3) Sodium dichromate (CAS#10588-01-9) Sodium polyacrylate Zinc lignosulfonate Zinc oxide (CAS#1314-13-2)	Immediate (Acute), Delayed (chronic), Fire
Crosslinkers Boron compounds Organo-metallic complexes	Immediate (Acute), Fire
Defoaming Agents Aluminum stearate Fatty acid salt formation Mixed alcohols Silicones	Immediate (Acute)
Deflocculants Acrylic polymer Calcium lignosulfonate Chrome-free lignosulfonate Chromium lignosulfonate Iron lignosulfonate Quebracho Sodium acid pyrophosphate (SAPP)	Immediate (Acute)

Sodium hexametaphosphate (CAS#10124-56-8) Sodium phosphate (oilfos) Sodium tetraphosphate Stryene, maleaic anhydride co-polymer salt Sulfo-methylated tannin	
Detergents/Foamers Amphoteric surfactant formulation Ethoxylated phenol Detergents	Immediate (Acute), Fire
Explosives Charged well jet perforating gun, Class C explosives Detonators, Class A explosives Explosive power device, Class B	Sudden release of pressure
Filtration Control Agents Acrylamide AMPS copolymer Aniline formaldehyde copolymer hydrochlorite Causticized leonardite Sulfomethylated phenol formaldehyde Leonardite Partially hydrolyzed polyacrylamide Polyalkanolamine ester Polyamine acrylate Polyanionic cellulose Potassium lignite Preserved starch Sodium carboxymethyl cellulose (CAS#9004-32-4) Starch (CAS#9005-25-8) Vinylsulfonate copolymer	Immediate (Acute)
Flocculants Anionic polyacrylamide	Immediate (Acute)
Fluoride Generating Compounds Ammonium bifluoride (CAS#1341-49-7) Ammonium fluoride (CAS#12125-0108)	Immediate (Acute)
Friction Reducers Acrylamide methacrylate copolymers Sulfonates	Immediate (Acute)
Fuels Diesel (CAS#68476-34-6) Fuel oil Gasoline (CAS#8006-61-9)	Immediate (Acute), Delayed (Chronic), Fire
Gelling Agents Cellulose and guar derivatives	Immediate (Acute)
Gel Stabilizers Sulfites Thiosulfates	Immediate (Acute)
Hydrogen Sulfide (CAS#7783-06-4)	Immediate (Acute), Fire
Inert Gases Carbon dioxide (CAS#124-38-9) Nitrogen (CAS#7727-37-9)	Immediate (Acute), Sudden release of pressure

Lost Circulation Materials Cane fibers Cedar fibers Cellophane fibers Corn cob Cottonseed hulls Mica (CAS#12001-26-2) Nut shells Paper Rock wool Sawdust	Immediate (Acute)
Lubricants, Drilling Mud Additives Graphite (CAS#7782-42-5) Mineral oil formulations Organo-fatty acid salts Vegetable oil formulations Walnut shells	Immediate (Acute)
Lubricants, Engine Motor oil Grease	Immediate (Acute)
Miscellaneous Drilling Additives Diatomaceous earth (CAS#68855-54-9) Oxalic acid (CAS#144-62-7) Potassium acetate (CAS#127-08-2) Zinc bromide (CAS#7699-45-8)	Immediate (Acute), Delayed (Chronic)
Odorants Mercaptans, aliphatic	Immediate (Acute)
Oil Based Mud Additives Amide polymer formulations Amine treated lignite Asphalt Diesel (CAS#68476-34-6) Gilsonite (CAS#12002-43-6) Mineral oil Organophilic clay Organophilic hectorite Petroleum distillate (CAS#8030-30-6) Polymerized organic acides Sulfonate surfactant	Immediate (Acute), Delayed (Chronic), Fire
Organic Acids Acetic acid (CAS#64-19-7) Acetic anhydride (CAS#108-24-7) Benzoic acid (CAS#65-85-0) Citric acid (CAS#5949-29-1) Formic acid (CAS#64-18-6) Organic acid salts	Immediate (Acute), Fire
Preservatives Dithiocarbamates Paraformaldehyde (CAS#30525-89-4) Isothiazions	Immediate (Acute)
Produced Hydrocarbons Condensate Crude oil (CAS#8002-05-9) Natural Gas	Immediate (Acute), Delayed (Chronic), Fire, Sudden release of pressure

Proppants Bauxite (CAS#1318-16-7) Resin coated sand Zirconium proppant	Immediate (Acute)
Radioactive, Special Form Cesium 137 (encapsulated) logging tool	Delayed (Chronic)
Resin and Resin Solutions Melamine resins Phenolic resins Polyglycol resins	Immediate (Acute), Fire
Salt Solutions Aluminum chloride (CAS#7446-70-0) Ammonium chloride (CAS#12125-02-9) Calcium bromide (CAS#17626-99-8) Calcium chloride (CAS#10035-04-8) Calcium sulfate (CAS#778-18-9) Ferrous sulfate (CAS#7782-63-0) Potassium chloride(CAS#7447-40-7) Sodium chloride (CAS#7647-14-5) Sodium sulfate (CAS#7757-82-6) Zinc bromide (CAS#7699-45-8) Zinc chloride (CAS#7646-85-7) Zinc sulfate	Immediate (Acute)
Scale Inhibitors Ethylenediaminetetraacetic acid (EDTA) (CAS#60-00-4) Inorganic phosphates Isopropanol (CAS#67-63-0) Nitrilotriacetic acid (NTA) (CAS#139-13-9) Organic phosphates Polyacrylate Polyphosphates	Immediate (Acute), Fire
Shale Control Additives Hydrolyzed polyacrylamide polymer Organo-aluminum complex Polyacrylate polymer Sulfonated asphaltic residuum	Immediate (Acute)
Silica	Immediate (Acute), Delayed (Chronic)

Solvents 1,1,1-Trichloroethane (CAS#71-55-6) Acetone (CAS#67-64-1) Aliphatic hydrocarbons Aromatic naphtha (CAS#8032-32-4) Carbon tetrachloride (CAS#56-23-5) Diacetone alcohol Ethylene glycol monobutyl ether (CAS#111-76-2) Kerosene (CAS#8008-20-6) Isopropanol (CAS#67-63-0) Methyl ethyl ketone (MEK) (CAS#78-93-3) Methyl isobutyl ketone (MIBK) (CAS#108-10-1) Methanol (CAS#67-56-1) t-Butyl alcolhol (CAS#75-65-0) Toluene (CAS#108-88-3) Turpentine (CAS#8006-64-2) Xylene (CAS#1330-20-7)	Immediate (Acute), Delayed (Chronic), Fire
Spotting Fluids Nonoil base spotting fluid Oil base spotting fluid (diesel oil base) Oil base spotting fluid (mineral oil base) Sulfonated vegetable ester	Immediate (Acute), Fire
Surfactants - Corrosive Alcohol ether sulfates Amines Quarternary polyamine Sulfonic acids	Immediate (Acute)
Surfactants - Flamable Amines Ammonium salts Fatty alcohols Isopropanol (CAS#67-56-1) Oxylalkylated phenols Petroleum naphtha (CAS#8030-30-6) Sulfonates	Immediate (Acute), Fire
Surfactants - Miscellaneous Amine salts Glycols Phophonates	Immediate (Acute)
Temporary Blocking Agents Benzoic acid (CAS#65-85-0) Naphthalene (CAS#91-20-3) Petroleum wax polymers Sodium chloride (CAS#7647-14-5)	Immediate (Acute)
Viscosifiers Attapulgite Bentonite Guar gum (CAS#9000-30-0) Sepiolite Xantham gum	Immediate (Acute)

Weight Materials Barite (CAS#7727-43-7) Calcium carbonate (CAS#1317-65-3) Galena Hematite (CAS#1317-60-8) Siderite	Immediate (Acute)

APPENDIX F
SOILS

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1.0 FACTORS THAT CONTROL THE ERODIBILITY OF SOILS AND SOIL HAZARDS

1.1 WATER EROSION

Water erosion causes the removal of soil material by flowing water and can cause soil and geologic hazards associated with mass movement. Part of the process of water erosion involves detachment of soil material by impact of raindrops. Loosened soil material is then carried off in suspension in runoff. Four kinds of generally recognized water erosion are sheet, rill, gully, and pipe (tunnel).

Sheet erosion involves the removal of soil from an area without the development of conspicuous channels. The channels instead are very numerous and unstable in that they enlarge and straighten as the volume of runoff increases. Sheet erosion can be serious on soils with slope gradients of only 1 or 2 percent, but becomes more serious as gradient increases.

Rill erosion involves the removal of soil through cutting of many small, but conspicuous channels where runoff concentrates. The channels are small enough though that they are easily obliterated by tillage.

Gully erosion occurs when water cuts down into the soil along a line of flow. Gullies form in exposed natural drainages, in animal trails, in vehicle ruts, and below broken man-made terraces or stock ponds. Gullies cannot be obliterated by ordinary tillage and deep gullies cannot be crossed easily. Gullies and gully patterns vary considerably. V-shaped gullies form in material that is equally or increasingly resistant to erosion with depth. U-shaped gullies form in material that is equally or decreasingly resistant to erosion with depth. The maximum depth to which gullies are cut is determined by resistant layers in the soil, by bedrock, or by the local base level. Many gullies develop headward; that is, they extend up the slope as the gully deepens in the lower part.

Piping (or tunneling) can occur in soils with subsurface horizons or layers that allow water to pass more freely than the surface horizon or layer. Free water enters the soil through surface-connected macropores such as rodent burrows. Soil material entrained in the moving water moves downward within the soil and may move out of the soil completely if there is an outlet. The result is the formation of pipes or tunnels that enlarge and coalesce. Piping is especially prevalent in badland regions with large volumes of mudstone (an unsorted mixture of sand, silt, and clay), but is also common in soils rich in clay but with relatively unsorted textures. Piping is a major factor in the development of gullying by means of headward erosion along established stream courses. Piping and headward erosion can occur on slopes of less than 1 percent grade, however, extensive or rapid gullying generally requires significant water runoff on steeper, less permeable soils. Piping is also favored by the presence of appreciable exchangeable sodium.

To assess a water erosion problem or potential problem soil characteristics and rainfall and runoff factors must be considered. The impact of raindrops can break up soil aggregates and disperse soil material. Very fine sand, silt, clay and organic matter can be removed easily by raindrop splash and runoff, whereas greater raindrop energy or runoff is necessary to remove sand and gravel. Soil movement caused by rainfall is usually greatest and most noticeable during short-duration, high intensity storms. However, less spectacular, long-lasting and less-intense storms can also result in significant soil loss. The effect of runoff can be compounded by soils that have reduced infiltration capacity.

1.2 SOIL ERODIBILITY

Soil erodibility is an estimate of the ability of soils to resist water erosion, based on its physical characteristics. The higher its erodibility, the less resistant a soil is to water erosion. In general soils with faster infiltration rates, greater organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam and loam-textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils. Decreased infiltration and increased runoff can result from compacted subsurface soil layers. A decrease in infiltration can also be caused by a formation of a soil crust, which seals off the surface. Although a soil crust might decrease the amount of soil loss from sheet or rain splash erosion, it might cause a corresponding increase in the amount of runoff water and contribute to greater rill erosion problems.

Past erosion also has an effect on the erodibility of a soil. Exposed subsurface soils on eroded sites tend to be more erodible than the original soils, because of their poorer structure and lower organic matter. Lower organic matter supports lesser vegetation and promotes poorer vegetative cover, which in turn provides less protection for the soil.

1.3 SLOPE GRADIENT AND LENGTH

The steeper the slope of the land, the greater the amount of soil loss from erosion by water. Soil erosion by water also increases as slope length increases due to the greater accumulation of runoff. Consolidation of small slopes into larger ones results in longer slope lengths with increased erosion potential, due to increased velocity of water which permits greater scouring.

1.4 VEGETATION

Soil erosion potential is increased if the soil has no or very little vegetative cover. Plant cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infiltrate. The erosion-reducing effectiveness of plant covers depends on the type, extent and quantity of cover.

1.5 WIND EROSION

The rate and magnitude of soil erosion by wind is controlled by the following factors: (1) erodibility, with respect to wind, (2) soil surface roughness; (3) climate; (4) unsheltered distance; and (5) vegetative cover. Very fine soil particles can be suspended by the wind and then transported great distances. Fine and medium size particles can be lifted and deposited, while coarse particles are blown along the surface (saltation). Abrasion that results from transport can reduce soil particle size and increase the soil erodibility. Soil surfaces that are not rough or ridged have little resistance to the wind. Over time, however, ridges can be filled in and the roughness broken down by abrasion to produce a smoother surface more susceptible to the wind. The speed and duration of the wind have a direct relationship to the extent of soil wind erosion. Soil moisture levels can be very low at the surface of excessively drained soils or during periods of drought, thus releasing the particles for transport by wind. This effect also occurs in freeze-drying of the surface during winter months. The lack of windbreaks (trees, shrubs) allows the wind to put soil particles into motion for greater distances thus increasing the effects of abrasion and soil erosion. Knolls are usually exposed and suffer the most. The lack of permanent vegetation cover in certain locations can result in extensive erosion by wind. Loose, dry, bare soil is most susceptible.

Soil drifting of an area can gradually causes a textural change in the soil. Loss of fine sand, silt, clay and organic particles from sandy soils serves to lower the moisture holding capacity of the soil. This, in turn, increases the erodibility of the soil, compounding the problem. The removal of wind blown soils from fencerows, ditches, roads and from around buildings can be costly.

1.6 RILL AND SHEET EROSION – RUSLE2 ESTIMATES

Rates of soil loss under natural vegetation are generally low and there is a steady state with very little variation with time. With cultivation, however, the rates change dramatically. The Revised Universal Soil Loss Equation (RUSLE2) is a tool that helps quickly visualize the likely sheet and rill soil erosion potential (soil detachment potential but not transport and deposition) based on several major environmental parameters for large areas. RUSLE2 is the newest iteration of the Revised Universal Soil Loss Equation (Renard 1997), which was an improvement to the Universal Soil Loss Equation (Wishmeier and Smith 1978).

RUSLE2 is represented by the simple equation

$$a = r\,k\,l\,S\,c\,p$$

where: a = net detachment (mass/unit area), r = erosivity factor, k = soil erodibility factor, l = slope length factor, S = slope steepness factor, c = cover-management factor, and p = supporting practices factor.

Table F-1 shows calculated soil detachment, soil loss, average upslope erosion calculations by soil texture type and slope based on the RUSLE2 equation. The table compares rates of sheet and rill erosion only for soil texture types as soil substrata on various slopes ranging from essentially flat to 20 degrees for three situations: (1) no management/bare with no disturbance; (2) rough bare with fresh disturbance; and (3) range grass 4 years since last disturbance.

Comparing the rates of sheet and rill erosion, the RUSLE2 estimate shows that sheet and rill erosion is a small, albeit important, part of overall erosion that reduces landscape.

Table F-1. RUSLE2 Soil Detachment, Soil Loss, Average Upslope Erosion Calculations By Soil Texture, Type, and Slope

(Sheet wash and Rill Erosion Only).

Soil Texture Type as Substratum Soil	Average Slope Steepness	Soil Detachment/Soil Loss (Eroded Part)/Average Upslope Erosion (t/ac/yr)		
		No Management/ Bare, No Disturbance	Rough Bare, Fresh Disturbance	Range Grass 4 yrs Since Last Disturbance
Clay-Loam	0.0010	0.013.0	0.27	0.0098
	5	0.73	1.7	0.54
	10	1.7	3.5	1.2
	15	3.1	5.7	2.7
	20	4.5	7.9	3.3
Loamy Sand	0.0010	0.0058	0.014	0.0043
	5	0.34	0.96	0.25
	10	0.80	2.0	0.59
	15	1.5	3.2	1.1
	20	2.1	4.5	1.6
Sand	0.010	0.0031	0.0084	0.0027
	5	0.19	0.54	0.14
	10	0.44	1.1	0.32
	15	0.80	1.8	0.58
	20	1.2	2.5	0.84
Sandy Clay Loam	0.010	0.010	0.021	0.0075
	5	0.58	1.4	0.43
	10	1.3	2.9	0.99
	15	2.4	4.7	1.8
	20	3.6	6.6	2.6
Sandy Loam	0.0010	0.014	0.033	0.011
	5	0.83	2.2	0.61
	10	1.9	4.5	1.5
	15	3.5	7.4	2.6
	20	5.2	10	3.8

1.7 SOIL HAZARDS AND LIMITING FACTORS

Some soils have properties that can limit their suitability for certain types of uses. In general, the utility of a particular soil for a specific use is based on knowledge of the climate and existing or potential geologic hazards of the area under study, as well as a combination of one or more of the following soil properties: (1) slope; (2) permeability; (3) vegetative cover; (4) parent material; and (5) clay content.

Several hazards relate to soil type. Chief among these are the relatively rapid mass-wasting effects of earth flow and slumping. Earth flow commonly results from the saturation of soils on slopes and the collection of water and ensuing loss of cohesion along the plane separating the subsoil from the soil parent material. Similarly, rapid rotational slumping can occur when soils and underlying parent materials are undercut by streams, or when the toe of a mass of soil or sediment is supersaturated or eroded away or has been removed by excavation. Both mass-wasting and slumping result from a combination of soil parameters (slope, permeability, nature of parent materials) acting in conjunction with two climatic aspects: precipitation and its spacing throughout the year.

Earth flow and rotational slumping can occur within spans of days or hours—even seconds—however, other mass-movements take place over a period of weeks or months to years. Soil creep is the slow, downward movement of soils or soil materials on slopes. Creep can affect residual and colluvial soils as well as soils with sharply marked horizons, and this process results in phenomena as divergent as the piling-up of boulders at the bottom of an outcrop hill to the downhill tilt of trees. Soil collapse results from the frequent wetting and drying of mixed layer illitic/smectitic (expanding) clays in soils with thick (generally texturally unsorted) subsurface horizons rich in those clay minerals.

Soil piping or tunnel erosion and headward erosion of gullies are ubiquitous—occurring in all arid and semiarid landscapes, and to some degree everywhere within the WRPA. The relationship between breached stock tanks and gullying is particularly noticeable.

Dune formation is a final soil hazard, and one particular to windblown semiarid areas with abundant supplies of loose sediment due to little or no vegetation cover in sediment source areas. With increased moisture and plant growth dune migration can be arrested, leading to the formation of stabilized dunes. Dunes can form on slopes of almost any gradient. If the vegetation disappears, the dunes can be reactivated and also (because of their unconsolidated nature) become subject to gullying on steeper slopes.

2.0 DESCRIPTION OF SOIL SAMPLES

2.1 SOIL, SITE, SPECITIC DATA, LOCATION, SLOPE, ELEVATION, PARENT MATERIAL, PHYSIOGRAPHIC SETTING, THICKNESS AND OBSERVATIONS ON SOIL HORIZONS.

1. Apron—Lostwells Association

The following profile was examined below the southeast extremity of Muddy Ridge, on Harris Bridge Quadrangle:

SITE WR-05

UTM Zone 12: 700894E, 4793876N; slope = 2-3%; permeability good to moderate, with low erosion due to runoff except in established drainages.

A = Very calcareous loamy sand, covered with surficial pebbles probably lagged down from terraces. Aeolian. 2-4 cm.

Bt = Highly calcareous brown sandy clay; 10YR4/3; pH = 7.0; 38 cm.

Ck = Highly calcareous sand-supported pebble conglomerate with CaCO3 rinds on pebbles and CaCO3 granules in matrix; pH = 6.9 (most of carbonate from this horizon mobilized and deposited in pebble rinds and as granules); 10 cm +.

At 40-42 cm depth, the soil at WR-05 is a relatively shallower soil that those Young (1974) records as typical of soils in the Apron—Lostwells association.

2. Persayo-Oceanet Association

No soil profiles of this association were examined in the field.

3. Tipperary—Trook Association

The following profiles were measured in the northern (Mexican Pass SW Quadrangle) and southern Mexican Pass SE Quadrangle) parts of the WRPA.

SITE WR-01

UTM Zone 12: 707926E, 4802215N; slope = approximately 0%; permeability excellent, with little erosion potential except near established drainages or where topsoil has been disturbed or vegetation removed. Although the permeability is excellent this area is posted for flash flood warning because of the relatively large size of the cachement basin along Cottonwood Creek upstream from the test pit.

A = Sand, probably eolian; slightly calcareous and with tiny amount of clay, with coarse sand and quartzite and chert pebble gravel forming surficial lag. 2-3 cm.

Bw = Yellowish-brown slightly loamy sand; 10YR6/4; pH=6.9; moderately calcareous; 30 cm.

Btk = loamy sand to sandy loam; light gray (10YR7/2); pH = 7.1; highly calcareous, with fine platy structure and granular and dusty CaCO3Concentrations; 10 cm +.

This soil is clearly developed on a very stable bedrock (strath) terrace formed on the lower Eocene Wind River Formation.

SITE WR-03

UTM Zone 12: 717550E, 4795290N; slope = approximately 2%; permeability moderate, but weak if clay-rich Bw horizon exposed.

A = Sand, mildly calcareous; slightly grayer than Bw with lag veneer of pebble gravel at surface. Probably eolian. 2 cm.

Bt = Sandy clay, calcareous; massive to friable; 10YR5/4 (yellowish-brown); pH = 7.0; 20 cm.

Ck = Sand-supported gravel conglomerate with CaCO3 rinds evident on pebbles. 12 cm+.

This soil was almost certainly formed on a gravel-capped terrace of late Quaternary age.

4. Apron—Trook Association

The following two soil profiles were examined at top of Muddy Ridge:

SITE WR-06

UTM Zone 12: 694890E, 4797726 N; elevation = 5,650 feet; slope = approximately 1-2%; permeability good, with low runoff potential except near scarp edges, and where top of soil has been disturbed or removed.

A = Loamy sand with a lag of pebble gravel at surface; very calcareous; 4 cm. The sand is probably of eolian origin.

Bt = Sandy clay; highly calcareous; 10YR5/3 (brown); pH = 7.0; 35 cm.

Bk = Sandy clay; extremely calcareous, with abundant CaCO3 pisoliths up to 2.0 cm diameter; 10YR4/3 (brown); 14 cm+.

Ck = Polymictic pebble/cobble/roundstone conglomerate with some sand; most clasts with CaCO3 rinds.

This soil formed on a high, very stable, gravel/cobble/boulder-supported stream terrace of considerable age. The sand atop the conglomerate is almost certainly reworked eolian material, a conclusion supported by the high degree of calcareousness of the A horizon sediment. This soil is permeable and stable; it will yield little runoff and erode very slowly, except in well-established areas of surface disturbance (edges of existing gullies or road cuts).

SITE WR-07

UTM Zone 12: 700877E, 4794479N; elevation = approximately 5,530 feet; slope about 1% or less; permeability good, with low runoff potential except near scarp edges, and where top of soil has been disturbed or removed.

A = Sandy loam; very calcareous; lag of pebble gravel on surface; 4 cm.

Bt = Sandy clay; granular; very calcareous; 10YR5/4 (yellowish-brown); pH = 6.7; 31 cm.

Bk = Sandy clay with carbonate pisoliths up to 7 mm diameter; granular; pH = 6.5; 15 cm.

Ck = Polymictic pebble/cobble/roundstone conglomerate with some sand; $CaCO_3$ rinds on most conglomeratic clasts.

As at Site WR-06, this is an old, well developed, and stable soil exhibiting relatively high permeability and little runoff potential.

5. Fivemile—Binton Association

No soil profiles of this association were examined in the field.

6. Birdsley—Effington—Boysen Association

The following profile documents a probably soil of this association at a locality only a few hundred feet outside of the WRPA.

SITE WR-04

UTM Zone 12: 703596E, 4792496N; slope = approximately 1-2%; permeability low to moderate and runoff potential moderate due to high surficial clay content. Water logging and ponding of soil is probable where soil is developed on relatively flat surfaces.

A = Sandy clay loam; loose to friable and almost certainly with some eolian component; very calcareous; 10YR5/2 (grayish-brown); 3 cm.

Btk = Sandy clay; slightly platy; highly calcareous; pH = 7.2; 10YR6/2 (light brownish-gray); 16 cm.
Bw = Sandy clay loam; slightly platy; very calcareous; pH = 7.0; 10YR4/2 (dark grayish-brown); 27 cm.

APPENDIX G
WATER RESOURCES DATA

WATER RESOURCES DATA

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Table G-1. Wyoming Water Quality Standards.

PRIORITY POLLUTANTS				
Pollutant	**Aquatic Life Acute Value Micrograms/l**	**Aquatic Life Chronic Value Micrograms/l**	**Human Health Value Fish & Drinking Water (2) Micrograms/l**	**Human Health Value Fish Only (8) Micrograms/l**
Acenaphthene			20(7)	2700
Acrolein			320	780
Acrylonitrile (3)			0.059	0.66
Benzene(3)			1.2	71
Benzidine(3)			0.00012	0.00054
Carbon tetrachloride(3) (Tetrachloromethane)			0.25	4.4
Chlorobenzene (Monochlorobenzene)			20(7)	21000
1,2,4 Trichlorobenzene			70(9)	940
Hexachlorobenzene(3)			0.00075	0.00077
1,2-Dichloroethane(3)			0.38	99
1,1,1-Trichlorobenzene			200(9)	
Hexachloroethane(3)			1.9	8.9
1,1,2-Trichloroethane			0.60	42
1,1,1,2-Trichloroethane(3)			0.17	11
Bis(2-chloroethyl) ether(3)			0.031	1.4
2-Chloronaphthalene			1700	4300
2,4,6-Trichlorophenol(3)			2.1	6.5
p-Chloro-m-cresol (4-Chloro-3-methylphenol)			3000(7)	
Chloroform (HM) (3) (Trichloromethane)			5.7	470
2-Chlorophenol			0.1(7)	400
1,2-Dichlorobenzene			600(9)	17000
1,3-Dichlorobenzene			400	2600
1,4- Dichlorobenzene			75(9)	2600
3,3-Dichlorobenzidine(3)			0.04	0.077
1,1-Dichloroethylene(3)			0.057	3.2
1,2-trans-Dichloroethylene			100(9)	140000
2,4-Dichlorophenol			0.3(7)	790
1,2-Dichloropropane			0.52	39
1,3-Dichloropropylene (1,3-Dichloropropene) (cis and trans isomers)			10	1700
2,4-Dimethylphenol			400(7)	2300
2,4-Dinitrotoluene(3)			0.11	9.1
1,2-Diphenylhydrazine(3)			0.040	0.54
Ethylbenzene			700(9)	29000

Fluoranthene			300	370
Bis (2-chloroisopropyl) ether			1400	170000
Methylene chloride (HM)(3) (Dichloromethane)			4.7	1600
Methyl bromide (HM) Bromomethane)			48	4000
Bromoform (HM) (6) (Tribromomethane)			4.3	360
Dichlorobromomethane (HM) (6)			0.56	46
Chlorodibromomethane (HM) (6)			0.41	34
Hexachlorobutadiene(3)			0.44	50
Hexachlorocyclopentadine			1(7)	17000
Isophorone(3)			36	2600
Nitrobenzene			17	1900
2,4-Dinitrophenol			70	14000
4,6-Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)			13	765
N-Nitrosodimethylamine(3)			0.00069	8.1
N-Nitrosodiphenylamine(3)			5.0	16
N-Nitrosodi-n-propylamine(3)			0.005	1.4
Pentachlorophenol	19(5)	15(5)	0.28	8.2
Phenol			300(7)	4600000
Bis(2-ethylhexyl)phthalate(3)			1.8	5.9
Butyl benzyl phthalate			3000	5200
Di-n-butyl phthalate			2700	12000
Diethyl phthalate			23000	120000
Dimethyl phthalate			313000	2900000
Benzo(a)anthracene (PAH) (3)			0.0044	0.49
Benzo(a)pyrene (PAH) (3)			0.0044	0.49
Benzo(b)fluoranthene (PAH) (3) (3,4-Benzofluoranthene)			0.0044	0.49
Benzo(k)fluoranthene (PAH) (3) (11,12-Benzofluoranthene)			0.0044	0.49
Chrysene (PAH) (3)			0.0044	0.49
Anthracene (PAH) (3)			9600	11000
Fluorene (PAH) (3)			1300	14000
Dibenzo(a,h)anthracene (PAH) (3) (1,2,5,6-Dibenzoanthracene)			0.0044	0.049

Indeno(1,2,3-cd)pyrene (PAH) (3)			0.0044	0.049
Pyrene (PAH) (3)			960	11000
Tetrachloroethylene(3)			0.8	8.85
Toluene			1000(9)	200000
Trichloroethylene(3)			2.7	81
Vinyl chloride(3) (Chloroethylene)			2	525
Aldrin(3)			0.00013	0.00014
Dieldrin(3)			0.00014	0.00014
Chlordane(3)			0.0021	0.0022
4,4'-DDT(3)			0.00059	0.00059
4,4'-DDE(3)			0.00059	0.00059
4,4'-DDD(3)			0.00083	0.00084
alpha-Endosulfan	0.11	0.056	110	240
beta-Endosulfan	0.11	0.056	110	240
Endosulfan sulfate			110	240
Endrin	0.086	0.036	0.76	0.81
Endrin aldehyde			0.76	0.81
Heptachlor(3)	0.26	0.0038	0.00021	0.00021
Heptachlor epoxide(3)	0.26	0.0038	0.0001	0.00011
Alpha-BHC(3) (Hexachlorocyclohexane-alpha)			0.0039	0.013
beta-BHC(3) (Hexachlorocyclohexane-beta)			0.014	0.046
Gamma-BHC (Lindane) (3) Hexachlorocyclohexane-gamma)	0.95		0.019	0.063
PCB-1242 (Arochlor 1242) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1254 (Arochlor 1254) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1221 (Arochlor 1221) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1232 (Arochlor 1232) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1248 (Arochlor 1248) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1260 (Arochlor 1260) (3)		0.014	0.00017(13)	0.00017(13)
PCB-1016 (Arochlor 1016) (3)		0.014	0.00017(13)	0.00017(13)
Toxaphene(3)	0.73	0.0002	0.00073	0.00075
Antimony			14	4300
Arsenic(3)	340	150	7	7

Asbestos(3)			7000000 fibers/l(9)	
Beryllium(3)			4(9)	
Cadmium	4.3(4)	2.2(4)	5(9)	
Chromium (III)	569.8(4)	74.1(4)	100(9)	
Chromium (VI)	16	11	100(9)	
Cooper	13.4(4)	9(4)	1000(7)	
Cyanide (free)	22	5.2	200(9))	220000
Lead	64.6(4)	2.5(4)	15(9)	
Mercury	1.4	0.77	0.050	0.051
Nickel	468.2(4)	52.0(4)	100(9)	4600
Selenium	20	5(10)	50(9)	9000
Silver	3.4(4)			
Thallium			1.7	6.3
Zinc	117.2(4)	118.1(4)	5000(7)	69000
Dioxin (2,3,7,8-TCDD) (3)			0.000000013	0.000000014

NON-PRIORITY POLLUTANTS				
Pollutant	**Aquatic Life Acute Value Micrograms/l**	**Aquatic Life Chronic Value Micrograms/l**	**Human Health Value Fish &Drinking Water (2) Micrograms/l**	**Human Health Value Fish Only (8) Micrograms/l**
Alachlor(3)			2(9)	
Aluminum (pH 6.5 – 9.0 only)	750(10)	87(10)(14)		
Ammonia	See Appendix D Wyo. Water Quality Rules and Regulations			
Atrazine			3(9)	
Barium			2000(9)	
Bis(chloromethyle Ether(3)			0.00013	0.00078
Carbofuran			40(9)	
Chloride	860000	230000		
Chlorine (total residual)	19	11		
Chlorophenoxy Herbicide 2,4,5,-TP			10	
Chlorpyrifos	0.083	0.041		
Chlorophenoxy Herbicide 2,4,-D			70(9)	
Dalapon			200(9)	
Demeton		0.1		
Di(2-ethylhexyl)adipate			400(9)	
Dibromochloropropane (DBCP) (3)			0.2(9)	
Dichloroethylene (cis-1,2-)			70(9)	
Dinoseb			7(9)	
Dinitrophenols			70	14000
Dissolved Gases		100% sat		
Dissolved Oxygen	See Appendix D Wyo. Water Quality Rules and Regulations			
Diquat			20(9)	
Endothall			100(9)	
Ether, Bis Chloromethyl			0.00013	0.00078
Ethylene dibromide (EDB) (3)			0.05(9)	
Fluoride			4000(9)	
Glyphosate			700(9)	
Guthion		0.01		
Iron		1000(12)	300(11)	
Malathion		0.1		

Manganese	3110(4)(12)	1462(4)(12)	50(11)	
Methoxychlor		0.03	40(9)	
Mirex		0.001		
Nitrite (as N)			1000(9)	
Nitrates (as N)			10000(9)	
Nitrate & Nitrates (both as N)			10000(9)	
Nitrosamines			0.0008	1.24
Nitrosodidibutylamine, N			0.0064	0.587
Nitrosodiethylamine,N			0.0008	1.24
N-nitrosopyrrolidene(3)			0.016	91.9
Oxamyl (Vydate)			200(9)	
Parathion	0.065	0.013		
Pentachlorobenzene			3.5	4.1
pH		6.5 – 9.0		
Picloram			500(9)	
Simazine			4(9)	
Styrene			100(9)	
Sulfide-Hydrogen Sulfide (S^{2-}-,HS^{-})		2		
1,2,4,5-tetrachlorobenzen			2.3	2.9
Tributyltin	0.46	0.063		
Trichlorfluoromethane			10000	860000
2,4,5-trichlorophenol			1.0(7)	
2,4,5-TP(2,4,5-trichlorophenoxy) propionic acid			50(9)	
Xylenes			10000(9)	

(1) Except for the aquatic life values for metals and where otherwise indicated, the values given in this Appendix refer to the total recoverable (dissolved plus suspended) amount of each substance. For the aquatic life values for metals, the values refer to dissolved amount.

(2) Except where otherwise indicated, these values are based on EPA Section 304(a) **criteria** recommendations assuming consumption of 2 liters of **water** and 6.5 grams of aquatic organisms per day.

(3) Substance classified as a carcinogen with the value based on an incremental risk of one additional instance of cancer in one million persons.

(4) Hardness dependent **criteria**. Value given is an example only and is based on a $CaC0_3$ hardness of 100 mg/l. **Criteria** for each case must be calculated using the formula in Appendix G of Wyoming Water Quality Rules and Regulations

(5) pH dependent **criteria**. Value given is an example only and is based on a pH of 7.8. **Criteria** for each case must be calculated using the formula in Appendix H in Wyoming Water Quality Rules and Regulations.

(6) Chemicals which are not individually classified as carcinogens but which are contained within a class of chemicals with carcinogenicity as the basis for the **criteria** derivation for that class of chemicals; an individual carcinogenicity assessment for
these chemicals is pending.

(7) Value is based on organoleptic (taste and odor) effects and is more stringent than if based solely on toxic or carcinogenic effects.

(8) EPA Section 304(a) human health **criteria** recommendation assuming consumption of contaminated aquatic organisms at a rate of 6.5 grams per day.

(9) The criterion is based on an EPA drinking **water** standard (Maximum Contaminant Level or MCL).

(10) This value is expressed in terms of total recoverable metal in the **water** column.

(11) The iron and manganese **criteria** are based on Safe Drinking **Water** Act secondary standards and are intended to prevent undesirable aesthetic effects. These values represent the dissolved amount of each substance rather than the total amount.

(12) Value is based on the dissolved amount which is the amount that will pass through a 0.45 m membrane filter prior to acidification to pH 1.5-2.0 with nitric acid.

(13) This criterion applies to total PCBs, i.e., the sum of all congener or all isomer analyses.

(14) The aluminum **criteria** are expressed as total recoverable metal in the **water** column. The 87 µg/l chronic criterion for aluminum is based on information showing chronic effects on brook trout and striped bass. The studies underlying the 87 µg/l chronic value, however, were conducted at low pH (6.5 - 6.6) and low hardness (< 10 ppm $CaCO_3$), conditions uncommon in **Wyoming** surface waters. A **water** effect ratio toxicity study in West Virginia indicated that aluminum is substantially less toxic at higher pH and hardness (although the relationship is not well quantified at this time). Further, EPA is aware of field data indicating that many high **quality** waters in the U.S. contain more than 87 µg/l aluminum when either the total recoverable or dissolved aluminum is measured. Based on this information and considering the available toxicological information in Tables 1 and 2 of EPA's Aluminum **Criteria** Document (EPA 440/5-86-008), the Department of Environmental **Quality** will implement the 87 µg/l chronic criterion for aluminum as follows: where the pH is equal to or greater than 7.0 and the hardness is equal to or greater than 50 ppm as $CaCO_3$ in the receiving **water** after mixing, the 87 µg/l chronic criterion will not apply, and aluminum will be regulated based on compliance with the 750 µg/l acute aluminum criterion. In situations where the 87 µg/l chronic criterion applies, a discharger may request development of and provide the basis for a site-specific chronic criterion based on a **water**-effect ratio. Or, a discharger may request development of and provide the basis for a permitting procedure (a translator) that would take into account less toxic forms of particulate aluminum.

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (°C)	TEMP H_20 (°C)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 52	Muddy Cr	02/06/1997	10:40 AM		32.9	2370		1.2	49.6	5.73	8.61				0
G 52	Muddy Cr	04/09/1997	12:00 PM		41	2062			98.2	10.1	8.67				0
G 52	Muddy Cr	05/08/1997	09:30 AM		51.44	2140		1.1	87.8	7.81	8.75				0
G 52	Muddy Cr	06/11/1997	01:40 PM		64.4	2060			84.1	6.43	8.44				184
G 52	Muddy Cr	07/09/1997	11:25 AM		65.3	2450			94.2	7.02	8.4				6
G 52	Muddy Cr	08/12/1997	09:45 AM		60.98	2420			64.2	5.09	8.47				24
G 52	Muddy Cr	09/23/1997	03:30 PM		54.32	1862					8.55				15
G 52	Muddy Cr	10/28/1997	02:00 PM		42.08	252			81.2	9.89	8.18				10
G 52	Muddy Cr	11/18/1997	09:30 AM	41	36.68	245			24.6	8.3	7.79				10
G 52	Muddy Cr	06/03/1998	01:00 PM	50	53.24	2440			94.5	8.22	8.18				10
G 52	Muddy Cr	08/20/1998	02:30 PM	83	72.68	2310			112.9	8.01	9				7
G 52	Muddy Cr	09/18/1998	05:45 PM	77	64.4	1268		0.6	101.5	8.19	8.44				27
G 52	Muddy Cr	10/15/1998	05:50 PM	51	50.54	1326		0.7			9.37				4
G 52	Muddy Cr	10/16/1998	04:10 PM	38	44.06	854		0.4	110.7	11	8.63				9
G 52	Muddy Cr	12/01/1998	02:10 PM	54	38.48	1098		0.5	119.8	12.89	7.85				4
G 52	Muddy Cr	03/25/1999	02:55 PM		50.8	1599	102.4	0.85	103.8	8.95	7.99	0.22	2.71	11.17	11
G 52	Muddy Cr	04/21/1999	02:40 PM		50.8	1972	126.4	1.05	103.1	8.49	8.19	0.19	31.37	28.91	13.1
G 52	Muddy Cr	06/30/1999	01:10 PM	75	64.84	1453	944	0.73	121.3	11.39	8.41	0.296	2.882	16.87	11.9
G 52	Muddy Cr	07/23/1999	01:00 PM		73.1	2351	1522.7	1.21	132.3	11.53	8	0.623	1.379	26.02	6.6
G 52	Muddy Cr	09/02/1999	11:00 AM	64	59.16	1777	1155	0.9	82.9	8.26	7.6	1.321	1.327		9.5
G 52	Muddy Cr	10/20/1999	02:55 PM	59	45.1	1920	1250	1	91.2	10.87	8.19	0.7	0.4	9.7	12.3
G 52	Muddy Cr	11/22/1999	10:45 AM	29	34.4	1728	1120	0.9	95.3	13.34	8.25	1.1	1.5	13.9	18.7
G 52	Muddy Cr	02/28/2000	12:11 PM	54	34.16	1629	1060	0.8	97.8	13.74	8.16	0.7	1.1	14.7	29.1
G 52	Muddy Cr	05/31/2000	10:37 AM	66	58	3347	2180	1.8	123.4	12.46	8.08	1.2	1.9	63.9	13.7
G 52	Muddy Cr	06/29/2000	11:10 AM	81	61	3672	2360	1.9	115.7	11.5	8.25	0.5	0.22	73.2	10.1
G 52	Muddy Cr	08/28/2000	11:00 AM	78	61	3995	2600	2.1	111.2	10.78	6.8	0	2.2	130	6.3
G 52	Muddy Cr	02/08/2001	11:25 AM	35											
G 52	Muddy Cr	09/21/2001	02:15 AM	81											
G 52	Muddy Cr	11/29/2001	02:30 PM												
G 52	Muddy Cr	12/19/2001	02:09 PM	29											
G 52	Muddy Cr	01/31/2002	10:55 AM	12											
G 52	Muddy Cr	05/16/2002	11:00 AM	51	54	2400	2400	1.2	122.5	12.92	8.02	0.4	0.4	16.7	15.2
			minimum	12.00	32.90	245.00	102.40	0.40	24.60	5.09	6.80	0.00	0.22	9.70	0.00
			maximum	83.00	73.10	3995.00	2600.00	2.10	132.30	13.74	9.37	1.32	31.37	130.00	184.00
			average	55.40	52.55	1962.96	1401.71	1.05	96.95	9.72	8.27	0.60	3.95	36.82	17.31
			median	54.00	53.24	1972.00	1202.50	0.95	98.20	9.89	8.25	0.56	1.44	16.87	10.00
			mode	51.00	64.40	#N/A	#N/A	1.20	#N/A	#N/A	8.44	0.70	0.40	#N/A	0.00
			samples	20.00	27.00	27.00	12.00	18.00	25.00	25.00	27.00	12.00	12.00	11.00	27.00

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (^oC)	TEMP H_20 (^oC)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 52b	Muddy Cr	06/30/1999	02:20 PM	73	65.12	657	427	0.32	114.9	10.73	8.82	0.207	3.829	5.7	91.8
G 52b	Muddy Cr	07/23/1999	02:00 PM		71.7	715	465	0.35	97	8.45	8.61	0.249	3.503	10.46	128.3
G 52b	Muddy Cr	09/02/1999	11:55 AM	58	56	1274	828	0.64	117.1	12.05	8.47	0.871	4.13		24.6
G 52b	Muddy Cr	10/27/1999	03:36 PM	62	48	1464	950	0.7	93.9	10.73	8.42	0.8	1.4	14.8	101.3
G 52b	Muddy Cr	11/22/1999	12:29 PM	38	37.03	2558	1660	1.3	105.6	14.17	8.48	1.2	5.5	36.8	8.6
G 52b	Muddy Cr	02/28/2000	02:03 PM	57	40.17	2732	1780	1.4	104.2	13.34	8.33	1.2	3.1	39	32
G 52b	Muddy Cr	05/31/2000	11:50 AM	78	61	917	600	0.5	127.8	12.53	8.51	0.4	1.9	6.4	101.6
G 52b	Muddy Cr	06/29/2000	12:20 PM	80	66	733	480	0.4	119	10.95	8.82	0.1	0.2	4.5	55.5
G 52b	Muddy Cr	08/28/2000	12:45 PM	89	68	775	500	0.4	93.3	8.4	7.93	0	0.6		27.4
G 52b	Muddy Cr	02/08/2001	12:00 PM	34											
G 52b	Muddy Cr	03/28/2001	12:00 PM												
G 52b	Muddy Cr	11/29/2001	03:05 PM	31	33	2900	1900	1.5	116.9	16.5	7.99	0.9	144.5	32.3	12.3
G 52b	Muddy Cr	12/19/2001	02:04 PM	30											
G 52b	Muddy Cr	01/31/2002	11:03 AM	17											
			minimum	17.00	33.00	657.00	427.00	0.32	93.30	8.40	7.93	0.00	0.20	4.50	8.60
			maximum	89.00	71.70	2900.00	1900.00	1.50	127.80	16.50	8.82	1.20	144.50	39.00	128.30
			average	53.92	54.60	1472.50	959.00	0.75	108.97	11.79	8.44	0.59	16.87	18.75	58.34
			median	57.50	58.50	1095.50	714.00	0.57	110.25	11.50	8.48	0.60	3.30	12.63	43.75
			mode	#N/A	#N/A	#N/A	#N/A	0.40	#N/A	10.73	8.82	1.20	#N/A	#N/A	#N/A
			samples	12.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	8.00	10.00

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (°C)	TEMP $H_2$0 (°C)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 52a	Muddy Cr	09/28/1998	05:00 PM	74	62.24	732		0.4	115.7	9.59	8.73				25
G 52a	Muddy Cr	12/02/1998	04:20 PM	52	37.76	1236		0.6	130.5	14.77	8.53				2
G 52a	Muddy Cr	03/26/1999	03:40 PM		51.2	2492	160.6	1.34	104.1	8.81	8.28	0.38	12.93	92.63	16.7
G 52a	Muddy Cr	04/22/1999	12:15 PM		45.7	637.4	408	0.33	104.7	8.12	8.45	0.09	40.88	20.16	1000
G 52a	Muddy Cr	06/30/1999	02:50 PM	73	67	762	495	0.37	108.6	9.84	8.64	0.207	4.258	10.73	2.793
G 52a	Muddy Cr	07/23/1999	02:30 PM		75.51	895	582	0.44	102.5	8.58	8.8	0.308	4.572	11.72	137.7
G 52a	Muddy Cr	09/02/1999	12:30 PM	64	52	929	632	0.48	111.8	11.85	8.57	0.74	3631		99.3
G 52a	Muddy Cr	10/27/1999	02:45 PM	60	47	1201	780	0.6	97.2	11.34	8.47	0.5	1.6	12.2	290.8
G 52a	Muddy Cr	11/22/1999	01:16 PM	39	37.45	2582	1680	1.3	101.6	13.55	8.63	1.3	5.3	43.8	18.7
G 52a	Muddy Cr	02/28/2000	02:29 PM	52	33.29	2781	1810	1.4	103.6	14.71	8.62	1.5	3.7	51.2	47
G 52a	Muddy Cr	05/31/2000		78	64	887	580	0.4	129.9	12.25	8.65	0.4	1.2	7	267.1
G 52a	Muddy Cr	06/29/2000	12:45 PM	81	70	657	430	0.3	103.1	9.08	8.77	0.1	0.4	4.4	337.3
G 52a	Muddy Cr	08/28/2000	01:30 PM	84	69	962	630	0.5	92.4	8.21	7.96	0	1.5		57.1
G 52a	Muddy Cr	02/08/2001	12:31 PM	32											
G 52a	Muddy Cr	03/28/2001	12:20 PM	50	32	2483	1610	0.3	81.8	11.8	8.4	0.1	1.7	23.1	84.5
G 52a	Muddy Cr	11/29/2001	03:40 PM												
G 52a	Muddy Cr	12/11/2001	02:20 PM	30											
G 52a	Muddy Cr	01/31/2002	12:02 PM	22											
			minimum	22.00	32.00	637.40	160.60	0.30	81.80	8.12	7.96	0.00	0.40	4.40	2.00
			maximum	84.00	75.51	2781.00	1810.00	1.40	130.50	14.77	8.80	1.50	3631.00	92.63	1000.00
			average	56.50	53.15	1374.03	816.47	0.63	106.25	10.89	8.54	0.47	309.09	27.69	170.43
			median	56.00	51.60	945.50	606.00	0.46	103.85	10.59	8.60	0.34	3.98	16.18	70.80
			mode	52.00	#N/A	#N/A	#N/A	0.40	#N/A	#N/A	#N/A	0.10	#N/A	#N/A	#N/A
			samples	14.00	14.00	14.00	12.00	14.00	14.00	14.00	14.00	12.00	12.00	10.00	14.00

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (°C)	TEMP $H_2$0 (°C)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 50	Five Mile Cr	01/07/1997	11:00 AM		32.18	1680		1		9.78	8.62				4
G 50	Five Mile Cr	02/06/1997	10:20 AM		32.18	2930		1.5		5.73	8.34				3
G 50	Five Mile Cr	04/09/1997	11:30 AM		38.12	2900			104.6	11.41	8.93				4
G 50	Five Mile Cr	05/08/1997	09:10 AM		48.02	3060		0.2	98.8	9.16	8.77				0
G 50	Five Mile Cr	06/11/1997	01:10 PM		64.04	2190			90.3	6.88	8.3				272
G 50	Five Mile Cr	07/09/1997	11:00 AM		69.08	3370			95.4	6.84	8.08				0
G 50	Five Mile Cr	08/12/1997	09:15 AM		59.72	288			94.1	7.52	8.54				11
G 50	Five Mile Cr	09/23/1997	03:05 PM		61.34	2190					8.3				2
G 50	Five Mile Cr	10/28/1997	01:30 PM		44.24	307			80.4	9.49	8.38				3
G 50	Five Mile Cr	11/18/1997	09:00 AM		32.18	308			79.1	11.16	8.11				5
G 50	Five Mile Cr	06/03/1998	12:40 PM	50	51.44	3550			98.6	8.76	7.91				0.1
G 50	Five Mile Cr	08/20/1998	01:55 PM	85	78.08	3070			97.4	6.68	8.86				0.11
G 50	Five Mile Cr	09/18/1998	05:15 PM	76	68.54	2050		1.1	99.8	7.64	8.42				5
G 50	Five Mile Cr	10/15/1998	05:30 PM	47	50	1780		0.9			8.19				4
G 50	Five Mile Cr	12/01/1998	01:15 PM	53	38.48	1792		0.9	119.1	12.79	7.61				2
G 50	Five Mile Cr	03/25/1999	02:25 PM		56.1	2945	1886	1.59	101.2	8.34	8.21	0.51	3.48	143.8	4.8
G 50	Five Mile Cr	04/21/1999	02:15 PM		53.8	3135	2004	1.69	115.7	1.7	8.28	0.35	24.21	160.7	2
G 50	Five Mile Cr	06/30/1999	12:35 PM	76	65.79	3527	2293	1.86	108.4	9.98	8.22	1.057	3.764	85.99	0.6
G 50	Five Mile Cr	07/23/1999	12:30 PM		76.27	4205	2734	2.23	111.5	9.1	8.1	1.344	2.784	111.9	0.1
G 50	Five Mile Cr	09/02/1999	10:30 AM	64	52	4073	2647	2.17	97.9	10.01	7.62	2.769	1.508		0.1
G 50	Five Mile Cr	10/20/1999	02:15 PM	66	49.16	3199	2080	1.7	88.8	10.03	8.22	1.6	0.4	63.6	6
G 50	Five Mile Cr	11/22/1999	09:59 AM	31	32.76	3023	1970	1.5	90.6	12.95	8.28	1.9	1.2	86.7	17.7
G 50	Five Mile Cr	02/28/2000	11:37 AM	55	33.09	2812	1830	1.4	91.9	13.07	8.12	1.4	1	85.3	175.7
G 50	Five Mile Cr	04/26/2000	03:45 PM	63	60	759	492	0.37	78.2	7.77	8.68	0.274	1.421	8.413	202.4
G 50	Five Mile Cr	05/31/2000	10:58 AM	68	62	3434	2230	1.8	122.2	11.7	8.07	1.1	1.1	60.6	6.5
G 50	Five Mile Cr	06/29/2000	11:30 AM	78	71	3672	2390	1.9	116.9	10.16	8.29	0.4	0.2	65.9	0.5
G 50	Five Mile Cr	08/28/2000	11:30 AM	80	65	4410	2870	2.4	116.6	10.8	6.94	0	1.3	42.9	0.5
G 50	Five Mile Cr	01/31/2001	10:03 AM	12	32	3000	2000	1.5	95.5	13.79	7.41	1	4	85.5	11.5
G 50	Five Mile Cr	02/08/2001	11:03 AM	35											
G 50	Five Mile Cr	03/28/2001	11:15 AM	54	40	2557	1660	1.3	86.5	11.08	8.25	0.2	0.6	33.3	48.3
G 50	Five Mile Cr	09/20/2001	01:52 AM	81	67	3300	2160	1.8	110.6	10.17	8.96	2.3	0.4	58	1
G 50	Five Mile Cr	11/29/2001	02:00 PM	39	33	3310	2200	1.7	90.3	12.9	7.81	1.25	36.7	70.5	26.9
G 50	Five Mile Cr	12/19/2001	01:42 PM	28	32.3	3240	2100	1.65	46.2	6.65	7.5	0.31	2	64.56	2.6
G 50	Five Mile Cr	05/16/2002	09:48 AM	50	50	3000	2000	1.6	120.2	13.42	8.11	0.7	0.3	51.7	5.8
			minimum	12.00	32.00	288.00	492.00	0.20	46.20	1.70	6.94	0.00	0.20	8.41	0.00
			maximum	85.00	78.08	4410.00	2870.00	2.40	122.20	13.79	8.96	2.77	36.70	160.70	272.00
			average	56.71	51.48	2698.97	2085.89	1.49	98.17	9.60	8.19	1.03	4.80	75.26	25.10
			median	55.00	51.44	3000.00	2090.00	1.60	97.90	9.98	8.22	1.03	1.36	65.90	4.00
			mode	50.00	32.18	2190.00	2000.00	1.50	90.30	#N/A	8.30	#N/A	0.40	#N/A	4.00
			samples	21.00	33.00	33.00	18.00	24.00	29.00	31.00	33.00	18.00	18.00	17.00	33.00

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (°C)	TEMP H_20 (°C)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 50b	Five Mile Cr	06/30/1999	02:00 PM		63.41	673	437	0.33	111	10.62	8.55	0.256	8.669	7.201	205
G 50b	Five Mile Cr	07/23/1999	01:45 PM		67.96	565	367	0.27	8.49	92.1	8.54	0.244	4.131	21.76	107.4
G 50b	Five Mile Cr	09/02/1999	11:40 AM	60	56	728	472	0.36	114.4	11.66	8.38	0.661	4.695		85.8
G 50b	Five Mile Cr	10/27/1999	04:10 PM	62	47	2769	1800	1.4	92	10.62	8.43	0.9	5.6	33.3	77.9
G 50b	Five Mile Cr	11/22/1999	11:43 AM	36	35.22	3198	2080	1.7	108.2	14.88	8.44	2	9.6	57.9	26.2
G 50b	Five Mile Cr	02/28/2000	01:49 PM	53	36.76	3191	2070	1.7	106.3	14.29	8.19	1.5	8.6	65.4	125.4
G 50b	Five Mile Cr	05/31/2000	11:35 AM	78	61	991	640	0.5	125.3	12.19	8.48	0.4	2.5	9	131.7
G 50b	Five Mile Cr	06/29/2000	12:00 PM	79	65	976	630	0.5	112.2	10.44	8.75	0.1	1	11.3	147.3
G 50b	Five Mile Cr	08/28/2000	12:07 PM	85	63	1105	720	0.6	93.4	8.88	7.53	0	1.7	7.8	47.6
G 50b	Five Mile Cr	02/08/2001	12:10 PM	34											
G 50b	Five Mile Cr	03/28/2001	11:48 AM	58	42.3	2907	1890	1.5	112.4	13.96	8.38	0.2	5.4	22.7	34.9
G 50b	Five Mile Cr	11/29/2001	02:20 PM	31											
G 50b	Five Mile Cr	12/19/2001	03:00 PM	29											
G 50b	Five Mile Cr	01/31/2002	11:04 AM	17											
			minimum	17.00	35.22	565.00	367.00	0.27	8.49	8.88	7.53	0.00	1.00	7.20	26.20
			maximum	85.00	67.96	3198.00	2080.00	1.70	125.30	92.10	8.75	2.00	9.60	65.40	205.00
			average	51.83	53.77	1710.30	1110.60	0.89	98.37	19.96	8.37	0.63	5.19	26.26	98.92
			median	55.50	58.50	1048.00	680.00	0.55	109.60	11.93	8.44	0.33	5.05	21.76	96.60
			mode	#N/A	#N/A	#N/A	#N/A	1.70	#N/A	10.62	8.38	#N/A	#N/A	#N/A	#N/A
			samples	12.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.00	10.00

Table G-2. Water Quality Data for the Wind River Project Area.

STATION	CREEK	DATE	TIME	TEMP AIR (^oC)	TEMP H_20 (^oC)	SPEC COND (uS/cm)	TDS (mg/L)	SALINITY (mg/L)	D.O. (%SAT.)	D.O. (mg/L)	pH (std. units)	NH_4-N (mg/L)	NO_3-N (mg/L)	CL (mg/L)	NTU (units)
G 50a	Five Mile Cr	09/28/1998	05:20 PM	75	61.52	492		0.2	104.5	8.73	8.69				38
G 50a	Five Mile Cr	10/16/1998	03:50 PM	38	46.04	788		0.4	106.9	10.33	8.55				26
G 50a	Five Mile Cr	12/02/1998	04:00 PM	52	39.74	856		0.4	144.3	15.24	8.58				11
G 50a	Five Mile Cr	03/26/1999	03:20 PM		52.2	1955	125.2	1.04	96.7	7.36	8.42	0.26	30.92	47.29	13.5
G 50a	Five Mile Cr	04/22/1999	12:00 PM		42.4	783.5	501.5	0.41	114.1	9.89	9.34	0.15	55.34	15.15	174.7
G 50a	Five Mile Cr	06/30/1999	03:15 PM	74	65.69	619	402	0.3	110.7	10.31	8.62	0.247	6.548	6.705	137.9
G 50a	Five Mile Cr	07/23/1999	02:45 PM		71.55	622	404	0.3	94.7	8.33	8.57	0.275	5.667	6.87	111.9
G 50a	Five Mile Cr	09/02/1999	01:00 PM	64	60	689	447	0.34	108.2	10.72	8.41	0.696	4.929		87
G 50a	Five Mile Cr	10/27/1999	02:20 PM		48.63	1446	940	0.7	108.3	12.4	8.67	0.7	2.2	12.2	66.5
G 50a	Five Mile Cr	11/22/1999	01:56 PM	37	39.34	1631	1060	0.8	123.8	16.11	8.82	0.9	11.1	21.1	29.1
G 50a	Five Mile Cr	12/29/1999	03:32 PM	38	32.13	1790	1160	0.9	143.2	20.77	8.52	0.7	1.8	37.2	43.5
G 50a	Five Mile Cr	02/28/2000	02:47 PM	57	43.46	1960	1270	1	106.3	13.03	8.64	1.1	10.9	27.4	74.5
G 50a	Five Mile Cr	05/31/2000	12:35 PM	78	63	753	490	0.4	125.7	11.95	8.49	0.3	2.8	4.7	96.2
G 50a	Five Mile Cr	08/28/2000	01:55 PM	85	68	815	530	0.4	103.5	9.36	8.09	0	5.1		36.7
G 50a	Five Mile Cr	02/08/2001	12:45 PM	33											
G 50a	Five Mile Cr	03/28/2001	12:50 PM	52	42.3	2907	1890	1.5	112.4	13.96	8.38	0.2	5.4	22.7	34.9
G 50a	Five Mile Cr	11/29/2001	04:00 PM	30	32.4	2100	1350	1.04	103.2	14.88	8.18	0.82	153.1	23.02	74.8
G 50a	Five Mile Cr	11/29/2001	02:20 PM	31											
G 50a	Five Mile Cr	12/11/2001	02:30 PM	32	32.07	2250	1460	1.13	116.3	16.86	8.29	0.14	18.13	34.15	11.7
			minimum	30.00	32.07	492.00	125.20	0.20	94.70	7.36	8.09	0.00	1.80	4.70	11.00
			maximum	85.00	71.55	2907.00	1890.00	1.50	144.30	20.77	9.34	1.10	153.10	47.29	174.70
			average	51.73	49.44	1320.97	859.26	0.66	113.11	12.37	8.54	0.46	22.42	21.54	62.82
			median	52.00	46.04	856.00	735.00	0.41	108.30	11.95	8.55	0.29	6.11	21.90	43.50
			mode	38.00	#N/A	#N/A	#N/A	0.40	#N/A	#N/A	#N/A	0.70	#N/A	#N/A	#N/A
			samples	7.00	6.00	6.00	6.00	7.00	6.00	6.00	6.00	7.00	6.00	6.00	6.00

Table G-3. Wyoming NPDES Permits near the WRPA.

Permit Number	County	Section	Township	Range	Facility	RWAT Description	FTypeID	ExpDate
WY0000221	Fremont	30	02N	02E	Lander Field NW Discharge	Popo Agie River (2)	13	6/30/2002
WY0000248	Fremont	10	33	96	Amoco-Beaver Creek Gas Plant	Beaver Creek (3B) via an unnamed drainage (Class 3B)	10	6/30/2007
WY0000256	Fremont	10	33	96	Beaver Creek Field Madison-Cody Battery	Beaver Creek (Class 3B), eventually trib to the Wind River	13	6/30/2007
WY0000256	Fremont	10	33	96	Beaver Creek Field Madison-Cody Battery	Beaver Creek (Class 3B), eventually trib to the Wind River	13	6/30/2007
WY0000469	Fremont	26	06N	02W	Maverick Springs Field	Blue Draw (4)	13	3/31/2002
WY0000493	Fremont	36	32	95	South Sand Draw Unit	West Fork Long Creek (4)	13	12/31/2003
WY0000621	Fremont				Tribal A-1x Lease	Five Mile Creek (2)	13	12/31/1991
WY0000779	Fremont	22	06N	02W	Maverick Springs Field	Maverick Springs Draw (4)	13	3/31/2002
WY0000795	Fremont	11	42	107	Dubois Field	Little Horse Creek (3B), eventually trib to Wind R	13	6/30/2007
WY0000809	Fremont	23	41	81	Tisdale Field Newman Facility	Thomas Creek	13	12/31/2000
WY0000922	Fremont	16	06N	02W	Maverick Springs Chatterton	Five Mile Creek (2)	13	3/31/2002
WY0000949	Fremont	6	06N	02W	Circle Ridge Battery	Coal Draw (4)	13	3/31/2002
WY0001171	Fremont	13	32	99	Dallas Pit & Fourt 4 & 5 Pits	Little Popo Agie River (Class 2AB), eventually trib to Wind R	13	6/30/2007
WY0001210	Fremont	4	31	98	Derby Field, Carmody, USA & USA CH Leases	Twin Creek (Class 2AB), eventually trib to Wind R	13	6/30/2007
WY0002003	Fremont	16	41	106	Dubois Fish Hatchery	Jakeys Fork Wind River (Class 2AB water), Wind River Basin	7	1/31/2008
WY0002062	Fremont	18	37	89	Graham Unit #10	Alkali Creek (4)	13	12/31/2003
WY0002071	Fremont	9	37	89	Graham Unit #9	Alkali Creek (4)	13	12/31/2003
WY0002089	Fremont	16	37	89	Graham Unit #5	Alkali Creek (4)	13	12/31/2003
WY0002101	Fremont	21	37	89	Graham Unit #1	Alkali Creek (4)	13	12/31/2003
WY0002194	Fremont	15	32	95	Big Sand Draw Field, Unit D	Little Sand Draw (4)	13	12/31/2003
WY0002208	Fremont	15	32	95	Big Sand Draw Field, Unit B	Little Sand Draw (4)	13	12/31/2003
WY0002216	Fremont	14	32	95	Big Sand Draw Field, Unit C	Little Sand Draw (4)	13	12/31/2003
WY0002224	Fremont	18	28	92	Crooks Gap Unit	Crooks Creek (2AB) & Claytor Irrigation Ditch (4C)	13	6/30/2007
WY0002224	Fremont	18	28	92	Crooks Gap Unit	Claytor Irrigation Ditch (4A)	13	6/30/2007
WY0003042	Fremont	35	06N	03W	NW Sheldon Dome Field, Tribal A	Dry Creek (2)	13	9/30/2002
WY0003131	Fremont	22	33	90	Lucky Mc Mine	Fraser Draw (Class 3B water), Wind River Basin	10	6/30/2008
WY0003174	Fremont	36	30	100	Atlantic City Iron Mine & Mill	Rock Creek (2)	10	12/31/2001
WY0020222	Fremont		01N	03E	Pavillion Wastewater Lagoon	Ocean Lake #6 Drain (3)	11	9/30/2003
WY0020338	Fremont	22	5N	2W	Tribal 22 Sheldon Lease	Dry Creek (2)	13	3/31/2002
WY0020389	Fremont		33	99	Lander Wastewater Lagoon	Popo Agie River (2)	11	6/30/2005
WY0020389	Fremont				Lander Wastewater Lagoon		11	6/30/2005
WY0020664	Fremont		02S	02E	Hudson Wastewater Lagoon	Popo Agie River (Class 2AB water, Wind River Basin)	11	2/28/2008
WY0020672	Fremont		01N	04E	Riverton WWTF	Wind River (Class 2AB water)	11	5/31/2008
WY0020834	Fremont		41	106	Dubois Wastewater Lagoon	Wind River (2)	11	4/30/2004
WY0021636	Fremont	9	01S	04E	Wastewater Treatment Lagoon	Little Wind River (2)	14	3/31/2005
WY0021890	Fremont		38	94	Shoshoni Wastewater Lagoons	Poison Creek (4)	11	12/31/2004

Table G-3. Wyoming NPDES Permits near the WRPA.

Permit Number	County	Section	Township	Range	Facility	RWAT Description	FTypeID	ExpDate
WY0022641	Fremont	8	28	92	Crooks Gap Field, Federal MKM	Crooks Creek (2AB), eventually trib to the North Platte R	22	6/30/2007
WY0023108	Fremont	12	01S	02W	Chief Washakie Recreation Complex	Trout Creek & Little Wind River (2)	6	6/30/2002
WY0023191	Fremont				Mill Creek School	Mill Creek (2)	14	8/31/1991
WY0024244	Fremont	4	28	93	Happy Springs Unit	Nancy Creek (2)	13	12/31/2003
WY0024244	Fremont	4	28	93	Happy Springs Unit		13	12/31/2003
WY0024252	Fremont				Salt Creek Field, Texas N Battery	Castle Creek (4)	13	12/31/1995
WY0024490	Fremont	17	28	92	Sheep Mountain Mines	Crooks Creek (Class 2AB water) via an unnamed drainage (Class 3B water), North Platte River Basin	22	6/30/2003
WY0024872	Fremont	20	02N	01W	Winkleman Dome Field Continental	Big Horn Draw (4)	13	3/31/2002
WY0024945	Fremont	27	06N	03W	Rolff Lake Unit	Dry Creek (2)	13	9/30/2002
WY0024953	Fremont	15	05N	02W	Sheldon Field	Dry Creek (2)	13	9/30/2002
WY0024961	Fremont				Arapahoe Lease	Teapot Wash (4)	13	12/31/1996
WY0025232	Fremont	18	02N	01W	Tribal A Tensleep Battery #1	Big Horn Draw (4)	13	3/31/2002
WY0025267	Fremont	13	01S	03E	Great Plains Hall Lagoon	Little Wind River Drainage (2)	6	12/31/2004
WY0025275	Fremont				Arapahoe Industrial Park	Little Wind River	6	5/31/1996
WY0025526	Fremont	20	37	89	Graham Unit #8	Alkali Creek (4)	13	12/31/2003
WY0025534	Fremont	16	37	89	Graham Unit #19	Alkali Creek (4)	13	12/31/2003
WY0025542	Fremont	17	37	89	Graham Unit #6	Alkali Creek (4)	13	12/31/2003
WY0025551	Fremont				Hoffman Lease	Trail Canyon Creek	13	12/31/1995
WY0025607	Fremont	1	05N	03W	NW Sheldon Dome Field, Sheldon Tribal Battery	Dry Creek (2)	13	9/30/2002
WY0025879	Fremont	15	03N	01W	Heslin Lease	Wind River (2) via an unnamed ditch (4)	13	3/31/2002
WY0025887	Fremont	14	28	92	Sheep Creek Field Cheyenne	Sheep Creek (2)	13	12/31/2003
WY0025950	Fremont		28	92	Big Eagle Mine	Crooks Creek (Class 2AB water), via an unnamed drainage, North Platte River Basin	10	6/30/2008
WY0027260	Fremont				Green Valley Estates WWT Plant	Wildcat Creek Drainage (4)	18	8/31/1997
WY0027456	Fremont	7	37	89	Graham Unit #15	Alkali Creek (4)	13	12/31/2003
WY0027758	Fremont				A & T Stp	Spencer Draw	4	4/30/1988
WY0028045	Fremont	25	44	110	Brooks Lake Lodge	Brooks Lake	4	9/30/2004
WY0028053	Fremont				Prenalta Government 33-31-39-6	Bridge Creek (4)	13	12/31/1992
WY0028118	Fremont				Day Loma Mine	Coyote Creek (4)	10	12/31/1995
WY0028282	Fremont		01N	04E	Gardens North WTP	Spencer Draw	4	6/30/2004
WY0028771	Fremont	8	37	89	Graham Unit #13	Alkali Creek (4)	13	12/31/2003
WY0028789	Fremont				#1-18 Federal-Thompson	Crazy Woman Creek (4)	13	12/31/1992
WY0028967	Fremont	8	01S	04E	Saint Stephens Indian School WWTF	Little Wind River (2)	14	3/31/1999
WY0028975	Fremont				Black Mountain Mine	Tongue River (2)	10	12/31/1990
WY0029041	Fremont	12	01S	02W	Ft. Washakie WTP	South Fork Little Wind River (2)	19	12/31/2004
WY0029041	Fremont	12	01S	02W	Ft. Washakie WTP		19	12/31/2004
WY0029041	Fremont	12	01S	02W	Ft. Washakie WTP		19	12/31/2004
WY0031097	Fremont	12	36	94	Davison Ranch Federal #1-12	Dry Cheyenne Creek	13	12/31/1993
WY0031461	Fremont	7	36	93	Fuller Reservoir Federal #2-7, #4-7, #5-7 #6-7	Dry Cheyenne Creek via an unnamed drainage.	13	12/31/2003
WY0031470	Fremont	13	36	94	Fuller Reservoir Federal #2-13	Dry Cheyenne Creek (4)	13	12/31/2003

Table G-3. Wyoming NPDES Permits near the WRPA.

Permit Number	County	Section	Township	Range	Facility	RWAT Description	FTypeID	ExpDate
WY0031518	Fremont	17	36	93	Fuller Reservoir Federal 886 3-17, 4-17 & 10-17	Muskrat Creek (4)	13	12/31/2003
WY0031526	Fremont	18	36	93	Fuller Reservoir Federal 193 1-17, 2-18, 4-18, 7-	Dry Cheyenne Creek (4)	13	12/31/2003
WY0031534	Fremont	18	36	93	Fuller Reservoir Federal 193 3-18, 2-19 & 4-20	Dry Cheyenne Creek (4)	13	12/31/2003
WY0031569	Fremont	18	36	93	Fuller Reservoir Federal 193 1-13, 5-13 & 5-18	Dry Cheyenne Creek (4)	13	12/31/2003
WY0031577	Fremont	18	36	93	Fuller Reservoir Federal 886 6-18	Dry Cheyenne Creek (4)	13	12/31/2003
WY0031593	Fremont				Carbon Basin Mine	Third Sand Creek drainage (4)	10	10/31/1992
WY0031941	Fremont				Wyoming Honor Farm Feedlot	Madden Draw (4)	8	4/30/1988
WY0031984	Fremont				Maverick Springs #15-13	Five Mile Creek (2)	13	5/31/1991
WY0032166	Fremont				#3-13 Federal Fuller	Dry Cheyenne Creek (4)	13	
WY0032271	Fremont	13	36	94	Fuller Reservoir Federal 6-13, 13-18 & 14-18	Dry Cheyenne Creek (4)	13	12/31/2003
WY0032280	Fremont	17	36	93	Fuller Reservoir Federal 13-17	Muskrat Creek (4)	13	12/31/2003
WY0032468	Fremont	2	01S	04E	Riverton Livestock Auction Feedlot	Wind River (2)	8	5/31/2004
WY0033294	Fremont	13	36	94	Poison Creek Federal 7-13	Dry Cheyenne Creek (4)	13	12/31/2003
WY0033308	Fremont				Shoshone Wells 2-6 And 1-7	Coal Draw (4)	13	5/31/1991
WY0033618	Fremont	14	29	100	Mary Ellen Mine	Little Beaver Creek (2AB) via Tabor Gulch (3B)	10	10/31/2006
WY0033685	Fremont				Bison Basin In-situ Rehabilita	West Alkali Creek via an unnamed drainage	10	1/31/1992
WY0033740	Fremont	5	03N	01W	Steamboat Butte North Water	Mission Lake (4)	13	6/30/2004
WY0033740	Fremont	8	03N	01W	Steamboat Butte North Water		13	6/30/2004
WY0033758	Fremont	8	03N	01W	Southern Water Injection Plant	Mission Lake (4)	13	12/21/1998
WY0033821	Fremont				Umtra Site	Little Wind River (2)	10	6/30/1992
WY0033898	Fremont	22	33	99	Popo Agie, Federal 12-23	Smith Creek (2)	13	12/31/2003
WY0033952	Fremont	8	27	91	Jackpot Mine	Fourth Creek & No Name Creek	10	8/31/2003
WY0033952	Fremont	8	27	91	Jackpot Mine	Fourth Creek & No Name Creek (2)	10	8/31/2003
WY0034207	Fremont	4	01S	04E	Riverton Sulfuric Acid Plant	Little Wind River (2)	10	11/30/2003
WY0035432	Fremont				B&B Gravel Pit	Big Goose Creek (2)	17	11/30/1997
WY0035645	Fremont	30	38	89	Moneta Hills #2	Alkali Creek (4)	22	12/31/2003
WY0035734	Fremont				Mount Rogers Field Davey	Boiler Draw (4)	13	12/31/1998
WY0035742	Fremont				Federal #22-15	Muskrat Creek (4)	13	12/31/1998
WY0035840	Fremont	28	33	95	Cenex 4-28 Federal	Big Sand Draw (4)	13	12/31/2003
WY0035866	Fremont				Glenrock No. 1 & 2 Mines	North Platte River (2)	5	2/28/2003
WY0036056	Fremont	8	29	99	Smith Gulch Placer Operation	Rock Creek (Class 2AB water) & Smith Gulch (Class 3B water)	22	6/30/2005
WY0036056	Fremont	17	29	99	Smith Gulch Placer Operation		22	6/30/2005
WY0036056	Fremont	21	29	99	Smith Gulch Placer Operation		22	6/30/2005
WY0036056	Fremont	21	29	99	Smith Gulch Placer Operation		22	6/30/2005
WY0036056	Fremont	8	29	99	Smith Gulch Placer Operation		22	6/30/2005
WY0036196	Fremont	11	38	90	Lost Cabin Gas Plant	Sand Creek (Class4B), tributary to Badwater Creek (Class 2AB). Wind River Basin.	10	3/31/2008

Table G-3. Wyoming NPDES Permits near the WRPA.

Permit Number	County	Section	Township	Range	Facility	RWAT Description	FTypeID	ExpDate
WY0036196	Fremont	12	38	90	Lost Cabin Gas Plant	Sand Creek (Class4B), tributary to Badwater Creek (Class 2AB). Wind River Basin.	10	3/31/2008
WY0036544	Fremont				Honor Farm Well Pump Test	Prison Farm Draw (4)	5	12/31/1997
WY0037028	Fremont	36	38	91	North Merrian 44-36	Reservoir Creek (3B)	22	11/30/2006
WY0043681	Fremont	16	01N	03E	Eckley Feeding	Wind River (2)	8	4/30/2006
WY0044474	Fremont	16	01S	03E	Weber Feedlot	Little Wind River (2)	8	12/31/1999
WY0044474	Fremont	21	01S	03E	Weber Feedlot		8	12/31/1999
WY0044482	Fremont	12	02S	01E	Lander Field NW Discharge	Pogo Agie River (2)	13	12/31/2004
WY0044521	Fremont				Enviro-Tech Portable WWTP		11	
WY0044539	Fremont				Ethete Water Treatment Plant		11	3/31/2005
WY0048828	Fremont	6	28	92	Bayne Federal #6-6	total containment pond (4A) eventually trib to Crooks Creek (2AB)	13	6/30/2007
WY0048828	Fremont	6	28	92	Bayne Federal #6-6	Total containment pond (4A)	13	6/30/2007
WYR101109	Fremont	32	39	90W	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2002
WYR101113	Fremont	6	38	90W	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2002
WYR101137	Fremont	36	39	90W	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2006
WYR101138	Fremont	31	39	90	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2002
WYR101139	Fremont	29	39	90	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2006
WYR101247	Fremont	30	39	90	Burlington Resources Oil and Gas	Cottonwood Creek		8/31/2002
WYR320059	Fremont				Wyomin Department of Transportation	Cottonwood Creek		3/31/2007

A Water Quality Evaluation of Five Mile and Muddy Creek Drainages near Riverton, Wyoming

Ocean Lake Drain entering Middle Five Mile Creek at North Portal Road (below site: G50a)

Prepared as part of the Wind River Indian Reservation Non-point source Assessment
by: David H. Haire and Arthur H. Shoutis
Dec. 18, 2003

(cited as WREQC. 2003. A Water Quality Evaluation of Fivemile and Muddy Creek Drainages near Riverton, Wyoming. Wind River Environmental Quality Commission)

Table of Contents

Introduction:

This report evaluates physical and chemical stream data that were collected since 1997 by the Wind River Environmental Quality Commission of the Shoshone and Arapaho Tribes. The community structure of macroinvertebrates that were collected and identified to species during 2002 and 2003 is also evaluated and interpreted. The Lower Wind River Conservation District is paying for these analyses as part of a cooperative effort.

Six sites are analyzed and each is a reflection of the water quality in the stream segment above that site. Site G50 is Upper Five Mile Creek and the data reflect the water quality in the upstream segment above this site, segment 5MC1(See Map Fig. 1). The rest of the sites also have associated stream segments upstream of them. The lowest site on both Five Mile Creek and Muddy Creek were positioned upstream form Boysen Reservoir so that lentic influences would not complicate analyses of these stream segments. In this case the stream segments continue below the sites for a little way, but the analyses should apply to these reaches also, since there are no major tributaries or potential inputs.

Each stream segment is listed and the following topics are discussed by stream section:
A. Background
B. Physical and Chemical Parameters (Rosgen measurements were not taken and are tentative, based on the BPJ of investigators.
C. Biological data (Macroinvertebrate reports and fish observations)
D. Assessment and Ranking (Tribal Classification is pending)
E. Recommendations

The ranking system was developed to help analyze potential impacts for the physical and chemical data (Appendix C). A further discussion of this system and the methods involved appears below for the individual site evaluations.

Raw data, lab bench sheets, macroinvertebrate reports and a series of biometrics, are presented for each site in Appendix B. Biometrics are chosen and discussed which best reflect the potential impairments that are expected at that site. A short discussion of macroinvertebrate methods, collection, identification and scientific rationale is also presented before the individual site analyses.

Method of Ranking

Streams on the Reservation were ranked for severity of impact by reviewing data from: long term monitoring stations (WREQC 2003) (Figure 1) and reports from various agencies including the U.S. Geological Survey (USGS 1996), the state of Wyoming 305(b) Report and 303(d) List of Impaired Waterbodies, and the Lower Wind River Natural Resources District (Haire 1999). Both a comparison of these data with proposed Tribal water quality standards and best professional judgment were used to determine the level of severity - minor, moderate, or severe for each stream segment of the watersheds.

Rating of watersheds (severity of impact) was determined by assessing the available monitoring data, the number of exceedances, the type of exceedance (threatening to aquatic life, human health/life, or both), and the assumed effect(s) on designated beneficial use(s). For example, an exceedance of a heavy metal standard may endanger both the life and health of animals and humans, thereby warranting a higher severity rating than a temperature exceedance, which endangers aquatic life, but not human life. The general ranking system is as follows:

Minor: At least four (4), but not more than nine (9) total exceedances of proposed Tribal water quality standard(s) or recommended EPA maximum concentrations; plus (at least) one other impact from a NPS category/subcategory (e.g. Flow Modification), and a riparian condition rating from the NRCS of "Functioning At Risk or Not Functioning."

Moderate: At least ten (10), but not more than twenty four (24) total exceedances of proposed Tribal water quality standard(s) or recommended EPA maximum concentrations; plus (at least) two other impacts from a NPS category/subcategory, and a riparian condition rating from the NRCS of "Functioning At Risk or Not Functioning." Single extreme readings (over or under) the standard may also result in a rating of moderate.

Severe: Twenty five (25) or more than total exceedances of proposed Tribal water quality standard(s) or recommended EPA maximum concentrations; plus (at least) one other impact from a NPS category/subcategory, and a riparian condition rating from the NRCS of "Functioning At Risk or Not Functioning." Single extreme readings (over or under) the standard may also result in a rating of Severe.

In many cases, best professional judgment was used as the determining factor in assigning the severity rating for a particular stream segment. This method was employed where available data do not indicate impairment from NPS pollution, but the stream or segment is considered impaired by Tribal staff.

Fig. 1

Fig. 2

Introduction and Background to Macroinvertebrates

Environmental Protection Agency (EPA) approved macroinvertebrate reports exist at the WREQC office and include a Sampling and Analyses Plan (SAP), a Standard Operations Procedure manual (SOP) (WREQC 2001), and a Quality Assurance and Quality Control plan (QAPP)(WREQC 2003b). A brief overview is presented here, but these documents should be consulted for details.

WREQC uses a rapid bioassessment approach (Barber, et al. 1999), but does not use the State Department of Environmental Quality (DEQ) Beneficial Use Reconnaissance Protocols (BURP). A 500u kick net is used with semi quantitative protocols. A Surber sampler is not appropriate for most reservation streams, nor is it an appropriate sampling device for these two watersheds because of the general lack of cobble substrate. (mostly Rosgen, 1996, G 4 and G5, see Appendix A, photos 2, 4, and 5 and the substrate analyses) or depths and velocities that exceed Surber sampling limits (Lower Five Mile Creek, B2,B3, Appendix A, photo 3).

A one hundred meter segment of stream is chosen and sampled by percentage of substrates /habitat with a combined sample of 20 kicks/jabs/or scrubs. The method also allows WREQC to compare wetland and lake littoral macroinvertebrates because similar methods and protocols can be used. Lastly, a kick net and the same methods can be used in the higher altitude sites, such as the headwaters of Muddy Creek. Large rocks, boulders and ledgerock dominate these sites and a Surber sampler is totally inappropriate.

A spring index period was chosen because the fauna is more completely represented in the stream at this time, instars are larger and more easily identified, samples are easier to pick because of less leaves and green and blue green alga, and biometrics are not skewed by a plethora of newly hatching instars that often is encountered in fall samples. This index period and the spring season can be followed altitudinally. (An August sample at 10,000 feet is a spring index sample) Also most trunk stream, non-point source problems are likely to be at their worst in the spring after a winter of low flows and sediment accumulations and before the spring high water events flush, clean and "reset" the system as part of a naturally occurring annual cycle.

WREQC picks their own samples to a 300 count according to standard protocols and QAQC procedures. Water Bear Consulting identified the macroinvertebrates to species level whenever possible. Where names did not exist or keys were not available Water Bear used a species number, and documented this "morpho species" with a description and many digital photos. This species level data is entered into a database, which calculates the biometrics much as the EPA/TetraTech program EDAS does. Unlike EDAS, the database can recalculate the biometrics at any higher "clumped level" and thus be compared to other lab data and also, importantly, the macroinvertebrate data is constantly updated and revised with the latest taxonomic changes. Thus the reports can easily be rerun and all reports will reflect the same, and latest taxonomic changes. These reports do not become "historical data". Most importantly, the species level of identification allows fair comparisons among benthic groups at the same taxonomic level and allows the use of species diversity indices, evenness and their ecologically based concepts.

Copies of the field data sheets, sorting and picking forms, taxonomic identifications and the biometrics that are calculated and discussed in this report are attached as Appendix B. All macroinvertebrate samples have been saved and a voucher collection was made.

The reservation has been stratified by altitude into four strata (Alpine/Subalpine, Montane, Foothills, and Basin) and an ecological apriori classification within these strata has been proposed and is being field-tested. (Shoutis, 1999b) This classification applies only to high mountain environments, their foothills, and the immediate basin drainages below these mountains. Data indicate that this stratification is much more logical and robust than using the Omernik ecoregions approach.(Omernik,1987, 1995 and USEPA, 1996) It is based on ecological principles and includes previous classifications such as Rosgen(1996), and Pennak, R. W.1966), zonation concepts such as Allan, J. D. 1995 , and importantly the River Continuum Concept of Vannote, R. L. et. al. 1980. Data also indicate that this classification is appropriate for many high mountain ranges that span and overlay portions of several, different Omernik's ecoregions Mountain aquatic fauna is similar worldwide, just as alpine plants in one ecoregion are very similar to alpine plants in another ecoregion (Hynes, H.B.N., 1970 p. 115). Both lotic and lentic ecologies fundamentally change with altitude and as such, so do the biometrics Also the potential threats to the strata change and different methods and suites of indicators should be used for evaluation. For example most of the potential threats for the higher altitudes are more global in nature. Acid precipitation is a potential threat to the granite geologies of higher altitudesbut it might be a blessing to alkali basin waters and soils.

All sites on Five Mile and Muddy Creeks are in the basin stratification. Basin sites have lower diversities than foothills sites and there is a general lack of leaf fall and coarse particulate organic matter (CPOM). This can easily be seen by the almost total absence of shredders in column IX of Fig. 2 (Highlighted in purple). The EPT index should not be used or used with extreme caution, because the Plecoptera are often replaced with Odonata and Coleoptera in basin streams and rivers. Scanning the faunal lists of Appendix A will reveal this pattern. Finer substrates, more erosion because of the sedimentary geology, higher chemical values and TDS, and increased turbidity, can all be expected in basin streams, and these naturally occurring physical and chemical parameters make it difficult to identify anthropogenic inputs in the monitoring data. These basin sites should be evaluated with these background parameters in mind and they should by no means be compared against or included with, an analysis of foothills streams.

Macroinvertebrate evaluations are performed by listing the stratification and the potential impacts that a site might encounter, and then using a suite of biometrics that are best suited to evaluate these kinds of impacts. (Hynes,H. B.N. 1966 chapter XIII) A discussion of potential complicating factors to these biometrics is performed, such as knowing the past history of the site and that it just received a recent flooding event, or knowing that the substrate accounts for a lot of the biometric variation.

Evaluation by Stream Segments

1. Upper Five Mile (Segment 5MCI) (Five Mile Creek Watershed from headwaters downstream to Site G50)

A. Background

The Five Mile Creek watershed is a narrow, linear watershed which begins in the Circle Ridge area near the center of the Reservation at an elevation of about 7,000' above sea level. In its headwaters, Five Mile Creek is dominated by oil and gas production. The produced water from these well fields provide the primary source of flow for the stream in this segment. There are several NPDES permitted discharges in this segment, all of which are oil field production facilities. There is a substantial amount of livestock grazing which occurs in this watershed segment as well.

B. Physical and Chemical

The temperature standard was exceeded 3 times. The maximum temperature recorded was 79^{o} F at Site G50.
Stratification: Basin Site
Rosgen Tentative G-4 to G-5
The average conductivity value recorded was 2,638 *u*mhos/cm. TDS values averaged 1970 mg/L (See Appendix A). The very high maximum values in chlorides, specific conductivity, and TDS are most likely associated with the produced waters of the source.

C. Biological

A significant number of amphibians and non-game fish have been observed in this segment. Mountain suckers, a sensitive species according to the Wyoming Game and Fish classification system, has been collected at the sampling site (G50), indicating that (at least) the lower portion of this segment has adequate water quality conditions to meet all designated uses. Further delineation (segmentation) may be necessary following additional data collection in the upper reaches of the segment.

Potential Sources and the Best Macroinvertebrate Biometrics to evaluate them

Potential Threats (NPS & PS)	Best Suite of Biometrics and/or species list for evaluation	Potential Complications to Interpretation
A. Oil & Gas NPDES points, produced waters	Toxic Effects: I&II Stressing but not toxic :III, IV , &V	Gypsum Springs Formation Substrate Ponds and wetlands between this point and the NPDES points?
B. Agriculture: Livestock Grazing	3III,IV,V,VII,X	Wildlife Riparian use Beaver ponds and substrate
C. Hydrologic Modification: Flow Regulation	I, and look for higher Diptera and other temporary stream fauna.	3 rd year of drought

A. Richness and density indicate that the benthic fauna is not being impacted by any of the potentially toxic effects associated with produced waters (heavy metals, H_2S, no oxygen, etc). This may be occurring closer to the NPDES points however.

Although diversity is not a good indicator of toxicity it is a good indicator of stress because of decreasing water quality such as sulfates. Both diversity indices of III and V are highlighted in red in Fig. 2, and indicate that there are potential impacts from the produced waters that might be stressing the benthic community structure at this site. Evenness values of II are also low and confirm community stress. A comparison with other sites that have gravel, sand, silt, and mud substrates indicate that this is not just a phenomenon of the finer substrates.

Back ground sulfate levels are high in the basin and are associated with the Gypsum Springs formation. It is suspected that the waters nearer the NPDES discharge points are much higher than these background levels, but that will have to be tested.

The number of, and ecologies of any settling ponds and wetlands between our sample point and the NPDES discharges will have a great influence on deciding whether the lower diversity is because of these point sources.

B. The low values of X indicate that grazing and wildlife are probably not an issue at this site. It can be seen in both streams that the numbers of filter feeders increase in the down stream direction, indicating that there is more of an influence at the lower sites and that these non-point source impacts can be accumulative in the down stream direction.

The macroinvertebrate collections were far enough below any beaver dams that there was probably no influence of the dams (tail water effects) on the macroinvertebrate community structure.

C. Hydrological Flow Modification. Low or intermittent flows could account for the low diversity, and the temperature exceedances that were discovered. The absence of higher diptera and the good richness values indicate that the stream has probably not dried up and the drought or any intermittent flows are not the cause of the low diversity values. Discharges are low enough that the beaver ponds could slow the water enough that it warms up, and this could easily create temporary high temperatures readings.

D. Assessment

NPS categories include “Hydrologic Modification: Flow Regulation,” “Agriculture: Livestock Grazing” and “Other: Unknown/Natural.”

This segment was assigned a Severity Rating of “Severe” due to a total of 62 exceedances of the temperature, conductivity, nitrate, and TDS standards. The NRCS also determined that the riparian area is “Functional, At Risk.” Low benthic diversity and evenness values also support this evaluation.

E. Recommendations A water quality site should be established closer to the NPDES sources on upper Five Mile Creek to help evaluate the effects of the produced water. A field survey of both upper Five Mile and upper Muddy Creeks for beaver ponds, wetlands and/or reservoirs that might help settle and mitigate produced water effects would also be useful.

2. Middle Five Mile (Segment 5MC2) (Five Mile Creek from Site G50 to site G50b)

A. Background.
Immediately below site G50b, the Ocean Lake Drain empties into Five Mile Creek. The drain discharges from a 4' diameter culvert and is often flowing in excess of 100 cubic feet per second (cfs). This volume will often double or triple the flow of the creek downstream from this point. Livestock grazing and wildlife riparian use dominate this segment.

B. Physical and Chemical
The middle monitoring station (G50b) is characterized by a sand to muddy bottom and a wide, shallow incised channel The stream is more incised with steeper banks than 5MC1 and there are often Russian olive or other small trees sloughed off from the steep eroded banks that end up partially or fully in the water. Beaver may also contribute to this.
Stratification: Basin Site
Rosgen Tentative G4 to G5
It is easily seen from the mean chemical values in Appendix A that the influence of the produced waters is much less in this segment since it is also much further downstream. The specific conductivity, TDS, Salinity, and Cloride values are significantly less. Chemical values associated with increased grazing and wildlife riparian use are all up including turbidity, and nitrates. Mean turbidity in particular, jumps from 26.5 NTU's to 203.1 NTU's.

C. Biological
Fish were observed but not collected or identified.

Potential Sources and the Best Biometrics to Evaluate Them

Potential Threats (NPS & PS)	**Best Suite of Biometrics and/or site species list evaluation**	**Potential Complications to Interpretation**
A. Oil & Gas NPDES points, produced waters	Toxic Effects: 1&2 Stressing but not toxic: III, IV, & V	Gypsum Springs Formation Substrate Ponds and wetlands between this point and the NPDES points?
B. Agriculture: Livestock Grazing	III,IV,V,VII,X	Wildlife Riparian use Beaver ponds and substrate
C. Hydrologic Modification: Flow Regulation/low flow	I, and look for higher Diptera and other temp stream fauna.	3 rd year of drought

A. This stream segment is very similar to the first segment 5MC1, except that it is much further from the NPDES oil and gas discharge points. This is reflected by the return of the diversity and evenness values to higher level and supports the hypothesis that the community structure is being affected at 5MC1 by oil and gas produced water.
B. The steady increase in filter feeders is reflected in X, the orange highlighted number. This reflects the steady downstream accumulative affects of riparian grazing and wildlife use that is typically seen in very dry landscapes.

C. Low flows are the same as 5MC1 and probably not a factor at this site.

D. Assessment
State Classification: 2AB
Tribal Classification: Pending
This stream segment is rated as moderate, with 9 exceedances in temperature, conductivity, TDS, and nitrates.

E. Recommendations It is difficult to separate out natural erosion form that caused by riparian use, but efforts to control erosion and overgrazing in the riparian areas should continue.

3. Lower Five Mile(5MC3) (Site G50b downstream to site G50 a and Boysen Reservoir)

A. Background
Five Mile Creek changes drastically, from a moderately turbid, gravel bottomed stream to one with very high turbidity and a cobble to small boulder sized substrate. This is caused by the augmentation of flow provided by the canal. Farther downstream in the drainage there is considerable amounts of irrigation return flow entering the channel. These waters are generally higher in TDS and turbidity. Monitoring data at the lower station (G50a) reflect these changes.

B. Physical and Chemical.
Several other irrigation return flow channels enter the creek below the middle monitoring station and above its mouth at Boysen Reservoir. These drainages include Sand Gulch and several unnamed draws and gulches. The USGS has determined that the Five Mile Creek watershed is a larger contributor than the Wind River to the sediment loading of Boysen Reservoir (USGS 1996). This estimate is surprising, but not unexpected considering that the Five Mile watershed is subject to a huge volume of irrigation return flows and augmentation from the Ocean Lake Drain. These two sources result in the stream downcutting more than 20 feet into the terrain and thus increasing the in-channel sediment load which is subsequently transported to Boysen Reservoir.

The average conductivity value recorded was 1,101 *u*mhos/cm, with a maximum value of 2,970 *u*mhos/cm. TDS values averaged 847mg/L, to a very high of 1,890 mg/L. The maximum nitrate value recorded was 153.1 mg/L, the highest level recorded on the Reservation.
The NRCS determined that the riparian area is "Functional, At Risk."
Stratification: Basin Site
Rosgen: Tentative B2 to B3

C. Biological
Fish have not been observed in the lower segment of Five Mile Creek, but this might be because of the very high flows and turbidities obscure observation.

Potential Sources and the Best Biometrics to Evaluate Them

Potential Threats (NPS & PS)	**Best Suite of Biometrics and/or site species list evaluation**	**Potential Complications to Interpretation**
A. Agriculture: Livestock Grazing	III, IV, V, VII, X	Wildlife Riparian use
B. Agriculture: crop production	III, IV, V, VII, X	Substrate, turbidity, high flow
C. Hydrologic Modification: Flow Regulation/high flows	VII	

A. There is a steady increase in filter feeders that is reflected in X, the green highlighted number.

B. Both diversity indices and evenness are below desired levels. The likely causes are the very high inputs of nutrients from agricultural farming practices and probably winter cattle feeding operations, especially the very high nitrate levels that were recorded and the very high TDS values.. The history of Ocean Lake and the tremendous efforts and projects to arrest eutrophication processes occurring in the lake support this as a likely cause.

The macroinvertebrate data alone are rather inconclusive because of the complications in interpretation that were listed. One would expect the N, P, and K nutrients to produce a heavy increase in algae and macrophytes, with a resulting decrease in scrapers and increase gather/collectors. This is not observed because of the complicating factors of high flows, highly turbid waters and the resulting substrate changes. The high flows were not natural and the stream is still down cutting, with no meanders or pools. Smaller substrates have been removed. There is a tremendous load of erosional material from the steep banks but because of the high velocities it stays in suspension and is deposited further down stream where the flows dissipate as the waters hit Boysen Reservoir and become lentic.

The high flows make it difficult for any higher plants to attach, and the highly turbid waters block the light so it is a difficult habitat for any photosynthetic organisms. In the shallow water however, where there is sufficient light, there was an abundance of algae on the larger more stable rocks and ledges. These algae were not identified, but appear to be adapted to the swift water with hold fast organs. The cleaner, algae free rock and ledge rock substrates of the deeper water in this stream segment also reflect the high velocities, and turbidities. As can be seen in VII, the scraper numbers were very high on these deeper cleaner rock substrates, especially when compared to the other sites. Similarly, in VIII, there was a significant decrease in gatherer/collectors, especially when compared to the other sites. These are very likely substrate affects, which dominate and mask the high nutrient loading affects.

C. The same comments that were written above in section B. apply here to the increased flows.

D. Assessment

NPS categories include “Hydrologic Modification: Flow Regulation,” “Agriculture: Livestock Grazing, Crop Production” and “Other: Unknown/Natural.”

The Tribal staff has assigned an impairment status for the cold-water fisheries use. This determination is based on review of historical USGS data, as well as more recent Tribal Program chemical and field physical parameter data and reconnaissance level physical habitat assessment. Macroinvertebrate impairments confirm this evaluation and assessment.

This segment was assigned a Severity Rating of “Severe” due to a total of 26 exceedances of the temperature, conductivity, pH, nitrate, and TDS standards.

State Classification: 2AB
Tribal Classification: Pending

E. Recommendations

Monitor winter feeding operations in the tributary streams such as Sand Draw.
Continue to fund and implement control measures and BMP's designed to reduce excess irrigation run-off.
Continue this as a monitoring trend site to see if new practices improve the water quality in the future or if it degrades further.
Use additional evaluation tools such as bacteria and fish monitoring at this site

4. Upper Muddy Creek (MuC1)(Muddy Creek Watershed - from headwaters downstream to site G52)

A. Background
The Muddy Creek watershed begins on the south facing slopes of the Owl Creek Mountains at an elevation of nearly 10,000' above sea level. In the uppermost portions of this segment, Muddy Creek is a perennial mountain stream with a channel substrate comprised of boulders and cobbles. There are reported populations of wild trout in this section. From the edge of the foothills of the Owl Creek Mountains, the creek turns to the east-southeast, flowing toward Boysen Reservoir. In the basin portion of this segment, the stream becomes an intermittent or ephemeral channel, with considerable numbers of beaver ponds. Throughout this segment, livestock grazing/rangeland is the primary land use, although there are some areas of oil and gas production. Near the sampling site (G52), the stream is mostly perennial, with some intermittent sections.

B. Physical and Chemical
Stratification: Basin Site
Tentative Rosgen C4 or C5
The NRCS determined that the riparian area is "Functional, At Risk" in the upper reaches of this segment and "Not Functioning" in the lower reaches. "Not Functioning" is the lowest possible rating for riparian health."
The average conductivity value recorded was 2,124 *u*mhos/cm, with a maximum value of 3,995 *u*mhos/cm. TDS values averaged 1,514 mg/L, with a maximum value of 2,600 mg/L recorded. High average values for specific conductance, chlorides, and TDS suggest that there may be some produced water affect in Upper Muddy but they appear to be less than the affects seen in upper Five Mile Creek.

PS categories include NPDES oil and gas and produced water.
NPS categories include "Hydrologic Modification: Flow Regulation," "Agriculture: Livestock Grazing" and "Other: Unknown/Natural."

C. Biological

Fish have been observed in the immediate area of the sampling site, however, only nongame fish have been captured and identified.

Potential Sources and the Best Biometrics to Evaluate Them

Potential Threats (NPS & PS)	Best Suite of Biometrics and/or site species list evaluation	Potential Complications to Interpretation
A. Oil & Gas NPDES points,	Toxic Effects: I&II	Gypsum Springs Formation

produced waters	Stressing but not toxic :III, IV , &V	Substrate Ponds and wetlands between this point and the NPDES points?
B. Agriculture: Livestock Grazing	III,IV,V,VII,X	Wildlife Riparian use Beaver ponds and substrate
C. Hydrologic Modification: Flow Regulation	I, and look for higher Diptera and other temp. Stream fauna.	3 rd year of drought

A. Richness and density (I & II) indicate that the benthic fauna is not being impacted by any of the potentially toxic effects associated with produced waters (heavy metals, H_2S, no oxygen, etc). This may be occurring closer to the NPDES points however.

This stream segment is a bit different from 5MC1 in that there are mountain headwaters associated with this watershed. Dilution with these mountain waters may be why the diversity and evenness values (III-IV) do not show impairment from the produced waters. Another hypothesis is that the produced waters don't reach the stream as they do in Five Mile. A more thorough investigation of this stream segment, as in Five mile, would be beneficial.

B. This stream follows an almost identical pattern of increasing filter feeders in the down stream direction (X of Fig. 1, colors blue, orange, green), and indicates worsening riparian conditions and increasing grazing pressures in the down stream direction. This seems to be in agreement with the riparian report

C. Hydrological Flow Modification. Low or intermittent flows are possible in this segment, and temperature exceedances were reported. The absence of higher diptera and the good richness values (I) indicate that the stream has probably not dried up totally. Discharges are low enough and the beaver ponds could slow the water enough that it warms up, and this could easily account for the high temperatures readings. The high percentage of Oligochates may be a reflection of the small partial beaver dams that were in the sampling reach. (see notes on field sheet)

D. Assessment
Based upon historical USGS data, Tribal Program chemical and physical field parameter data, and reconnaissance level physical habitat assessments, this segment is assigned an impairment status of threatened, with a qualifier of insufficient data for the cold water fisheries designated use. The Tribal Program intends to collect additional information on the biota and physical habitat within this segment in order to accurately determine its impairment status.

This segment was assigned a Severity Rating of "Severe" due to a total of 42
exceedances of the temperature, conductivity, pH, nitrate, and TDS standards.
State Classification: 2AB
Tribal Classification: Pending

E. Recommendations
A Survey for native species should be conducted in the very high montane reaches.
A water quality site should be established closer to the NPDES sources on Muddy Creek to help evaluate the effects of the produced water.

A field survey of both upper Five Mile and upper Muddy Creeks for beaver ponds, wetlands and/or reservoirs that might help settle and mitigate produced water effects would also be useful.

5. Middle Muddy Creek (MuC2) (Segment from site G52 to site G52b)

A. Background Middle
A comparison with Middle Five Mile Creek is very interesting since both have potential affects from produced water in their upper reaches.

B. Physical and Chemical
Muddy is a smaller stream than Five Mile, with less slope, and not as incised.
Stratification: Basin Site
Tentative Rosgen C4 to C5 (sections may warrant a G4 to G5 rating) and actual map and field measurements are needed.

Like Middle Five Mile, the Middle reaches of Muddy show a significant decrease in chlorides, specific conductivity, and TDS and is perhaps because of an increase in the distance from the NPDES points. Also like Middle Five Mile Creek, there in an increase in turbidities but to a much lesser extent probably due to the lesser slope, lower incised banks, and decreased flows. Unlike Middle Five Mile there is a decrease in average Nitrates from the upper reaches from 3.9 to .57. This is unexpected and unexplained. It is perhaps because of more beaver ponds and/or less riparian grazing, but these hypotheses will need more data such as grazing allotment numbers before we can interpret this number. Dilution from the higher montane reaches is also a likely hypothesis.

C. Biological

Potential Sources and the Best Biometrics to Evaluate Them

Potential Threats (NPS & PS)	**Best Suite of Biometrics and/or site species list evaluation**	**Potential Complications to Interpretation**
A. Oil & Gas NPDES points, produced waters	Toxic Effects: 1&2 Stressing but not toxic: III, IV, & V	Gypsum Springs Formation Substrate Ponds and wetlands between this point and the NPDES points?
B. Agriculture: Livestock Grazing	III,IV,V,VII,X	Wildlife Riparian use Beaver ponds and substrate
C. Hydrologic Modification: Flow Regulation/low flow	I, and look for higher Diptera and other temp stream fauna.	3 rd year of drought

A. This stream segment is very similar to the first segment and 5MC2. It is also much further from the NPDES oil and gas discharge points. This is reflected by the high richness value in I and the improving diversity value in III.

B. The steady increase in filter feeders is reflected in X, the orange highlighted number.

C. Same as 5MC1 and probably not a factor.

D. Assessment
This segment was assigned a moderately impacted status because of the 14 exceedances in temperature, TDS, conductivity, and Nitrates.

E. Recommendations
Maintain beaver populations as they may be lowering turbidities and sediment.
Continue to implement BMPs and control riparian grazing.

6. Lower Muddy Creek (MuC3)(Muddy Creek Watershed - from Site G52b downstream to site G52a and Boysen Reservoir)

A. Background
This segment of Muddy Creek is similar to the lower segment of Five Mile Creek (5MC2) described above. It also is subject to augmented flows from the Wyoming Canal and has a channel, which has down cut into the terrain, in some instances up to 20 feet deep. Unlike Lower Five Mile there is a small secondary flood plain that is vegetated. Also, unlike the rock, cobble, and boulder substrate sizes of lower Five Mile Creek, the substrate size is generally gravel and a smaller size. The substrate is probably a result of lower flows, less slope, and a more developed, and vegetated flood plain within the incised area.

B. Physical and Chemical
There are some substantial irrigation return flows into this segment, but nothing approaching the volumes which Ocean Lake Drain supplies to Five Mile Creek. The substrate is considerably smaller (gravel, sand, and mud). Turbidity levels with an average of 146.2 NTU's, are very high and even higher than those found in lower Five Mile Creek and much higher than Middle Muddy, the site just above this one. This is a bit surprising but could be the result of improved land status because of the irrigation and land leveling activities associated with intense crop production such as corn and sugar beets that is found in lower Five Mile.

The NRCS determined that the riparian area is "Not Functioning" in the lower reaches. "Not Functioning" is the lowest possible rating for riparian health."

Rosgen: tentative G4 or G5
Statification: Basin Site

The maximum temperature recorded was 76^{o}F. The average conductivity value recorded was 1,405 *u*mhos/cm, with a maximum value of 2,781 *u*mhos/cm. TDS values averaged 950 mg/L, with a maximum recorded value of 1,810 mg/L. These values are very similar to those recorded for Middle Muddy Creek.

C. Biological
The physical habitat does not appear capable of supporting a viable fish population**.** No fish were seen but the high turbidities could account for this.

Very high E. coli levels were discovered during the USGS NAQUA monitoring. The State has put this section of stream on the State 303d list because of this data. These high levels are probably due to the fact that this riparian corridor provides the only water in a very arid landscape and both cattle and wildlife are drawn and concentrated here.

Macroinvertebrates:

Potential Sources and the Best Biometrics to Evaluate Them

Potential Threats (NPS & PS)	Best Suite of Biometrics and/or site species list evaluation	Potential Complications to Interpretation
A. Agriculture: Livestock Grazing	III, IV, V, VII, X	Wildlife Riparian use Beaver ponds and substrate
B. Hydrologic Modification: Flow Regulation/high flow	VII	3 rd year of drought

A. Lower Muddy is very different from Lower Five Mile. As mentioned above, the flows, velocities and gradient are less and a flood plain is developing. This allows for finer substrates. The other big difference is that there is hardly any crop production in this watershed, compared to the Five Mile watershed. Taxa richness (I), and the diversity and evenness values were all high (III-V). The low density values of II are more difficult to explain but could be a result of both the finer substrates and the high turbidity of the water. (Again, little or no photosynthesis and primary production)(See Appendix C and notes on field sheet about turbidity). The steady increase in filter feeders is reflected in X, the green highlighted number.

B. High flows do not appear to be impacting this site as they are in lower Five Mile, but high turbidity could be a factor in less production and fewer macroinvertebrates.

The third year of a drought is very difficult to assess. It could potentially mean less water in the upper reaches but possibly more water in these lower reaches because of increased irrigation. A more thorough investigation of the stream gauge discharge data would be necessary before conclusions such as this could be reached.

D. Assessment

NPS categories include “Hydrologic Modification: Flow Regulation,” “Agriculture: Livestock Grazing” and “Other: Unknown/Natural.”

Based upon historical USGS data, Tribal Water Quality Program chemical and physical field parameter data, and reconnaissance level physical habitat assessment data, this segment is assigned an impaired status, with a qualifier of insufficient data for the cold-water fisheries designated use. Based upon additional fish data collection, it may be determined that the cold water fisheries designation is inappropriate.

This segment was assigned a Severity Rating of “Severe” due to a total of 21 exceedances of the temperature, conductivity, pH, nitrate, and TDS standards. Mostly, the high turbidities and the high E. coli values account for this status.

State Classification**:** 2AB This segment is on the State 303d list for impairment because of E. coli.

Tribal Classification: Pending

E. Recommendations

The fish community, or the lack of a fish community, should be evaluated and the classification of this segment as 2AB should be reconsidered when the new data is taken.

The riparian area should be restored so that it is at least partially functioning again. These very high turbidities in this lower section are probably, and mostly, a function of natural erosion, but any new grazing BMP's that can be implemented will help. Every effort should be made to keep the cattle out of this non-functioning riparian zone, but this will be difficult to achieve.

The very high bacteria levels should continue to be monitored and are not an immediate concern to this stream segment where there is little or no recreation, but they are a very high concern for Boysen Reservoir (a State Park), because of high amount of recreation that takes place there.

7. Cottonwood Creek Watershed

The Cottonwood Creek watershed begins in the Owl Creek Mountains at elevations around 8,000' above sea level. The numerous tributaries flow directly south out of the mountains and turn east to converge and then flow into Boysen Reservoir. It is reported that some tributaries have perennial portions in the uppermost reaches of the watershed, however, the lower portions are entirely ephemeral and intermittent. The Tribal Water Quality Program has not collected any water quality data within this watershed; thus there are insufficient data for assigning an impairment status to this watershed. The watershed was not assessed for this report.

Summary of Conclusions and Recommendations

1. Water quality sites should be established closer to the NPDES sources on upper Five Mile Creek and Upper Muddy Creek to help evaluate the effects of the produced water. A survey of both upper Five Mile and upper Muddy Creeks for beaver ponds, wetlands and/or reservoirs that might help settle and mitigate produced water effects would also be useful.

2. The headwaters of upper Muddy Creek that are in the montane strata should be evaluated for native species

3. We applaud the efforts of the "Save Ocean Lake Committee" and all of the agencies involved in the eutrophication mitigation efforts that have already taken place around Ocean Lake. However, the data suggest that agricultural eutrophication is still a very large problem in Lower Five Mile Creek below the Ocean Lake Drain. Grazing and agricultural BMPs should continue to be implemented. Efforts should continue to minimize excess agricultural run off water that contribute to the very high discharges and erosional down cutting that is occurring in this section

4. An evaluation of the very high nitrates in Lower Five Mile should be made. Since these values were mostly recorded in early winter and early spring they could be related to winter cattle feeding operations. This should be kept in mind when the evaluation is done.

5. Fisheries data on both streams is desirable so that proper water quality classifications can be made.

6. Restore Lower Muddy Creek's riparian area

7. Continue to be monitor bacteria in lower Muddy Creek. This should include the shoreline areas of Boysen Reservoir next to the mouth of this creek. Recreation in this section of the reservoir should be monitored and if both the e. coli values are high and there is significant recreation, then this section of the reservoir should be posted with warning signs so that public can take proper precautions..

8. The NRCS, the Lower Wind River Conservation District and the Wind River Environmental Quality Commission should continue to work cooperatively. The District could easily fund WREQC technicians to collect data from both the reservation and the shared streams segments. This seems logical since WREQC already has the equipment, staff and monitoring skills in place. We would further recommend that agencies without large mapping and GIS capabilities utilize the excellent facilities and expert staff that works in that department. All could work together on securing 319 funds and working on restoration projects, BMPs, etc.

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WREQC 2001 Standard Operating Proceedures for Collecting Macroinvertebrates on the Wind River Indian Reservation.

APPENDIX H
WETLAND INVENTORY FOR THE WRPA

Appendix H. Classification of Wetland Areas Identified on NWI Maps within the WRPA.

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Pavillion Quad.			
Sec. 8 T3N R2E	PEMA	3	Unnamed Wetlands
	PEMC	3	Unnamed Wetlands
	PEMCx	1	Unnamed Irrigation Ditch
	PEMCh	1	Unnamed Wetland
	R4SBCx	1	Unnamed Irrigation Ditch
	P $^{EM}/^{US}$ Ad	1	Unnamed Wetland
Sec. 9 T3N R2E	R4SBCx	2	Pavillion Main Lateral/Unnamed Ditches
	PEMC	8	Unnamed Wetlands/Drainages
	PSSC	1	Unnamed Wetland
	PEMCh	1	Unnamed Wetland
	PEMAh	1	Unnamed Wetland
	PABGh	1	Unnamed Wetland
	P $^{SS}/^{EM}$ A	1	Unnamed Wetland
Sec. 17 T3N R2E	PEMA	3	Unnamed Wetlands
	PEMC	24	Unnamed Wetlands
	PEMAd	1	Unnamed Wetland
	PUSA	1	Unnamed Wetland
	PEMCx	1	Unnamed Drainage
	PEMF	1	Unnamed Wetland
	R4SBCx	1	Unnamed Irrigation Ditch
Sec. 15 T3N R2E	PEMA	2	Unnamed Drainages
	PEMC	6	Unnamed Wetlands & Ditches
	PEMCx	1	Unnamed Drainage to Pavillion Main Lateral
	PABF	1	Unnamed Wetland
	R4SBCx	2	Unnamed Ditches
	P $^{EM}/^{SS}$ A	1	Unnamed Wetland
	PEMB	1	Unnamed Wetland
Sec. 16 T3N R2E	PEMA	4	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMC	2	Unnamed Wetlands
	PEMCx	2	Unnamed Drainages/Ditches
	R4SBCx	2	Pavillion Main Lateral/Unnamed Ditches
	P AB/EM F	1	Unnamed Wetland
Sec. 20 T3N R2E	PEMC	24	Unnamed Wetlands/Drainages
	PEMA	6	Unnamed Wetlands
	PEMCx	2	Unnamed Ditches
	PSSC	2	Unnamed Wetlands
	P $^{AB}/^{EM}$ F	3	Unnamed Wetlands
Sec. 21 T3N R2E	PEMC	9	Unnamed Wetlands
	PEMCx	2	Unnamed Ditches
	PSSC	1	Unnamed Wetland
	P $^{AB}/^{EM}$ F	1	Unnamed Wetland
	P $^{AB}/^{EM}$ Pn	1	Unnamed Wetland
	R3SBCx	1	Unnamed Drainage
	PEMB	3	Unnamed Wetlands
	PEMA	7	Unnamed Wetlands
Sec. 22 T3N R2E	PEMA	2	Unnamed Wetlands
	PEMC	6	Unnamed Wetlands
	P $^{EM}/^{SS}$ A	1	Unnamed Wetland
	R4SBCx	1	Unnamed Drainage
Pavillion Butte Quad.			
Sec. 16 T4N R2E	PUSCh	1	Unnamed Wetland
Sec. 17 T4N R2E	PUSCh	1	Unnamed Wetland
	R4SBA	1	Unnamed Drainage
Sec. 20 T4N R2E	R4SBA	1	Unnamed Drainage
Sec. 21 T4N R2E	PABFh	2	Unnamed Wetlands
	PUSCh	1	Unnamed Drainage
	R4SBA	3	Unnamed Drainages
	R4SBFx	1	Wyoming Canal
	R4SBCx	1	Unnamed Drainage

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 22 T4N R2E	R4SBFx	1	Wyoming Canal
	PEMC	1	Unnamed Drainage
Sec. 27 T4N R2E	R4SBFx	1	Wyoming Canal
	PEMC	4	Unnamed Wetlands
	PEMCd	2	Unnamed Wetlands
	PEMCx	3	Unnamed Drainages
	PABF	1	Unnamed Wetland
	PUSC	1	Unnamed Wetland
	PABFh	1	Unnamed Wetland
Sec. 28 T4N R2E	R4SBCx	2	Unnamed Drainages
	R4SBFx	1	Wyoming Canal
	PEMC	6	Unnamed Wetlands
	PEMA	1	Unnamed Wetland
	PEMCx	3	Unnamed Drainages
	PEMAd	1	Unnamed Wetland
Sec. 29 T4N R2E	R4SBFx	1	Wyoming Canal
	PEMC	4	Unnamed Wetlands
	PEMCd	4	Unnamed Wetlands
	PEMCx	1	Unnamed Drainage
	PSSC	3	Unnamed Drainages
	R4SBCx	1	Unnamed Drainage
	PSSCd	1	Unnamed Wetland
	P $^{SS}/^{EM}$ C	2	Unnamed Wetlands
	R4SBF	1	Fivemile Creek
Sec. 32 T4N R2E	PEMC	7	Unnamed Wetlands
	PEMA	2	Unnamed Wetlands
	P $^{SS}/^{EM}$ C	2	Unnamed Wetlands
	R4SBCx	1	Unnamed Drainage
	PEMCd	1	Unnamed Wetland
	PSSC	2	Unnamed Wetlands
	R4SBF	1	Fivemile Creek

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMCx	2	Unnamed Drainages
Sec. 33 T4N R2E	$P^{SS/EM}C$	1	Unnamed Wetland
	PEMA	5	Unnamed Wetlands
	PSSC	1	Unnamed Wetland
	PEMC	5	Unnamed Wetlands/Drainages
	PEMCx	1	Unnamed Drainage
	PFOA	1	Unnamed Wetland
	R4SBF	1	Fivemile Creek
Sec. 34 T4N R2E	PEMC	4	Unnamed Wetlands
	PEMCx	2	Unnamed Drainages
	PSSC	1	Unnamed Wetland
	$P^{EM/US}A$	1	Unnamed Wetland
Sec. 5 T3N R2E	PEMA	8	Unnamed Wetlands
	PEMC	6	Unnamed Wetlands/Drainages
	PEMCd	1	Unnamed Wetland
	R4SBCx	1	Tributary of Fivemile Lateral
	PEMCx	3	Tributaries of Fivemile Lateral
	$P^{SS/EM}C$	1	Unnamed Drainage
	$P^{EM/US}A$	1	Unnamed Wetland
	PUSC	1	Unnamed Drainage
	PEMF	2	Unnamed Wetlands
	PABFx	1	Unnamed Wetland
Sec. 4 T3N R2E	PSSC	4	Unnamed Wetlands
	PEMC	8	Unnamed Wetlands
	R4SBCx	2	Fivemile Lateral/Tributaries to Lateral
	R4SBF	1	Fivemile Creek
	$P^{EM/US}A$	1	Unnamed Wetland
	PEMCx	2	Tributaries to Fivemile Lateral
Sec. 3 T3N R2E	R4SBCx	3	Unnamed Ditch/Tributary to Fivemile Lateral/Fivemile Lateral
	R4SBF	1	Fivemile Creek
	PEMC	7	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PSSC	3	Unnamed Wetlands
Sec. 8 T3N R2E	PEMB	2	Unnamed Wetlands
	PEMCx	1	Pavillion Main Lateral
	R4SBCx	1	Extension of Five Mile Lateral
	PEMCd	1	Unnamed Wetland
	PEMC	3	Unnamed Wetlands
	PABFx	2	Unnamed Wetlands
	PEMA	3	Unnamed Wetlands
Sec. 9 T3N R2E	PEMC	4	Unnamed Wetlands
	R4SBCx	2	Fivemile Lateral/Trib. to Fivemile Lateral
Sec. 10 T3N R2E	R4SBCx	2	Fivemile Lateral/Trib. to Fivemile Lateral
Harris Bridge Quad.			
Sec. 1 T4N R2E	PEMC	3	Unnamed Wetlands
	R4SBFx	1	Wyoming Canal
	P $^{SS}/^{EM}$ C	1	Muddy Creek
	P $^{EM}/^{SS}$ C	1	Unnamed Drainage
Sec. 6 T4N R3E	P $^{EM}/^{SS}$ C	1	Unnamed Wetland
	R4SBFx	1	Wyoming Canal
	PEMC	1	Unnamed Wetland
	PSSC	1	Unnamed Wetland
Sec. 11 T4N R2E	R4SBFx	1	Wyoming Canal
	PEMCx	1	Unnamed Canal
	R4SBCx	2	Unnamed Canals
	PEMC	1	Unnamed Wetland
Sec. 12 T4N R2E	R4SBCx	3	Unnamed Canals
	P $^{SS}/^{EM}$ C	1	Muddy Creek
	PEMC	3	Unnamed Drainages
	PEMA	1	Unnamed Wetland
	PEMCx	1	Tributary to Wyoming Canal
	PABFx	1	Unnamed Wetland
	PSSC	1	Muddy Creek

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 7 T4N R3E	PEMCx	2	Tributaries to Muddy Creek
	PSSC	4	Unnamed Wetlands
	R4SBF	1	Muddy Creek
	PEMA	1	Unnamed Wetland
	PEMC	1	Unnamed Wetland
Sec. 8 T4N R3E	R4SBF	1	Muddy Creek
	P $^{SS}/^{EM}$ C	2	Muddy Creek/Tributary to Muddy Creek
	PEMC	7	Tributaries to Muddy Creek
	PEMCx	2	Tributary to Muddy Creek/Tributary to Wyoming Canal
Sec. 9 T4N R3E	PEMC	17	Unnamed Wetlands/Drainages to Muddy Creek
	PSSC	2	Tributaries to Muddy Creek
	P $^{SS}/^{EM}$ C	3	Unnamed Wetlands of Muddy Creek
	PABFx	1	Unnamed Wetland
	R4SBFx	1	Wyoming Canal
Sec. 10 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMCx	2	Tributaries to Wyoming Canal/Muddy Creek
	PEMC	6	Unnamed Drainages
Sec. 14 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMCx	1	Lateral to Wyoming Canal
	PEMC	1	Unnamed Wetland
Sec. 13 T4N R2E	R4SBFx	1	Wyoming Canal
	R4SBCx	1	Unnamed Ditch
	PABFx	1	Unnamed Wetland
	PEMC	3	Unnamed Wetlands
Sec. 18 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMC	3	Unnamed Wetlands
	PEMA	2	Unnamed Wetlands
	R4SBCx	1	Unnamed Drainage
	PABFx	1	Unnamed Drainage

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 17 T4N R3E	PEMA	5	Unnamed Wetlands
	PEMC	6	Unnamed Wetlands
	PEMCx	1	Unnamed Drainage
	PABFx	1	Unnamed Wetland
Sec. 16 T4N R3E	PEMC	13	Muddy Creek/Tributary to Muddy Creek/Unnamed Wetlands
	R4SBF	1	Muddy Creek
	PABFx	1	Unnamed Wetland
	PEMCx	1	Unnamed Drainage
	PEMA	1	Unnamed Wetland
	PSSC	1	Muddy Creek
Sec. 15 T4N R3E	PEMC	11	Muddy Creek/Tributaries to Muddy Creek
	PEMCx	1	Drainage to Wyoming Canal
	PUSCh	1	Unnamed Wetland
	PEMF	1	Unnamed Wetland
	P $^{EM}/^{SS}$ C	4	Muddy Creek/Unnamed Wetlands
	PEMA	1	Muddy Creek
Sec. 19 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMC	5	Unnamed Wetlands
	PUSA	1	Unnamed Wetland
	PSSC	1	Unnamed Wetland
	R4SBCx	1	Unnamed Drainage
	PEMB	1	Unnamed Wetland
Sec. 20 T4N R3E	R4SBCx	1	Unnamed Drainage
	PEMCx	2	Unnamed Drainages
	PEMA	1	Unnamed Wetland
	PEMC	4	Unnamed Wetlands
	PUSAh	1	Unnamed Wetland
	PABFx	1	Unnamed Drainage
Sec. 21 T4N R3E	PEMCx	3	Unnamed Drainages
	PEMC	6	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	P ^{EM}/^{SS} A	2	Unnamed Wetlands
	PABFx	1	Unnamed Wetland
	PSSA	2	Unnamed Wetlands
	PEMA	4	Unnamed Wetlands
Sec. 22 T4N R3E	PEMC	6	Unnamed Wetlands/Muddy Creek
	PSSC	3	Muddy Creek
	P ^{EM}/^{SS} C	3	Muddy Creek
	PEMA	5	Unnamed Wetlands
	PEMF	1	Unnamed Wetland
	PSSA	2	Unnamed Wetlands
	PEMCx	1	Unnamed Drainage
Sec. 27 T4N R2E	R4SBFx	1	Wyoming Canal
Sec. 26 T4N R2E	R4SBFx	2	Wyoming Canals
	PEMC	1	Unnamed Wetland
	R4SBCx	1	Lateral of the Wyoming Canal
Sec. 30 T4N R3E	R4SBFx	3	Wyoming Canals
	PUSCx	1	Unnamed Wetland
	PEMFx	1	Muddy Ridge Canal
Sec. 29 T4N R3E	R4SBCx	1	Lateral of the Wyoming Canal
Sec. 28 T4N R3E	R4SBCx	1	Lateral of the Wyoming Canal
	PEMCx	3	Laterals of the Wyoming Canal
	PEMA	2	Unnamed Wetlands
	PEMC	1	Unnamed Wetland
	PUSCx	1	Unnamed Wetland
	PUSAh	1	Unnamed Wetland
	PEMF	1	Unnamed Wetland
Sec. 27 T4N R3E	PEMA	6	Unnamed Wetlands
	PEMCx	4	Unnamed Drainages
	R4SBCx	1	Lateral of the Wyoming Canal
	PEMC	4	Unnamed Wetlands
	PSSA	1	Unnamed Wetland

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 34 T4N R2E	PEMCx	3	Unnamed Drainages
Sec. 35 T4N R2E	PEMCx	5	Unnamed Drainages
	R4SBCx	1	Lateral of the Wyoming Canal
	R4SBFx	1	Wyoming Canal
	PEMC	4	Unnamed Wetlands/Drainages
	PEMCd	2	Unnamed Wetlands
	PEMA	5	Unnamed Wetlands
	PEMAd	2	Unnamed Wetlands
	PEMF	1	Unnamed Wetland
Sec. 36 T4N R2E	R4SBFx	1	Wyoming Canal
	PEMC	7	Unnamed Wetlands/Drainages
	PEMA	7	Unnamed Wetlands/Drainages
	PFDA	1	Unnamed Wetland
	PEMF	4	Unnamed Wetlands
	PEMCx	1	Unnamed Drainage
Sec. 31 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMCx	6	Unnamed Drainages
	PEMC	4	Unnamed Wetlands
	P $^{FO}/^{SS}$ A	1	Unnamed Wetland
	PEMA	1	Unnamed Wetland
Sec. 32 T4N R3E	P $^{FO}/^{SS}$ A	2	Unnamed Wetlands/Drainages
	PUSCh	1	Unnamed Wetland
	PEMFx	1	Unnamed Drainage
	PABFx	1	Unnamed Wetland
Sec. 34 T4N R3E	R4SBCx	1	Lateral of the Wyoming Canal
	PUSCx	1	Unnamed Wetland
	PEMCx	2	Unnamed Drainages
Sec. 3 T3n R2E	PEMC	1	Unnamed Wetland
	PEMCx	2	Unnamed Drainages
	PEMF	1	Unnamed Wetland
	R4SBCx	3	Tributaries of Fivemile Creek

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 2 T3N R2E	PEMA	2	Unnamed Wetlands
	R4SBCx	3	Tributaries of Fivemile Creek
	R4SBF	1	Fivemile Creek
	PEMC	4	Unnamed Wetlands
	PEMCx	2	Unnamed Drainages
	PABF	1	Unnamed Wetland
	PEMF	1	Unnamed Wetland
Sec. 1 T3N R2E	PEMF	1	Unnamed Wetland
	PEMCx	2	Unnamed Drainages
	R4SBCx	1	Tributary of Fivemile Creek
	PEMA	1	Unnamed Wetland
	PEMC	1	Unnamed Wetland
Sec. 6 T3N R3E	PEMCx	7	Unnamed Drainages
	PEMC	4	Unnamed Wetlands
Sec. 5 T3N R3E	PEMCx	1	Unnamed Drainage
	PEMC	1	Unnamed Wetland
	PEMA	3	Unnamed Wetland
Sec. 4 T3N R3E	PEMA	1	Unnamed Wetland
	PEMCx	1	Unnamed Drainage
Sec. 3 T3N R3E	PEMCx	1	Unnamed Drainage
Sec. 10 T3N R2E	R4SBCx	1	Fivemile Main Lateral
Sec. 11 T3N R2E	R4SBF	1	Fivemile Creek
	PSSC	3	Wetlands of Fivemile Creek
	R4SBCx	1	Fivemile Main Lateral
	PEMC	1	Unnamed Wetland
Sec. 12 T3N R2E	R4SBCx	1	Fivemile Main Lateral
	R4SBF	1	Fivemile Creek
	PEMC	7	Unnamed Wetlands/Drainages
	PSSC	7	Unnamed Wetlands of Fivemile Creek
	P $^{EM}/^{SS}$ C	1	Unnamed Wetland
Sec. 7 T3N R3E	PEMC	6	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMA	1	Unnamed Wetland
	R4SBF	1	Fivemile Creek
	R4SBCx	1	Unnamed Drainage
	PEMCx	2	Unnamed Drainages
Sec. 8 T3N R3E	PEMCx	1	Unnamed Drainage
	PEMC	5	Unnamed Wetlands
	PEMA	2	Unnamed Wetlands
	PEMF	2	Unnamed Wetlands
Ocean Lake Quad.			
Sec. 10 T3N R2E	PEMC	1	Unnamed Drainage
Sec. 11 T3N R2E	R4SBCx	1	Lateral of the Pavillion Drain
Sec. 12 T3N R2E	R4SBCx	1	Fivemile Main Lateral
Sec. 13 T3N R2E	R4SBCx	4	Pavillion Drain & Lateral/Pavillion Main Lateral & Sublateral
	PEMC	4	Unnamed Wetlands/Drainages
	PEMA	5	Unnamed Wetlands/Drainages
SEC. 14 T3N R2E	R4SBCx	3	Pavillion Drain & Lateral/Pavillion Main Lateral
	PEMC	3	Unnamed Wetlands
	PEMA	3	Unnamed Wetlands
	PEMAd	1	Unnamed Wetland
Sec. 15 T3N R2E	PEMA	2	Unnamed Wetlands
	PEMC	4	Unnamed Wetlands/Drainages
	PEMB	1	Unnamed Wetland
	R4SBCx	1	Pavillion Main Lateral
	PABFh	1	Unnamed Wetland
Sec. 22 T3N R2E	PEMB	2	Unnamed Wetlands
	PEMC	1	Unnamed Wetland
	R4SBCx	2	Unnamed Drainages
Sec. 23 T3N R2E	PEMC	3	Unnamed Drainage/Wetlands
	PEMCd	2	Unnamed Wetlands
	PEMAd	3	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	R4SBCx	5	Unnamed Drainages
Sec. 24 T3N R2E	R4SBCx	5	Unnamed Drainages
	PEMAd	2	Unnamed Wetlands
	PEMAd	1	Unnamed Wetland
	PEMC	1	Unnamed Wetland
	PEMA	1	Unnamed Wetland
Sec. 7 T3N R3E	PEMC	1	Unnamed Wetland
	R4SBCx	2	Unnamed Drainage & Fivemile Main Lateral
	R4SBF	1	Fivemile Creek
	PSSC	1	Unnamed Wetland
Sec. 8 T3N R3E	PSSC	4	Wetlands of Fivemile Creek
	R4SBF	1	Fivemile Creek
	PEMC	2	Unnamed Wetland/Drainage
	PEMF	2	Unnamed Wetlands
	PEMA	1	Unnamed Wetland
	PEMCx	1	Unnamed Wetland
Sec. 9 T3N R3E	PEMA	1	Wetland of Fivemile Creek
	R4SBF	1	Fivemile Creek
Sec. 10 T3N R3E	PEMA	1	Tributary to Fivemile Creek
	PABFh	1	Unnamed Wetland
	P $^{EM}/^{US}$ Ah	1	Unnamed Wetland
Sec. 18 T3N R3E	PEMA	1	Unnamed Wetland
	PEMC	1	Unnamed Drainages
	R4SBCx	3	Fivemile Main Lateral/Pavillion Main Lateral/Unnamed Drainage
	PEMCx	1	Pavillion Drain
Sec. 17 T3N R3E	R4SBCx	1	Fivemile Main Lateral
	PEMC	9	Unnamed Wetlands/Drainages
	PEMCx	1	Pavillion Drain
Sec. 16 T3N R3E	R4SBF	1	Five Mile Creek
	PSSC	7	Wetlands of Fivemile Creek

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	R4SBCx	1	Fivemile Main Lateral
	PEMA	5	Unnamed Wetlands
	PEMC	2	Unnamed Wetlands
	PEMCx	2	Pavillion Drains
	P $^{AB}/^{EM}$ F	1	Unnamed Wetland
Sec. 15 T3N R3E	R4SBF	3	Fivemile Creek & Associated Wetlands
	PSSC	4	Wetlands of Fivemile Creek
	PEMC	2	Unnamed Wetland/Drainage
	R4SBCx	1	Fivemile Main Lateral
	P $^{SS}/^{EM}$ C	1	Wetland of Fivemile Creek
Sec. 20 T3N R3N	R4SBCx	1	Pavillion Main Lateral
Sec. 19 T3N R3E	R4SBCx	2	Pavillion Main Lateral & Sub-lateral
	PEMC	3	Unnamed Drainage
Sec. 21 T3N R3E	PEMC	2	Pavillion Drain/Unnamed Wetland
	PEMA	6	Unnamed Wetlands
	R4SBCx	1	Pavillion Main Lateral
	PEMCx	2	Pavillion Drain & Sub-lateral
Sec. 22 T3N R3E	PEMC	3	Pavillion Drain & Unnamed Wetlands
	PEMB	1	Unnamed Wetland
	R4SBCx	1	Pavillion Main Lateral
Mexican Pass SW Quad.			
Sec. 10 T4n R3E	R4SBA	1	Unnamed Drainage
	PEMC	1	Unnamed Drainage
	PEMCx	1	Unnamed Drainage
Sec. 11 T4N R3E	PEMC	9	Unnamed Wetlands/Drainages
	PEMCx	4	Unnamed Drainages
	R4Sba	1	Unnamed Drainage
	P $^{EM}/^{US}$ A	2	Unnamed Wetlands
	PEMA	5	Unnamed Wetlands
Sec. 12 T4N R3E	PEMA	3	Unnamed Wetlands
	PUSAh	1	Unnamed Wetland

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMC	1	Unnamed Wetland
	PUSCh	1	Unnamed Wetland
	P $^{EM}/^{US}$ A	1	Unnamed Wetland
	PEMC	1	Unnamed Drainage
Sec. 13 T4N R3E	PEMF	2	Unnamed Wetlands
	PEMCx	5	Unnamed Drainages
	PEMC	24	Unnamed Wetlands/Drainages
	PEMA	19	Unnamed Wetlands
	PSSCx	1	Unnamed Drainage
	P $^{EM}/^{SS}$ C	1	Unnamed Wetland
	PEMB	4	Unnamed Wetlands
Sec. 14 THN R3E	PEMC	18	Unnamed Wetlands/Drainages
	R4SBFx	1	Wyoming Canal
	PEMB	6	Unnamed Wetlands
	P $^{EM}/^{SS}$ C	2	Unnamed Wetlands
	PEMA	4	Unnamed Wetlands
	PABFx	1	Unnamed Wetland
	PEMCx	2	Unnamed Drainages
Sec. 15 T4N R3E	R4SBFx	1	Wyoming Canal
	PEMCx	1	Unnamed Drainage
Sec. 22 T4N R3E	PEMC	2	Unnamed Wetlands
	PSSC	1	Unnamed Wetland
	PEMF	1	Unnamed Wetland
Sec. 23 T4N R3E	PSSC	11	Unnamed Wetlands/Drainages
	PEMC	19	Unnamed Wetlands/Drainages
	PEMCx	1	Tributary to Muddy Creek
	R4SBF	1	Muddy Creek
	PEMF	1	Unnamed Wetland
	P $^{EM}/^{SS}$ C	3	Unnamed Wetlands
	PabFh	2	Unnamed Wetlands
Sec. 24 T4N R3E	PEMC	23	Unnamed Wetlands/Drainages

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMB	7	Unnamed Wetlands
	PEMCx	3	Unnamed Drainages
	R4SBFx	1	Wyoming Canal
	PEMA	5	Unnamed Wetlands/Drainages
Sec. 25 T4N R3E	PEMC	5	Unnamed Wetlands/Drainages
	PEMCx	3	Tributaries of Muddy Creek
	R4SBF	1	Muddy Creek
	P $^{SS}/^{EM}$ C	2	Wetlands of Muddy Creek
	PSSC	4	Wetlands of Muddy Creek
	R4SBA	1	Wetland of Muddy Creek
	PEMA	2	Unnamed Wetlands
Sec. 26 T4N R3E	PSSC	5	Wetlands of Muddy Creek
	P $^{SS}/^{EM}$ C	1	Unnamed Wetland
	R4SBF	1	Muddy Creek
	PEMCx	1	Tributary of Muddy Creek
Sec. 27 T4N R3E	PEMCx	1	Tributary of Muddy Creek
Sec. 34 T4N R3E	PEMCx	1	Unnamed Drainage
	R4SBCx	1	Unnamed Drainage
Sec. 35 T4N R3E	PEMCx	3	Unnamed Drainages
	PEMC	7	Unnamed Wetlands
	PEMA	4	Unnamed Wetlands
	R4SBCx	1	Unnamed Drainage
Sec. 36 T4N R3E	PEMCx	2	Tributaries of Muddy Creek
	PEMC	13	Unnamed Wetlands/Drainage
	PEMA	10	Unnamed Wetlands
Sec. 7 T4N R4E	PEMC	3	Unnamed Wetlands/Drainage
Sec. 8 T4N R4E	PEMC	2	Unnamed Wetlands
	PEMA	2	Unnamed Wetlands
	R4SBF	1	Drainage to Cottonwood Creek
Sec. 9 T4N R4E	R4SBF	1	Drainage to Cottonwood Creek
Sec. 10 T4N R4E	R4SBF	1	Drainage to Cottonwood Creek

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMA	1	Unnamed Wetland
	PEMC	3	Unnamed Drainages
Sec. 11 T4N R4E	PEMC	3	Unnamed Drainages
	R4SBFx	1	Wyoming Canal
Sec. 14 T4N R4E	R4SBFx	1	Wyoming Canal
	PEMC	1	Unnamed Drainage
	PEMA	1	Unnamed Drainage
	PABFx	2	Unnamed Wetlands
Sec. 15 T4N R4E	R4SBFx	1	Wyoming Canal
	PEMC	2	Unnamed Wetland/Drainage
Sec. 16 T4N R4E	R4SBFx	1	Wyoming Canal
Sec. 17 T4N R4E	R4SBC	1	Tributary to Cottonwood Creek
	PEMC	5	Unnamed Wetland & Tributaries of Cottonwood Creek
	PEMA	1	Unnamed Wetland
Sec. 18 T4N R4E	PEMA	11	Unnamed Wetland/Drainages
	PEMC	15	Unnamed Wetlands/Drainages
	PEMF	4	Unnamed Wetlands
	P $^{EM}/_{US}$ A	2	Unnamed Wetlands
	PABFh	2	Unnamed Wetlands
	R4SBC	1	Tributary to Cottonwood Creek
Sec. 19 T4N R4E	PEMC	26	Unnamed Wetlands/Drainages
	PEMF	2	Unnamed Wetlands
	PEMA	1	Unnamed Wetland
	P $^{EM}/_{SS}$ C	1	Unnamed Wetland
Sec. 20 T4N R4E	PEMC	12	Unnamed Wetlands/Drainages
	PEMA	6	Unnamed Wetlands
	R4SBFx	2	Wyoming Canal/Badger Wasteway
Sec. 21 T4N R4E	R4SBFx	2	Wyoming Canal/Badger Wasteway
	PEMC	2	Unnamed Wetlands
Sec. 22 T4N R4E	R4SBFx	2	Badger Wasteway/Cottonwood Drain

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	L2ABG	1	State Wildlife Management Area Upper Reservoir
	P $^{EM}/_{SS}$ C	2	Wetland of the Upper Reservoir
	PEMC	2	Unnamed Wetland & Wetland of the Upper Reservoir
Sec. 23 T4N R4E	R4SBCx	1	Cottonwood Drain
Sec. 26 T4N R4E	R4SBF	1	Muddy Creek
	PEMC	2	Unnamed Wetlands
Sec. 27 T4N R4E	R4SBF	1	Muddy Creek
	PEMC	1	Unnamed Wetland
	PSSC	4	Wetlands of Muddy Creek
	PEMA	1	Unnamed Wetland
Sec. 28 T4N R4E	PSSC	8	Wetlands of Muddy Creek
	PEMA	1	Wetland of Muddy Creek
	R4SBF	1	Muddy Creek
Sec. 29 T4N R4E	R4SBF	1	Muddy Creek
	PSSC	5	Wetlands of Muddy Creek
	P $^{EM}/_{SS}$ C	2	Wetlands of Muddy Creek
	PEMC	11	Unnamed Wetlands/Drainages
	PEMA	3	Unnamed Wetlands/Drainage
	PEMCx	2	Tributaries of Muddy Creek
	PEMB	1	Unnamed Wetland
	PABFx	1	Unnamed Wetland
	PUSCx	1	Unnamed Wetland
Sec. 30 T4N R4E	R4SBF	1	Muddy Creek
	PEMC	15	Unnamed Wetlands/Drainages
	P $^{EM}/_{SS}$ C	2	Wetlands of Muddy Creek
	PEMCx	2	Tributaries of Muddy Creek
	PEMA	2	Unnamed Wetlands
	PSSC	1	Unnamed Wetland
Sec. 31 T4N R4E	R4SBF	1	Muddy Creek
	PEMC	25	Unnamed Wetlands/Drainages

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PSSC	1	Wetland of Muddy Creek
	PEMA	3	Unnamed Wetlands/Drainage
Sec. 32 T4N R4E	R4SBF	1	Muddy Creek
	PEMC	2	Wetlands of Muddy Creek
	PSSC	3	Wetlands of Muddy Creek
	PEMA	1	Unnamed Drainage
	P $^{EM}/_{SS}$ C	2	Wetlands of Muddy Creek
	P $^{EM}/_{SS}$ C	1	Wetlands of Muddy Creek
	PUSCh	1	Unnamed Wetland
Sec. 33 T4N R4E	R4SBF	1	Muddy Creek
Sec. 34 T4N R4E	P $^{EM}/_{SS}$ C	1	Unnamed Wetland
Sec. 3 T3N R3E	PEMCx	1	Unnamed Drainage
Mexican Pass SE Quad.			
Sec. 11 T4n R4E	R4SBFx	1	Wyoming Canal
	PEMA	1	Unnamed Wetland
Sec. 12 T4N R4E	R4SBFx	1	Wyoming Canal
	PEMC	1	Unnamed Wetland
	PEMCx	2	Unnamed Drainages
	PEMA	1	Unnamed Wetland
Sec. 13 T4N R4E	PEMCx	1	Unnamed Drainage
	PEMA	7	Unnamed Wetlands
	PEMC	4	Unnamed Wetlands
	PUSC	1	Unnamed Wetland
	R4SBCx	1	Cottonwood Drain
	PEMAd	2	Unnamed Wetlands
	PABFx	1	Unnamed Wetland
	P $^{US}/_{EM}$ C	1	Unnamed Wetland
	PEMFx	1	Unnamed Wetland
	L2USA	1	Wetland of State Wildlife Management Area Middle Reservoir
Sec. 14 T4N R4E	PEMC	1	Unnamed Wetland

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	PEMA	4	Unnamed Wetlands/Drainage
	PABF	1	Unnamed Wetland
	PEMF	1	Unnamed Wetland
	PABFx	1	Unnamed Wetland
	$P\ ^{AB}/_{EM}\ F$	1	Unnamed Wetland
Sec. 23 T4N R4E	PEMC	7	Wetlands of Cottonwood Drain
	PEMA	3	Wetlands of Cottonwood Drain
	PEMCx	1	Tributary of Cottonwood Drain
	PEMFx	1	Unnamed Wetland
	$P\ ^{AB}/_{EM}\ F$	1	Wetland of Cottonwood Drain
	$P\ ^{SS}/_{EM}\ C$	1	Unnamed Wetland
	R4SBCx	1	Cottonwood Drain
	PUSC	1	Unnamed Wetland
Sec. 24 T4N R4E	PEMA	4	Wetlands of Cottonwood Drain
	PUSC	3	Unnamed Wetlands
	R4SBCx	1	Cottonwood Drain
Sec. 25 T4N R4E	$P\ ^{SS}/_{EM}\ C$	9	Wetlands of Muddy Creek
	PSSC	1	Wetland of Muddy Creek
	PEMC	7	Wetlands of Muddy Creek
	R4SBF	1	Muddy Creek
Sec. 26 T4N R4E	R4SBF	1	Muddy Creek
	$P\ ^{SS}/_{EM}\ C$	5	Wetlands of Muddy Creek
	PSSC	3	Wetlands of Muddy Creek
	PEMA	3	Wetlands of Muddy Creek/Unnamed Wetland
	PEMA	1	Unnamed Wetland
Sec. 36 T4N R4E	PEMC	2	Wetlands of Muddy Creek
	R4SBF	1	Muddy Creek
Sec. 7 T4N R5E	R4SBF	5	Tributaries of Cottonwood Creek
	PEMC	13	Tributaries of Cottonwood Creek
	PEMA	2	Unnamed Wetlands
	PEMB	3	Unnamed Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	P $^{EM}/_{SS}$ B	1	Unnamed Wetland
	PUBFx	1	Unnamed Wetland
	R4SBFx	1	Wyoming Canal
Sec. 8 T4N R5E	R4SBA	4	Tributaries of Cottonwood Creek
	PEMC	17	Tributaries of Cottonwood Creek
	P $^{EM}/_{SS}$ C	1	Unnamed Wetland
	PABFx	1	Unnamed Wetland
	PEMA	2	Unnamed Wetlands
	R4SBFx	1	Wyoming Canal
Sec. 9 T4N R5E	R4SBA	1	Tributary of Cottonwood Creek
	PEMC	30	Tributaries of Cottonwood Creek
	PUSCh	1	Unnamed Wetland
	PEMA	11	Unnamed Wetlands
	P $^{EM}/_{SS}$ C	1	Unnamed Wetland
	R4SBFx	1	Wyoming Canal
Sec. 10 T4N R5E	PEMC	17	Tributaries of Cottonwood Creek
	P $^{EM}/_{US}$ A	1	Unnamed Wetland
	P $^{EM}/_{US}$ Ah	1	Unnamed Wetlands
	PEMCh	1	Unnamed Wetland
	R4SBA	2	Unnamed Drainages
	PEMA	4	Unnamed Wetlands
	PABFh	1	Unnamed Wetland
Sec. 15 T4N R5E	PEMC	10	Unnamed Wetlands/Drainages
	PABFh	1	Unnamed Wetland
	P $^{EM}/_{SS}$ B	1	Unnamed Wetland
	P $^{SS}/_{EM}$ C	1	Unnamed Wetland
	PEMB	1	Unnamed Wetland
	PEMCx	1	Unnamed Drainage
	P $^{EM}/_{US}$ A	1	Unnamed Wetland
	PEMA	8	Unnamed Wetlands
	R4SBFx	2	Unnamed Drainages

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	R4SBFx	1	Wyoming Canal
	PEMAd	1	Unnamed Wetland
	PUBFx	1	Unnamed Wetland
Sec. 16 T4N R5E	R4SBFx	1	Wyoming Canal
	PEMCx	1	Tributaries of Cottonwood Drain
	$P\ ^{SS}/_{EM}\ C$	2	Unnamed Wetlands
	$P\ ^{SS}/_{EM}\ A$	1	Unnamed Wetland
	PEMA	7	Unnamed Wetlands
	PEMC	8	Unnamed Wetlands/Drainages
	R4SBCx	1	Unnamed Drainage
	PABFx	1	Unnamed Wetland
Sec. 17 T4N R5E	PEMCx	2	Unnamed Drainages
	PABFx	2	Unnamed Wetlands
	$P\ ^{SS}/_{EM}\ C$	2	Unnamed Wetland
	$P\ ^{SS}/_{EM}\ A$	2	Unnamed Wetlands
	PEMC	2	Wetlands of Middle Reservoir
Sec. 18 T4N R5E	L2USA	1	Wetland of Middle Reservoir
	L1UBH	1	Middle Reservoir
	L2UBF	1	Wetland of Middle Reservoir
	PEMF	1	Wetland of Middle Reservoir
	PEMC	3	Wetlands of Middle Reservoir
	PEMA	1	Wetland of Middle Reservoir
	PABFx	1	Unnamed Wetland
	$P\ ^{SS}/_{EM}\ A$	2	Unnamed Wetlands
	PEMCx	2	Unnamed Wetlands
Sec. 19 T4N R5E	PEMA	11	Unnamed Wetlands
	PUSCh	1	Unnamed Wetland
	$P\ ^{EM}/_{US}\ Ah$	1	Unnamed Wetland
	PEMC	2	Wetlands of Middle Reservoir
	L2ABFx	1	Unnamed Wetland
	R4SBCx	1	Cottonwood Drain

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
Sec. 20 T4N R5E	PABFx	1	Wetland of Middle Reservoir
	PEMC	4	Wetlands of Middle Reservoir
	R4SBCx	1	Cottonwood Drain
	PEMA	1	Unnamed Wetland
Sec. 21 T4N R5E	PEMA	4	Unnamed Wetlands
	PEMC	3	Unnamed Wetlands
	PEMCx	1	Cottonwood Drain
	PUBFx	1	Unnamed Wetland
	PABFx	1	Unnamed Wetland
	P $^{SS}/_{EM}$ C	1	Unnamed Wetland
Sec. 22 T4N R5E	PUBFx	2	Unnamed Wetlands
	PEMCx	1	Unnamed Drainage
	PEMA	2	Unnamed Wetlands
	PUSC	1	Unnamed Wetland
	PEMC	3	Unnamed Wetlands
	PABG	1	Unnamed Wetland
Sec. 27 T4N R5E	R4SBCx	1	Cottonwood Drain
	R4SBC	1	Lateral of Cottonwood Drain
	PEMA	2	Unnamed Wetlands
	PEMF	1	Unnamed Wetland
	P $^{EM}/_{US}$ A	1	Unnamed Wetland
Sec. 28 T4n R5E	PEMCx	1	Cottonwood Drain
Sec. 30 T4N R5E	PEMC	2	Muddy Creek Wetlands
	R4SBF	1	Muddy Creek
Sec. 31 T4N R5E	PEMC	2	Muddy Creek Wetlands
	P $^{SS}/_{EM}$ C	6	Muddy Creek Wetlands
	P $^{US}/_{EM}$ Ah	1	Unnamed Wetland
	PSSC	3	Muddy Creek Wetlands
	PEMA	3	Muddy Creek Wetlands
	R4SBF	1	Muddy Creek
Sec. 32 T4N R5E	PSSC	6	Muddy Creek Wetlands

Legal Description	Classification	No. of Sites	Drainage, Wetland or Reservoir Name
	R4SBF	1	Muddy Creek Wetland
	PEMC	1	Muddy Creek Wetland
	P $^{SS}/_{EM}$ C	2	Muddy Creek Wetlands
	R4SBF	1	Muddy Creek
Sec. 33 T4N R5E	P $^{SS}/_{EM}$ C	1	Muddy Creek Wetland
	PEMC	8	Muddy Creek Wetlands
	PEMA	2	Unnamed Wetlands
	R4SBF	1	Muddy Creek
Sec. 34 T4N R5E	R4SBF	1	Muddy Creek
	PEMC	6	Muddy Creek Wetlands
	PEMA	1	Muddy Creek Wetlands
	P $^{SS}/_{EM}$ C	1	Muddy Creek Wetlands

APPENDIX I
WILDLIFE

WILDLIFE SPECIES REPORTED IN THE WRPA
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Table I-1. Status of Mammals, Birds, Amphibians, Reptiles, and Fish in Wind River Project Area from Wyoming Game and Fish Department 1999.

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Mammals			
Badger *(Taxidea taxus)*	FB	No	Resident/Common
Beaver (*Castor canadensis)*	FB	Yes	Resident/Common
Big Brown Bat (*Eptesicus fuscus)*	NG SSC3	No	Unknown/Common
Bighorn Sheep (*Ovis canadensis)*	BG	No	Resident/Common
Bison *(Bos bison)*	N/A	No	Resident/Rare
Black Bear (*Ursus americanus)*	TG	No	Resident/Common
Black-footed Ferret *(Mustela nigripes)*	NG SSC1 Endangered	No	Resident/Rare
Bobcat (*Lynx rufus)*	FB	Yes	Resident/Common
Bushy-tailed Woodrat (*Neotoma cinerea)*	NG	No	Resident/Common
California Myotis *(Myotis californicus)*	NG	No	Unknown/Unknown
Coyote (*Canis latrans)*	PD	Yes	Resident/Common
Deer Mouse *(Peromyscus maniculatus)*	NG	Yes	Resident/Abundant
Desert Cottontail (*Sylvilagus auduboni)*	SG	No	Resident/Common
Dusky Shrew (*Sorex monticolus)*	NG	No	Resident/Common
Eastern Red Bat *(Lasiurus borealis)*	NG	No	Summer Resident/Rare
Eastern Fox Squirrel *(Sciurus niger)*	SG	No	Resident/Common
Elk (*Cervus elaphus)*	BG	Yes	Resident/Common

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Gray Fox (*Urocyon cinereogenteus)*	NG	No	Resident/Rare
Gray Wolf (*Canis lupus*)	PD Endangered	No	Resident/Uncommon
Grizzly Bear (*Ursus arctos*)	TG Threatened	No	Resident/Rare
Hoary Bat (*Lasiurus cinereus*)	NG	No	Summer Resident/Rare
House Mouse (*Mus musculus)*	NG	No	Resident/Common
Least Chipmunk (*Tamias minimum)*	NG	Yes	Resident/Abundant
Little Brown Myotis (*Myotis lucifugus*)	NG SSC3	No	Unknown/Common
Long-eared Myotis *(Myotis evotis)*	NG SSC2	No	Unknown/Uncommon
Long-legged Myotis (*Myotis volans)*	NG SSC2	No	Unknown/Unknown
Long-tailed Weasel *(Mustela frenata)*	FB	No	Resident/Common
Masked Shrew *(Sorex cinereus)*	NG	No	Resident/Common
Long-tailed Vole (*Microtus longicaudus)*	NG	No	Resident/Common
Marten (*Martes americana)*	FB	No	Resident/Uncommon
Meadow Vole *(Microtus pennsylvanicus)*	NG	No	Resident/Common
Mink (*Mustela vison)*	FB	No	Resident/Common
Moose (*Alces alces)*	BG	No	Resident/Common
Montane Vole (*Microtus montanus)*	NG	No	Resident/Common
Mountain (Nuttall's)Cottontail (*Sylvilagus nuttallii)*	SG	No	Resident/Common
Mountain Lion *(Felis concolor)*	TG	No	Resident/Uncommon

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Mule Deer (*Odocoileus hemionus)*	BG	Yes	Resident/Common
Muskrat (*Ondata zibethicus)*	FB	Yes	Resident/Common
Northern Flying Squirrel (*Glaucomys sabrinus)*	NG	No	Resident/Uncommon
Northern Grasshopper Mouse (*Onychomys leucogaster)*	NG	No	Resident/Common
Northern Pocket Gopher *(Thomomys talpoides)*	NG	No	Resident/Common
Olive-backed Pocket Mouse (*Perognathus fasciatus)*	NG	No	Resident/Common
Ord's Kangaroo Rat (*Dipodomys ordii)*	NG	No	Resident/Common
Pallid Bat *(Antrozous pallidus)*	NG SSC2	No	Summer Resident/Rare
Pika *(Ochotona princeps)*	NG	No	Resident/Common
Porcupine (*Erethizon dorsatum)*	PD	No	Resident/Common
Prairie Vole (*Microtus ochrogaster)*	NG	No	Resident/Common
Pronghorn (*Antilocapra americana)*	BG	Yes	Resident/Common
Raccoon *(Procyon lotor)*	PD	No	Resident/Common
Red Fox (*Vulpes vulpes)*	PD	No	Resident/Common
Red Squirrel (*Tamiasciurus hudsonicus)*	SG	Yes	Resident/Common
River Otter *(Lutra canadensis)*	NG	Yes	Resident/Uncommon
Silver-haired Bat (*Lasionycteris noctivagans)*	NG	No	Unknown/Uncommon

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Short-tailed (Ermine) Weasel (*Mustela erminea)*	FB	No	Resident/Uncommon
Southern Red-backed Vole (*Clethrionomys gapperi)*	NG	No	Resident/Common
Spotted Bat (*Euderma maculatum)*	NG SSC2	No	Summer Resident/Rare
Spotted Ground Squirrel (*Spermophilus spilosoma)*	NG	No	Resident/Rare
Striped Skunk (*Mephitis mephitis)*	PD	Yes	Resident/Common
Swift Fox (Vulpes velox)	NG SSC3	No	Resident/Common
Thirteen-lined Ground Squirrel (*Spermophilus spilosoma)*	NG	No	Resident/Common
Townsend's Big-eared Bat (*Plecotus townsendii)*	NG SSC2	No	Unknown/Rare
Uinta Chipmunk (*Tamias umbrinus)*	NG	No	Resident/Uncommon
Uinta Ground Squirrel *(Spermophilus armatus)*	NG	No	Resident/Uncommon
Vagrant Shrew (*Sorex vagrans)*	NG SSC3	No	Resident/Rare
Western Harvest Mouse (*Reithrodontomys megalotis)*	NG	No	Resident/Common
Western Heather Vole (*Phenacomys intermedius)*	NG	No	Resident/Common
Western Small-footed Myotis (*Myotis ciliolabrum)*	NG SSC3	No	Unknown/Uncommon
White-tailed Deer (*Odocoileus virginianus)*	BG	Yes	Resident/Common

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
White-tailed Jackrabbit (*Lepus townsendii)*	PD	No	Resident/Common
White-tailed Prairie Dog (*Cynomys leucurus)*	NG	Yes	Resident/Common
Wyoming Ground Squirrel (*Spermophilus elegans)*	NG	No	Resident/Common
Yellow-bellied Marmot (*Marmota flaviventris)*	NG	No	Resident/Common
Yellow-pine Chipmunk (*Tamias amoenus)*	NG	No	Resident/Uncommon
Birds			
American Goldfinch (*Carduelis tristis*)	NTMB	Yes	Resident/Common
American Kestrel (*Falco sparverius*)	NTMB F	Yes	Summer Resident/Common
American Pipit (*Anthus rubescens*)	NTMB	No	Summer Resident/Common
American Crow (*Corvus brachyrhynchos*)	N/A	Yes	Resident/Common
American Golden-Plover (*Pluvialis dominicus*)	N/A	No	Migrant/Rare
American Robin (*Turdus migratorius*)	NTMB	Yes	Resident/Common
American Redstart (*Setophaga ruticilla*)	NTMB	No	Summer Resident/Uncommon
American White Pelican (*Pelecanus erythrorhynchos)*	SSC3	Yes	Summer Resident/Common
American Avocet (*Recurvirostra americana*)	N/A	Yes	Summer Resident/Common
American Bittern (*Botaurus lentiginousus*)	SSC3	Yes	Summer Resident/Uncommon
American Tree Sparrow (*Spizella arborea*)	N/A	No	Winter Resident/Uncommon
American Dipper (*Cinclus mexicanus*)	N/A	No	Resident/Common

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
American Coot (*Fulica americana*)	Game Bird	Yes	Summer Resident/Abundant
American Wigeon (*Anas americana*)	Game Bird	Yes	Resident/Abundant
Ash-Throated Flycatcher (*Myiarchus cinerascens*)	SSC3 NTMB	No	Summer Resident/Unknown
Baird's Sandpiper (*Calidris bairdii*)	N/A	No	Migrant/Common
Baird's Sparrow (*Ammodramus bairdii*)	NTMB	No	Summer Resident/Uncommon
Bald Eagle (*Haliaeetus leucocephalus*)	SSC2 Threatened	Yes	Resident/Uncommon
Baltimore Oriole *(Icterus galbula)*	NTMB	No	Accidental/Rare
Bank Swallow (*Riparia riparia*)	NTMB	Yes	Summer Resident/Common
Barn Swallow (*Hirundo rustica*)	NTMB	Yes	Summer Resident/Common
Barrow's Goldeneye (*Bucephala islandica*)	GB	Yes	Resident/Common
Belted Kingfisher (*Ceryle alcyon*)	NTMB	Yes	Resident/Common
Black Tern (*Chlidonias niger*)	SSC3	Yes	Summer Resident/Common
Black Rosy-Finch (*Leucosticte atrata*)	N/A	No	Resident/Uncommon
Black Scoter (*Melanitta nigra*)	Game Bird	No	Accidental/Rare
Black-Bellied Plover (*Pluvialis squatarola*)	N/A	Yes	Migrant/Uncommon
Black-Billed Cuckoo (*Coccyzus erythropthalmus*)	NTMB	No	Summer Resident/Uncommon
Black-Billed magpie (*Pica pica*)	N/A	Yes	Resident/Abundant
Black-Capped Chickadee (*Poecile atricapillus*)	N/A	No	Resident/Common

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Black-Crowned Night-Heron (*Nycticorax nycticorax*)	SSC3	Yes	Summer Resident/Uncommon
Black-Headed Grosbeak (*Pheucticus melanocephalus*)	NTMB	No	Summer Resident/Common
Black-Necked Stilt (*Himantopus mexicanus*)	N/A	Yes	Summer Resident/Common
Black-Throated Gray Warbler (*Dendroica nigrescens*)	NTMB	No	Summer Resident/Uncommon
Blackburnian Warbler (*Dendroica fusca*)	NTMB	No	Migrant/Rare
Blue Grouse (*Dendragapus obscurus*)	GB	No	Resident/Common
Blue Grosbeak (*Guiraca caerulea*)	NTMB	No	Summer Resident/Rare
Blue Jay (*Cyanocitta cristata*)	N/A	No	Resident/Common
Blue-Gray Gnatcatcher (*Polioptila caerulea*)	NTMB	No	Summer Resident/Uncommon
Blue-Winged Teal (*Anas discors*)	GB	Yes	Summer Resident/Common
Bobolink (*Dolichonyx oryzivorus*)	NTMB	No	Summer Resident/Uncommon
Bohemian Waxwing (*Bombycilla garrulus*)	N/A	No	Winter Resident/Common
Bonaparte's Gull (*Larus philadelphia*)	N/A	Yes	Migrant/Uncommon
Brant (*Branta bernicla*)	GB	No	Accidental/Rare
Brewer's Sparrow (*Spizella breweri*)	NTMB	Yes	Summer Resident/Common
Brewer's Blackbird (*Euphagus cyanocephalus*)	NTMB	Yes	Summer Resident/Abundant

Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Broad-Tailed Hummingbird (*Selasphorus platycercus*)	NTMB	No	Summer Resident/Common
Brown Creeper (*Certhia americana*)	NTMB	No	Resident/Common
Brown Thrasher (*Toxostoma rufum*)	N/A	No	Summer Resident/Common
Brown-headed Cowbird (*Molothrus ater*)	NTMB	Yes	Summer Resident/Common
Bufflehead (*Bucephala albeola*)	GB	Yes	Resident/Uncommon
Bullock's Oriole (*Icterus bullockii*)	NTMB	No	Summer Resident/Common
Burrowing Owl (Athene *cunicularia*)	SSC4 NTMB	No	Summer Resident/Uncommon
California Gull (*Larus californicus*)	N/A	Yes	Summer Resident/Common
Canada Goose (*Branta canadensis*)	GB	Yes	Resident/Abundant
Canvasback (*Aythya valisineria*)	GB	Yes	Summer Resident/Uncommon
Canyon Wren (*Catherpes mexicanus*)	N/A	No	Summer Resident/Uncommon
Caspian Tern (*Sterna caspia*)	SSC3	Yes	Summer Resident/Uncommon
Cassin's Kingbird (*Tyrannus vociferans*)	NTMB	No	Summer Resident/Uncommon
Cassin's Finch (*Carpodacus cassinii*)	NTMB	No	Resident/Common
Cattle Egret (*Bubulcus ibis*)	N/A	No	Summer Resident/Rare
Cedar Waxwing (*Bombycilla cedrorum*)	NTMB	No	Resident/Uncommon
Chestnut-collared Longspur (*Calcarius omatus*)	NTMB	No	Summer Resident/Uncommon
Chipping Sparrow (*Spizella passerina*)	NTMB	No	Summer Resident/Common
Chukar (Alectoris chukar)	GB	Yes	Resident/Common

Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Cinnamon Teal (*Anas cyanoptera*)	GB	Yes	Summer Resident/Common
Clark's Grebe (*Aechmophorus clarkii*)	SSC4	Yes	Summer Resident/Uncommon
Clark's Nutcracker (*Nucifraga columbiana*)	N/A	No	Resident/Common
Clay-colored Sparrow (*Spizella pallida*)	NTMB	No	Summer Resident/Uncommon
Cliff Swallow (*Hirundo pyrrhonota*)	NTMB	Yes	Summer Resident/Common
Common Merganser (*Mergus merganser*)	GB	Yes	Resident/Common
Common Tern (*Sterna hirundo*)	N/A	Yes	Migrant/Uncommon
Common Poorwill (*Phalaenoptillus nutallii*)	N/A	No	Summer Resident/Uncommon
Common Loon (*Gavia immer*)	SSC1	Yes	Summer Resident/Uncommon
Common Yellowthroat (*Geothlypis trichas*)	SSC4 NTMB	Yes	Summer Resident/Common
Common Name (Latin Name)	Management Status	Observed in Project Area *	Potential Status in Project Area
Common Grackle (*Quiscalus quiscula*)	N/A	Yes	Summer Resident/Common
Common Raven (*Corvus corax*)	N/A	Yes	Resident/Common
Common Nighthawk (*Chordeiles minor*)	N/A	Yes	Summer Resident/Abundant
Common Goldeneye (*Bucephala clangula*)	GB	No	Resident/Common
Common Snipe (*Gallinago gallinago*)	GB	Yes	Summer Resident/Common
Cooper's Hawk (*Accipiter cooperii*)	NTMB F	No	Summer Resident/Common
Cordilleran Flycatcher (*Empidonax occidentalis*)	NTMB	No	Summer Resident/Common
Dark-eyed Junco (*Junco hyemalis*)	NTMB	No	Resident/Common

Dickcissel (*Spiza americana*)	NTMB	Yes	Summer Resident/Uncommon
Double-crested Cormorant (*Phalacrocorax auritus*)	N/A	Yes	Summer Resident/Common
Downy Woodpecker (*Picoides pubescens*)	N/A	No	Resident/Common
Dusky Flycatcher (*Empidonax oberholseri*)	NTMB	No	Summer Resident/Common
Eared Grebe (*Podiceps nigricollis*)	N/A	Yes	Summer Resident/Common
Eastern Kingbird (*Tyrannus tyrannus*)	NTMB	Yes	Summer Resident/Common
Eastern Bluebird (*Sialia sialis*)	NTMB	No	Summer Resident/Uncommon
Eastern Phoebe (*Sayornis phoebe*)	NTMB	No	Summer Resident/Unknown
European Starling (*Stumus vulgaris*)	N/A	Yes	Resident/Abundant
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Evening Grosbeak (*Coccothraustes vespertinus*)	N/A	No	Resident/Common
Ferruginous Hawk (*Buteo regalis*)	SSC3 NTMB F	Yes	Resident/Common
Field Sparrow (*Spizella pusilla*)	N/A	No	Summer Resident/Unknown
Forster's Tern (*Sterna forsteri*)	SSC3	Yes	Summer Resident/Common
Fox Sparrow (*Passerella iliaca*)	NTMB	No	Resident/Common
Franklin's Gull (*Larus pipixcan*)	N/A	Yes	Summer Resident/Common
Gadwall (*Anas strepera*)	GB	No	Resident/Abundant
Glossy Ibis (*Plegadis falcinellus*)	N/A	No	Accidental/Rare
Golden-crowned Kinglet (*Regulus satrapa*)	NTMB	No	Resident/Uncommon

Golden Eagle *(Aquila chrysaetos)*	NTMB	Yes	Resident/Common
Grasshopper Sparrow (*Ammodramus savannarum*)	SSC4 NTMB	No	Summer Resident/Common
Gray Partridge (*Perdix perdix*)	GB	Yes	Resident/Uncommon
Gray Flycatcher (*Empidonax wrightii*)	NTMB	No	Summer Resident/Common
Gray Catbird (*Dumetella carolinesis*)	NTMB	Yes	Summer Resident/Common
Gray-crowned Rosy-Finch (*Leucosticte tephrocotis*)	N/A	No	Resident/Common
Great Blue Heron *(Ardea herodias)*	SSC4	Yes	Summer Resident/Common
Great Gray Owl (*Strix nebulosa)*	SSC4	Yes	Resident/Unknown
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Great Horned Owl (*Bubo virginianus*)	N/A	Yes	Resident/Common
Great Egret (*Ardea alba*)	N/A	No	Accidental/Rare
Greater Scaup (*Aythya marila*)	GB	Yes	Migrant/Rare
Greater Yellowlegs (*Tringa melanoleuca*)	N/A	No	Migrant/Common
Green-tailed Towhee (*Pipilo chlorurus*)	NTMB	Yes	Summer Resident/Common
Green-winged Teal (*Anas crecca*)	GB	Yes	Resident/Abundant
Gray Jay (*Perisoreus canadensis*)	N/A	No	Resident/Common
Gyrfalcon (*Falco rusticolus*)	F	No	Winter Resident/Rare
Hairy Woodpecker (*Picoides villosus*)	N/A	Yes	Resident/Uncommon
Hammond's Flycatcher (*Empidonaz hammondii*)	NTMB	No	Summer Resident/Uncommon

Harlequin Duck (*Histrionicus histrionicus*)	SSC3 GB	No	Summer Resident/Uncommon
Harris' Sparrow (*Zonotrichia querula*)	N/A	No	Winter Resident/Uncommon
Hermit Thrush (*Catharus guttatus*)	NTMB	No	Summer Resident/Common
Herring Gull (*Larus argentatus*)	N/A	Yes	Migrant/Rare
Hooded Merganser (*Lophodytes cucullatus*)	GB	No	Resident/Uncommon
Horned Grebe (*Podiceps auritus*)	N/A	Yes	Summer Resident/Uncommon
Horned Lark (*Eremophila alpestris*)	NTMB	Yes	Resident/Abundant
House Sparrow (*Passer domesticus*)	N/A	Yes	Resident/Abundant
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
House Finch (*Carpodacus mexicanus*)	N/A	No	Resident/Common
House Wren (*Troglodytes aedon*)	NTMB	Yes	Summer Resident/Common
Juniper Titmouse (*Baeolophus griseus*)	SSC3	No	Resident/Uncommon
Killdeer (*Charadrius vociferus*)	NTMB	Yes	Summer Resident/Abundant
Lapland Longspur (*Calcarius lapponicus*)	N/A	No	Winter Resident/Common
Lark Bunting (*Calamospiza melanocorys*)	NTMB	Yes	Summer Resident/Abundant
Lark Sparrow (*Chondestes grammacus*)	NTMB	Yes	Summer Resident/Common
Lazuli Bunting (*Passerina amoena*)	NTMB	Yes	Summer Resident/Common
Least Flycatcher (*Empidonax minimus*)	NTMB	No	Summer Resident/Common
Least Sandpiper (*Calidris minutilla*)	N/A	No	Migrant/Common

Lesser Scaup (*Aythya affinis*)	GB	Yes	Summer Resident/Uncommon
Lesser Yellowlegs (*Tringa flavipes*)	N/A	Yes	Migrant/Common
Lincoln's Sparrow (*Melospiza lincolnii*)	NTMB	No	Summer Resident/Common
Loggerhead Shrike (*Lanius ludovicianus*)	NTMB	Yes	Summer Resident/Common
Long-Billed Dowitcher (*Limnodromus scolopaceus*)	N/A	Yes	Migrant/Common
Long-Billed Curlew (*Numenius americanus*)	SSC3 NTMB	Yes	Summer Resident/Uncommon
Long-Eared Owl (*Asio otus*)	NTMB	Yes	Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
MacGillivray's Warbler (*Oporomis tolmiei*)	NTMB	No	Summer Resident/Common
Mallard (*Anas platyrhynchos*)	GB	Yes	Resident/Abundant
Marbled Godwit (*Limosa fedoa*)	N/A	Yes	Migrant/Uncommon
Marsh Wren (*Cistothorus palustris*)	NTMB	Yes	Summer Resident/Common
McCown's Longspur (*Calcarius mccownii*)	NTMB	No	Summer Resident/Common
Merlin (*Falco columbarius*)	SSC3 NTMB F	No	Resident/Uncommon
Mountain Plover (*Charadrius montanus*)	SSC4 NTMB Proposed Threatened Species.	Yes	Summer Resident/Common
Mountain Bluebird (*Sialia currcoides*)	NTMB	Yes	Summer Resident/Common
Mountain Chickadee (*Parus gambeli*)	N/A	No	Resident/Common
Mourning Dove (*Zenaida macroura*)	GB NTMB	Yes	Summer Resident/Abundant
Northern Flicker (*Colaptes auratus)*	N/A	Yes	Resident/Common

Northern Waterthrush (*Seiurus noveboracensis*)	NTMB	No	Migrant/Uncommon
Northern Mockingbird (*Mimus polyglottos*)	NTMB	No	Summer Resident/Uncommon
Northern Saw-Whet Owl (*Aegolius acadicus*)	N/A	No	Resident/Unknown
Northern Rough-Winged Swallow (*Stelgidopteryx serripennis*)	NTMB	Yes	Summer Resident/Common
Northern Shrike (*Lanius excubitor*)	N/A	Yes	Winter Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Northern Harrier (*Circus cyaneus*)	NTMB F	Yes	Summer Resident/Common
Northern Pintail (*Anas acuta*)	GB	Yes	Resident/Abundant
Northern Shoveler (*Anas clypeata*)	GB	Yes	Summer Resident/Common
Northern Goshawk (*Accipiter gentillis*)	SSC4 NTMB F	No	Resident/Common
Oldsquaw (*Clangula hyemalis*)	GB	No	Migrant/Rare
Orange-Crowned Warbler (*Vermivora celata*)	SSC4 NTMB	No	Summer Resident/Uncommon
Orchard Oriole *(Icterus spurius)*	NTMB	Yes	Summer Resident/Uncommon
Osprey (*Pandion haliaetus*)	NTMB	No	Summer Resident/Common
Pacific Loon (*Gavia pacifica*)	N/A	No	Migrant/Rare
Parasitic Jaeger (*Stercorarius parasiticus*)	N/A	No	Accidental/Rare
Pectoral Sandpiper (*Calidris melanotos*)	N/A	Yes	Migrant/Uncommon
Peregrine Falcon (*Falco peregrinus*)	SSC3 NTMB Endangered	No	Resident/Rare

Pied-Billed Grebe (*Podilymbus podiceps*)	N/A	Yes	Summer Resident/Common
Pine Siskin (*Carduelis pinus*)	NTMB	No	Resident/Common
Pinyon Jay (*Gymnorhinus cyanocephalus*)	N/A	No	Resident/Uncommon
Prairie Falcon (*Falco mexicanus*)	NTMB F	Yes	Resident/Common
Pygmy Nuthatch (*Sitta pygmaea*)	SSC4	No	Resident/Uncommon
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Red Knot (*Calidris canutus*)	N/A	No	Migrant/Rare
Red Crossbill (*Loxia curvirostra*)	N/A	No	Resident/Common
Red Phalarope (*Phalaropus fulicaria*)	N/A	Yes	Accidental/Rare
Red-breasted Nuthatch (*Sitta canadensis*)	N/A	No	Resident/Common
Red-Brested Merganser (*Mergus serrator*)	GB	Yes	Summer Resident/Uncommon
Red-headed Woodpecker (*Melanerpes eythrocephalus*)	N/A	No	Summer Resident/Uncommon
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	NTMB	No	Summer Resident/Common
Red-necked Phalarope (*Phalaropus lobatus*)	N/A	No	Migrant/Uncommon
Red-tailed Hawk (*Buteo jamaicensis)*	NTMB F	Yes	Resident/Common
Red-winged Blackbird (*Agelaius phoeniceus*)	NTMB	Yes	Summer Resident/Abundant
Redhead (*Aythya americana*)	GB	Yes	Summer Resident/Common
Ring-billed Gull (*Larus delawarensis*)	N/A	Yes	Summer Resident/Common
Ring-necked Pheasant (*Phasianus colchicus*)	GB	Yes	Resident/Common
Ring-necked Duck (*Aythya collaris*)	GB	Yes	Summer Resident/Common

Rock Wren (*Salpinctes obsoletus*)	NTMB	Yes	Summer Resident/Common
Rock Dove (*Columba livia*)	N/A	Yes	Resident/Abundant
Ross' Goose (*Chen rossii*)	GB	No	Migrant/Rare
Rough-legged Hawk (*Buteo lagopus)*	N/A	Yes	Winter Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Ruby-crowned Kinglet (*Regulus calendula*)	NTMB	No	Summer Resident/Common
Ruddy Duck (*Oxyura jamaicensis*)	GB	Yes	Summer Resident/Common
Ruddy Turnstone (*Arenaria interpres*)	N/A	Yes	Migrant/Rare
Ruffed Grouse (*Bonasa umbellus*)	GB	No	Resident/Common
Sabine's Gull (*Xema sabini*)	N/A	No	Migrant/Rare
Sage Sparrow (*Amphispiza belli*)	NTMB	Yes	Summer Resident/Common
Sage Grouse (*Centrocercus urophasianus*)	GB	Yes	Resident/Common
Sage Thrasher (*Oreoscoptes montanus*)	NTMB	Yes	Summer Resident/Common
Sanderling (*Calidris alba*)	N/A	No	Migrant/Uncommon
Sandhill Crane (*Grus canadensis*)	GB	Yes	Summer Resident/Common
Savannah Sparrow (*Passerculus sandwichensis*)	NTMB	Yes	Summer Resident/Common
Say's Phoebe (*Sayornis saya*)	NTMB	Yes	Summer Resident/Common
Semipalmated Sandpiper (*Calidris pusilla*)	N/A	No	Migrant/Uncommon

Semipalmated Plover (*Charadrius semipalmatus*)	N/A	No	Migrant/Uncommon
Sharp-shinned Hawk (*Accipiter striatus*)	NTMB F	Yes	Summer Resident/Common
Short-eared Owl (*Asio flammeus*)	NTMB	No	Resident/Common
Snow Bunting (*Plectrophenax nivalis*)	N/A	No	Winter Resident/Uncommon
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Snow Goose (*Chen caerulescens*)	GB	Yes	Migrant/Uncommon
Snowy Egret (*Egretta thula*)	SSC3	Yes	Summer Resident/Uncommon
Snowy Plover (*Charadrius alexandrinus*)	N/A	Yes	Summer Resident/Rare
Snowy Owl (*Nyctea scandiaca*)	N/A	No	Winter Resident/Rare
Solitary Sandpiper (*Tringa solitaria*)	N/A	No	Migrant/Common
Song Sparrow (*Melospiza melodia*)	NTMB	Yes	Resident/Common
Sora (*Porzana carolina*)	GB	Yes	Summer Resident/Common
Spotted Sandpiper (*Actitis macularia*)	N/A	Yes	Summer Resident/Common
Spotted Towhee (*Pipilo maculatus*)	NTMB	Yes	Summer Resident/Common
Steller's Jay (*Cyanocitta stelleri*)	N/A	No	Resident/Common
Stilt Sandpiper (*Calidris himantopus*)	N/A	No	Migrant/Uncommon
Swainson's Hawk (*Buteo swainsoni*)	NTMB F	Yes	Summer Resident/Common
Swainson's Thrush (*Catharus ustulatus*)	NTMB	No	Summer Resident/Common
Swamp Sparrow (*Melospiza georgiana*)	NTMB	No	Migrant/Rare
Three-Toed Woodpecker (*Picoides tridactylus*)	N/A	No	Resident/Uncommon

Townsend's Warbler (*Dendroica townsendi*)	NTMB	No	Summer Resident/Unknown
Townsend's Solitaire (*Myadestes townsendi*)	NTMB	No	Resident/Common
Tree Swallow (*Tachycineta bicolor*)	NTMB	Yes	Summer Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Trumpeter Swan (*Cygnus buccinator*)	SSC2 GB - no season	Yes	Resident/Uncommon
Tundra Swan (*Cygnus columbianus*)	GB - no season	Yes	Winter Resident/Uncommon
Turkey Vulture (*Carthartes aura*)	NTMB	No	Summer Resident/Common
Upland Sandpiper (*Bartramia longicauda*)	SSC4 NTMB	No	Summer Resident/Uncommon
Vesper Sparrow (*Pooecetes gramineus*)	NTMB	Yes	Summer Resident/Common
Violet-Green Swallow (*Tachycineta thalassina*)	NTMB	Yes	Summer Resident/Common
Virginia Rail (*Rallus limicola*)	GB	No	Summer Resident/Unknown
Warbling Vireo (*Vireo gilvus*)	NTMB	No	Summer Resident/Abundant
Western Meadowlark (*Sturnella neglecta*)	NTMB	Yes	Summer Resident/Abundant
Western Tanager (*Piranga ludoviciana*)	NTMB	Yes	Summer Resident/Common
Western Kingbird (*Tyrannus verticalis*)	NTMB	Yes	Summer Resident/Common
Western Sandpiper (*Calidris mauri*)	N/A	No	Migrant/Uncommon
Western Grebe (*Aechmophorus occidentalis*)	SSC4	Yes	Summer Resident/Common
Western Bluebird (*Sialia mexicana*)	NTMB	No	Summer Resident/Uncommon
Western Wood-Pewee (*Contopus sordidulus)*	NTMB	No	Summer Resident/Common
Whimbrel (*Numenius phaeopus*)	N/A	No	Migrant/Rare

White Winged Scoter (*Melanitta fusca*)	GB	No	Migrant/Uncommon
White-breasted Nuthatch (*Sitta carolinensis*)	N/A	Yes	Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
White-crowned Sparrow (*Zonotrichia leucophrys*)	NTMB	No	Summer Resident/Common
White-faced Ibis (*Plegadis chihi*)	SSC3	Yes	Summer Resident/Uncommon
White-throated Sparrow (*Zonotrichia albicollis*)	NTMB	No	Migrant/Uncommon
White-throated Swift (*Aeronautes saxatalis*)	NTMB	Yes	Summer Resident/Common
Whooping Crane (*Grus americana*)	Endangered	No	Summer Resident/Controlled
Wild Turkey (*Meleagris gallopavo*)	GB	No	Resident/Common
Willet (*Catoptrophorus semipalmatus*)	N/A	Yes	Summer Resident/Common
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	NTMB	No	Summer Resident/Uncommon
Willow Flycatcher (*Empidonax traillii*)	NTMB	No	Summer Resident/Common
Wilson's Warbler (*Wilsonia pusilla*)	NTMB	No	Summer Resident/Common
Wilson's Phalarope (*Phalaropus tricolor*)	N/A	Yes	Summer Resident/Common
Wood Duck (*Aix sponsa*)	GB	Yes	Summer Resident/Uncommon
Yellow Warbler (*Dendroica petechia*)	NTMB	Yes	Summer Resident/Abundant
Yellow-Billed Cuckoo (*Coccyzus americanus*)	SSC2 NTMB	No	Summer Resident/Uncommon
Yellow-Breasted Chat (*Icteria virens*)	NTMB	No	Summer Resident/Common

Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)	NTMB	Yes	Summer Resident/Common
Yellow-rumped Warbler (*Dendroica coronata*)	NTMB	No	Summer Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Reptiles and Anphibians			
Bullsnake *(Pituophis melanoeucas sayi)*	NG	No	Resident/Common
Eastern Short-horned Lizard (*Phrynosoma douglassi brevirostre)*	NG	No	Resident/Common
Great Basin Gopher Snake (*Pituophis melanoleucas deserticola)*	NG	No	Resident/Uncommon
Northern Leopard Frog (*Rana pipiens)*	NG	No	Resident/Common
Northern Sagebrush Lizard (*Sceloporus graciosus graciosus)*	NG	No	Resident/Common
Ornate Box Turtle (*Terrapene ornata ornata)*	NG	No	Resident/Uncommon
Plains Hognose Snake *(Heterodon nasicus nasicus)*	NG	No	Resident/Common
Plains Spadefoot (*Scaphiopus bombiforms*)	NG	No	Resident/Common
Prairie Rattlesnake (*Crotalus viridis viridis)*	NG	No	Resident/Common
Tiger Salamander *(Ambystoma tigrinum*)	NG	No	Resident/Common
Wandering Garter Snake (*Thamnophis elegans vagrans)*	NG	No	Resident/Common

Woodhouses' Toad *(Bufo woodhousei woodhousei)*	NG	No	Resident/Common
Common Name (Latin Name)	**Management Status**	**Observed in Project Area ***	**Potential Status in Project Area**
Fish			
Flathead Chub (*Platygobio gracilis*)	Fish	Yes	N/A
Sauger *(Stizostedian canadense)*	Fish	Yes	N/A
Brown Trout (*Salmo trutta*)	Fish	Yes	N/A
White Sucker (*Catostomus commersoni*)	Fish	Yes	N/A
Longnose Sucker (*Catostomus catostomus)*	Fish	Yes	N/A
Mountain Sucker (*Catostomus platyrhynchus)*	Fish	Yes	N/A
Cutthroat Trout (*Salmo clarki)*	Fish	Yes	N/A
Lake Chub (*Couesius plumbeus)*	Fish	Yes	N/A
Longnose Dace (*Rhinichthys cataractae*)	Fish	Yes	N/A
Flathead Chub (*Platygobio gracilis*)	Fish	Yes	N/A
McConaughy Rainbow Trout (*Oncorhynchus mykiss)*	Fish	Yes	N/A
Brown Trout (*Salmo trutta*)	Fish	Yes	N/A

Acronyms and Abbreviations

BG	Big Game
F	Species Taken for Falconry
FB	Furbearer
N/A	Not Applicable
NG	Nongame Species
NTMB	Neotropical Migratory Bird
PD	Predator
SG	Small Game
SSC1	1996 Nongame Bird and Mammal Plan Species of Special Concern 1
SSC2	1996 Nongame Bird and Mammal Plan Species of Special Concern 2
SSC3	1996 Nongame Bird and Mammal Plan Species of Special Concern 3
TG	Trophy Game
*	Reported by WG&F Database

Table I – 2. Mammals and Birds Observed in the WRPA in August and September 2003. (R. Baldes 2003).

Common Name	Latin Name	Management Status[1]	Number Observed	Habitat
Mammals				
Beaver	*Castor canadensis*	FB	2	Wetlands, Riparian
Coyote	*Canis latrans*	PD	2	Sagebrush-Grasslands
Desert Cottontail	*Sylvilagus auduboni*	SG	6	Sagebrush-Grasslands
Mule Deer	*Odocoileus hemionus*	BG	19	Riparian
Pronghorn	*Antilocapra americana*	BG	265	Sagebrush-Grasslands
Raccoon	*Procyon lotor*	PD	2	Riparian
White-tailed Jackrabbit	*Lepus townsendii*	PD	3	Sagebrush-Grasslands
White-tailed Prairie Dog	*Cynomys leucurus*	NG	8	Sagebrush-Grasslands
Birds				
American Kestrel	*Falco sparverius*	NTMB F	22	Agricultural lands, Sagebrush-Grasslands
American Robin	*Turdus migratorius*	NTMB	1	Agricultural lands
American White Pelican	*Pelecanus eythrorhynchos*	SSC3	4	Lakes
American Coot	*Fulica americana*	Game Bird	37	Lakes
Black-billed magpie	*Pica pica*	N/A	2	Riparian
Blue-winged Teal	*Anas discors*	GB	7	Lakes
Brown-headed Cowbird	*Molothrus ater*	NTMB	571	Agricultural lands
Canada Goose	*Brantia canadensis*	GB	45	Lakes
Common Grackle	*Quiscalus quiscula*	N/A	137	Agricultural lands
Common Raven	*Corvus corax*	N/A	9	Agricultural land, Sagebrush-Grasslands
Eastern Kingbird	*Tyrannus tyrannus*	NTMB	95	Agricultural lands
European Starling	*Stumus vulgaris*	N/A	92	Agricultural lands
Ferruginous Hawk	*Buteo regalis*	SSC3 NTMB F	1	Sagebrush-Grasslands
Gadwall	*Anas strepera*	GB	6	Lakes
Great Blue	*Ardea herodias*	SSC4	2	Lakes

Common Name	Latin Name	Management Status[1]	Number Observed	Habitat
Heron				
Lark Bunting	*Calamospiza melanocorys*	NTMB	1	Agricultural lands
Mallard	*Anas platyrhynchos*	GB	23	Lakes
Merlin	*Falco columbarius*	SSC3 NTMB F	1	Agricultural lands
Mourning Dove	*Zenaida macroura*	GB NTMB	158	Agricultural lands
Northern Flicker	*Colaptes auratus*	N/A	8	Agricultural lands
Northern Harrier	*Circus cyaneus*	NTMB F	2	Wetlands
Peregrine Falcon	*Falco peregrinus*	SSC3 NTMB Endangered	1	Agricultural lands
Red-tailed Hawk	*Buteo jamaicensis*	NTMB F	3	Sagebrush-grasslands, Rock outcrops
Red-winged Blackbird	*Agelaius phoeniceus*	NTMB	18	Riparian, wetlands
Rock Dove	*Columba livia*	N/A	105	Agricultural lands
Ruddy Duck	*Oxyura jamaicensis*	GB	1	Lakes
Sandhill Crane	*Grus canadensis*	GB	50	Agricultural lands, Grasslands
Say's Phoebe	*Sayornis saya*	NTMB	2	Agricultural lands, rock outcrops
Sharp-shinned Hawk	*Accipiter striatus*	NTMB F	1	Agricultural lands
Tree Swallow	*Tachycineta bicolor*	NTMB	95	Riparian
Turkey Vulture	*Carthartes aura*	NTMB	1	Agricultural lands
Western Meadowlark	*Sturnella neglecta*	NTMB	31	Sagebrush-grasslands
Western Bluebird	*Sialia mexicana*	NTMB	18	Sagebrush-grasslands
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	NTMB	62	Wetlands

[1] Source: WG&F Database

Acronyms and Abbreviations

BG	Big Game
F	Taken for Falconry
FB	Furbearer
N/A	Not Applicable
NG	Nongame Species
NTMB	Neotropical Migratory Bird
PD	Predator
SG	Small Game
SSC1	1996 Nongame Bird and Mammal Plan Species of Special Concern 1
SSC2	1996 Nongame Bird and Mammal Plan Species of Special Concern 2
SSC3	1996 Nongame Bird and Mammal Plan Species of Special Concern 3
TG	Trophy Game

Table I - 3. Incidental Observations of Wildlife in the Vicinity of the WRPA Over the Last 30 Years (R. Baldes, ret. US FWS. personal communication).

Common Name	Scientific Name
Birds	
American Avocet	*Recurvirostra americana*
American Wigeon	*Anas americana*
Bald Eagle	*Haliaeetus leucocephalus*
Chukar	*Alectoris chukar*
Cinnamon Teal	*Anas cyanoptera*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Merganser	*Mergus merganser*
Common Nighthawk	*Chordeiles minor*
Double-crested Cormorant	*Phalacrocorax auritus*
Golden Eagle	*Aquila chrysaetos*
Gray Partridge	*Perdix perdix*
Great Horned Owl	*Bubo virginianus*
Green-winged Teal	*Anas crecca*
Horned Lark	*Eremophila alpestris*
House Sparrow	*Passer domesticus*
Killdeer	*Charadrius vociferus*
Long-billed Curlew	*Numenius americanus*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Redhead	*Aythya americana*
Ring-necked Pheasant	*Phasianus colchicus*
Rough-legged Hawk	*Buteo lagopus*
Sage-Grouse	*Centrocercus urophasianus*
Snow Goose	*Chen caerulescens*
Vesper Sparrow	*Pooecetes gramineus*
Violet-green Swallow	*Tachycineta thalassina*
Western Grebe	*Aechmophorus occidentalis*
Wilson's Phalarope	*Phalaropus tricolor*
Mammals	
Badger	*Taxidea taxus*
Elk	*Cervus elaphus*
Moose	*Alces alces*
Muskrat	*Ondatra zibethicus*
Porcupine	Erethizon dorsatum
Red Fox	*Vulpes vulpes*
Striped Skunk	*Mephitis mephitis*

APPENDIX J
WILDLIFE SURVEY REPORTS FOR THE WRPA

WILDLIFE SURVEY REPORTS FOR THE WRPA

TABLE OF CONTENTS

SPRING 2003 AERIAL SURVEY REPORT

Preliminary Wildlife Habitat Evaluation of Tom Brown, Inc.'s Wind River Natural Gas Field Development Project

Prepared for:

Bureau of Indian Affairs
Wind River Agency
Fort Washakie, Wyoming

and

Tom Brown, Incorporated
Denver, Colorado

Prepared by:

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April 2003

1.0 INTRODUCTION

Aerial surveys were conducted for sage grouse (*Centrocercus urophasianus*) leks, raptor nests, white-tailed prairie dog (*Cynomys leucurus*) colonies, and other wildlife and wildlife habitat in and adjacent to the Muddy Ridge and Pavilion petroleum production fields and the surrounding areas (collectively referred to as the Wind River Area). The purpose of the these preliminary aerial surveys was to identify the presence of the species mentioned above and/or potential habitat, in order to avoid adverse affects from the proposed exploration and development of future oil and gas wells within the Wind River Area.

2.0 METHODS

An aerial survey of sage grouse leks, raptor nests, and white-tailed prairie dog colonies within the Wind River Area and a two-mile buffer zone was conducted by Buys and Associates (B&A) on April 16 and 17, 2003. The aerial survey was conducted using a Cessna 180 with dual GPS capabilities. The survey protocol consisted of early-morning, low-level flights to document sage grouse strutting grounds (leks); the status and locations of two previously documented golden eagle (*Aquila chrysaetos*) nests as well as any new raptor nests within the project area; presence of mountain plover (*Charadrius montanus*) habitat; and general locations of white-tailed prairie dog colonies in the area. While flying above the project area, presence of other wildlife was documented as well as the wildlife habitat in the area. Total air-time over the project area and two-mile buffer zone was approximately nine hours.

2.1 Sage Grouse Leks

The aerial sage grouse lek surveys began on the morning of April 16, 2003, and ended on April 17, 2003. The aircraft was above the project area before sunrise on both mornings, when there was enough light to effectively see the ground and existing vegetation. The pre-determined protocol for the surveys was to fly north-south transects, spaced at approximately 3/4 of a minute longitude (approx. 0.62 mile). The purpose of flying transects north-to-south and vice versa, rather than east-to-west was to have the sun shining on the grouse so they could be more easily observed from the air. The transects were flown at approximately 250 feet above the ground during the surveys. The 3/4 of a minute longitude spacing of the transects flown at approximately 250 feet above the ground allowed the most sufficient observation of the ground below, with the most fuel-efficient flight to cover the project area. Because sage grouse only strut on their leks in early morning, the surveys for these leks were concluded within about two hours from when they were commenced. The remaining time was used to search for raptor nests and prairie dog colonies and to document the presence of other wildlife and wildlife habitat.

2.2 Raptor Nests

During the morning surveys for sage grouse leks on April 16 and 17, 2003, suitable raptor nesting habitat and nests within the project area were recorded. Upon completion of the sage grouse lek surveys, the crew in the aircraft flew over all habitat that appeared to be suitable for raptors to construct a nest, including cliff face-like edges of the dominant ridges in the area and any other bluffs or structures that could sufficiently support a raptor nest. The aircraft flew above and around all aspects of a bluff or ridge edge in the project area as many time as necessary to allow sufficient observation of the habitat for existing raptor nests. When a nest was observed, the location would be recorded with a hand-held GPS unit in order to display the nest location on a map and return to it in the future. Upon finding a nest, the crew in the aircraft would attempt to determine the status of the nest and look for nest occupancy or signs of occupancy, such as white-wash, feathers, or eggs.

2.3 Prairie Dog Colonies

Another target species during the aerial surveys was the white-tailed prairie dog. Although this species is not a Federally listed Threatened or Endangered species, the prairie dog is one of the primary food sources of the endangered black-footed ferret (*Mustela nigripes*). The purpose of surveying for the white-tailed prairie dog was to determine if the colonies in the area are large enough by themselves, or combined with nearby colonies, to support populations of black-footed ferrets. While flying the 3/4 minute longitude-spaced transects, a beginning and ending point was marked when flying over a prairie dog colony using the hand held GPS unit. The purpose of this was to use these points to represent rough boundaries of the colonies within the project area. In the future, the colonies can be more accurately surveyed on the ground to delineate precise boundaries for accurate area measurements. Subsequent to this, the colonies will be surveyed for burrow densities to estimate if there are enough prairie dogs using the area to potentially support populations of black-footed ferrets. If it is determined that the prairie dog colonies are large enough to support the endangered black footed ferret, a ferret survey will be conducted.

2.4 Other Wildlife and Habitat

While flying above the Wind River Project Area, observations were made of the different wildlife species and habitat types found within the area. Areas of special concern (sage grouse lek habitat, raptor nesting habitat, mountain plover nesting habitat) were marked with the GPS unit and documented with photographs (See Appendix A). Other wildlife species in the area were also noted, as well as areas used for livestock grazing and agriculture. The purpose of this was to get a general sense of how the area is currently being used and managed by local landowners and state agencies.

3.0 RESULTS

3.1 Sage Grouse Leks

No sage grouse leks were identified during the aerial surveys. Although there was some sage grouse habitat within the project area, the majority of the area did not appear to be suitable habitat for sage grouse. The area that appeared to contain the most suitable sage grouse habitat was actually south of the project area boundary, north of Five Mile Creek and south of the west end of Muddy Ridge. Because this area appeared to have the most potential for observing active sage grouse leks, it was flown on both mornings of April 16 and 17, 2003. The areas that did appear to be suitable habitat for sage grouse appeared to consist of approximately 50-60 percent sagebrush (*Artemisia* spp.), 10-15 percent short grasses, and the remaining area bare ground.

3.2 Raptor Nests

Two active raptor nests were documented within the surveyed area. These include one red-tailed hawk nest and one nest of an unknown raptor species. This unknown species could have been a small bird/raptor that was not observable in the air due to the position of the nest under a rocky ledge. The nest of this unidentified species was potentially that of a prairie falcon or another red-tailed hawk. The active red-tailed hawk (RTH) nest was located on the side of Muddy Ridge in the SE/SW 1/4 of Section 14 in T4N:R2E (See Appendix B; RTH A) on a north facing exposure of the ridge. One adult was present at this nest, but it was not evident if any eggs or fledglings were also in the nest. This nest had two alternative nests located approximately 60-80 feet on both sides of it. Both of these nests appeared to be inactive, containing dirt and other debris inside. The second active nest of the unidentified bird/raptor was located in the SE/SE 1/4 of Section 9 in T4N:R2E (See Appendix B; Nest X) on a south facing exposure, underneath a rock ledge of Muddy Ridge. Because this ledge hung over the nest, the species occupying the nest was unidentifiable.

Three other raptor nests were located during the aerial survey. However, all of them appeared to be inactive red-tailed hawk nests. The first was located in the SE/NE 1/4 of Section 23 in T4N:R2E (See Appendix B; RTH B). This nest contained soil inside and showed no evidence of recent use. The second nest located was in the NE/SW 1/4 of Section 29 in T4N:R3E (See Appendix B; RTH C). This nest also showed no evidence of recent use. The third nest observed was found in the NE/SW 1/4 of Section 28 in T4N:R3E (See Appendix B; RTH D). This nest appeared to be older, as it was falling apart, only partially intact. All three of these inactive nests were located on north-facing exposures of Muddy Ridge.

Two locations of historical golden eagle nests were provide by Wyoming Game and Fish (as latitude/longitude coordinates) to B&A prior to beginning the aerial surveys in order to check the status of the nests during the survey. Inserting these latitude/longitude coordinates into the GPS unit allowed the aircraft to fly directly over the locations of these nests. Although this area was searched repeatedly during the survey, no sign of either of the two nests was observed. Both of these nests were originally located on south-facing aspects of a small bluff running east and west in Section 10 (T3N:R2E). A substantial amount of what appeared to be gas producing facilities and associated storage units was evident in the immediate surroundings of this bluff.

During the aerial survey two golden eagle observations were made of individuals perched on top of bluffs in the western portion of Muddy Ridge. The second observation was approximately six miles west of the first observation, along the same bluff ridge. After the second observation (NWSE 1/4 Section 1, T3N:R3E) (See Appendix B; GE 2) the aircraft flew towards the location of the first observation (NENE 1/4 Section 12, T3N:R4E) (See Appendix B; GE 1) to see if the eagle was still present. Because the eagle that was first observed was no longer in the area, it is not evident if the second observation was another bird or the same bird as the first observation. Both eagle observations were located approximately one-half mile to one mile south of the project area boundary.

3.3 Prairie Dog Colonies

The eastern half of the project area contained little evidence of prairie dogs. The few burrows observed in this area covered only small areas less than one acre in size, separated by several miles of land with no sign of prairie dogs. These areas observed only appeared to have only a few burrows (5-15) in each of the locations.

A total of ten prairie dog colonies were located in the northwest section of the project area or immediately outside the project area boundaries. They were both northeast and southwest of Muddy Ridge (See Appendix B). Two of the colonies observed (Colonies A & B) (See Appendix B), appear to cross the border of privately owned land and land managed by the Bureau of Reclamation (SE 1/4 of Section 31 and SW 1/4 of Section 32, T4N:R3E; and NW 1/4 of Section 5 and NE 1/4 of Section 6, T3N:R3E). The combined area of these two colonies appeared to be less than 80 acres in size and they are 6-8 miles from any other colonies. They are also separated from all other colonies by the Wyoming Canal, which may prevent ferrets from reaching these prairie dog colonies.

Three of the colonies are within the boundaries of the project area. The largest colony (Colony C), appeared to consist of approximately 400 to 450 acres and is located immediately south of Muddy Ridge. The other two colonies are very small, only consisting of approximately 75 acres combined. The smaller of these two colonies (approximately 10-20 acres) (Colony D), was observed on top of Muddy Ridge, approximately 1.5 miles north of Colony C. The other colony (Colony E), also south of Muddy Ridge, lies roughly one-half mile north of Colony C and one mile southwest of Colony D. All three of these colonies, as well as the colonies located outside of the project area, appear to be on the Wind River Reservation.

Approximately one mile to the west of the western edge of the project area boundary, and roughly 1.5 miles west of the prairie dog colonies within the project area, is a large colony (Colony F), consisting of a possible 500-600 acres. This colony begins near the southwest edge of Muddy Ridge, and continues south for nearly three miles.

There is another prairie dog colony (Colony G), located approximately three to four miles southwest of the colonies mentioned above. This colony is roughly 1.5 miles northwest of the town of Pavillion and 2.5 miles west of the project area boundary. This colony consists of approximately 200-250 acres.

The other three colonies (H, I and J) observed during the survey are located north of the project area boundary, and are on the north side of Muddy Ridge. The closest of these three colonies to the project area (Colony H), is approximately one mile northeast of the colonies within the project area and consists of over 300 acres. The colony to the northeast (Colony I), consisting of nearly 200 acres, is approximately 1.25 miles away and is separated by Muddy Creek. The last colony (Colony J), roughly 1.75 miles to the east, has an approximate area of 150-200 acres.

3.4 Other Wildlife and Habitat

Opportunistic wildlife sightings during the aerial survey include numerous pronghorn antelope (*Antilocapra americana*), mule deer and/or white-tailed deer (*Odocoileus hemionus* and/or *Odocoileus virginianus*), coyotes (*Canis latrans*), Canada geese (*Branta canadensis*), duck species (*Anas* spp.), American crow and/or common raven (*Corvus brachyrhynchos* and/or *Corvus corax*), and western meadowlark *(Sturnella neglecta*).

In addition to the wildlife species mentioned above, there were also a lot of livestock observed from the air. The majority of the livestock in the area were located along the western and southern portions of the project area. The areas in which the livestock were observed appeared to consist of short grasses, most of which were surrounding or immediately adjacent to houses in the area. One group of five horses was observed on the Wind River Reservation during the aerial survey (NWNW 1/4 of Section 33, T5N:R3E). They appeared to be a herd of wild horses, unrestricted by fences and not in the vicinity of any houses. However, it was unclear if they were indeed wild horses or those owned by a local landowner in the area.

A large portion of the project area is currently being used for agricultural purposes. There were several canals winding through the area, all of which appeared to be used for irrigating adjacent agricultural fields. The majority of the western portion of the project area consisted of large irrigated crop circles and large fields, which appeared to be arranged so they could be flooded using the nearby canals. In addition to the western portion of the project area, a large strip of land covered with crop fields, approximately two - three miles wide, runs east and west along the project area, immediately north of Muddy Ridge. The remaining land north of these crop fields appeared to consist of roughly 20 percent short grasses, and 80 percent bare ground. This land was not being used by prairie dogs and did not look like suitable sage grouse habitat, however, it did appear to be suitable habitat for the mountain plover. The creeks running though the project area, including Muddy Creek and Fivemile Creek and their associated wetlands, as well as Boysen Reservoir and it's associated wetlands did not appear to contain any obligate wetland wildlife species that could be observed from the air. The few trees observed in the project area primarily surrounded houses, likely serving as windbreaks.

Oil and gas wells occurred within the boundaries of the project area. The majority of the wells was in the southwestern portion of the area, north of Ocean Lake. There were many existing gas wells and hydrocarbon/water storage tanks, as well as access roads to these locations in this area. There were also a few oil well locations visible from the air, recognized by the typical pumpjacks used to pump oil from below the surface.

4.0 CONCLUSIONS

Because no sage-grouse leks were observed from the air, no further ground truthing surveys should be necessary for this species. Although there was an active red-tailed hawk nest found in the area, as well as another active nest of an unidentified species, further ground truthing surveys are not considered to be necessary to confirm their presence.

Ground truthing of the prairie dog colonies located during the aerial surveys is necessary, because these colonies add up to more than 200 acres and they are within 4.34 miles of each other. A colony-complex of this size has the potential to support populations of the Federally endangered black-footed ferret (USFWS 1989). Ground truthing efforts would allow biologists to get a more precise boundary delineated around the colonies, and therefore, the entire complex. In addition, biologists could complete the necessary prairie dog burrow density estimates to further confirm the necessity of future black-footed ferret surveys. According to the US Fish and Wildlife Service, if a prairie dog complex of 200 acres or more has a burrow density of 8 burrows/acre (20 burrows/hectare), the potential exists for the complex to support black-footed ferrets and should therefore, be surveyed (USFWS 1989).

REFERENCES

U.S. Fish and Wildlife Service. 1989. Black-Footed Ferret Survey Guidelines for Compliance with the Endangered Species Act. U.S. Fish and Wildlife Service, Denver, Colorado and Albuquerque, New Mexico. April 1989.

Appendix A

Photos From the 2003 Aerial Survey

Appendix B

Map of Tom Brown, Inc.'s Wind River Natural Gas Development Project Area

White-tailed Prairie Dog (*Cynomys leucurus)* Survey for Tom Brown, Inc.'s Wind River Natural Gas Field Development Project

Prepared for:

Bureau of Indian Affairs
Wind River Agency
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July 30, 2003

1.0 INTRODUCTION

Buys & Associates (B&A) completed quantitative white-tailed prairie dog (*Cynomys leucurus*) colony surveys in and adjacent to the Wind River Project Area (WRPA). Aerial surveys of the WRPA and a two+ mile buffer zone were conducted on April 16 and 17, 2003. These surveys identified the presence of the species, and determined areas for ground surveys. Ground surveys, consisting of colony mapping and burrow density estimates, were conducted on July 10 and 11, 2003. These surveys were conducted at all prairie dog colonies meeting U.S. Fish and Wildlife Service (USFWS) requirements located within 2 miles of the WRPA. These areas included the following Townships (T) and Ranges (R) of Fremont County, Wyoming: T3N - R1E,T4N - R1E,T4N - R2E, and T5N - R2E.

The overall goal of these surveys was to determine if the prairie dog colonies could provide potential habitat for the Federally endangered black-footed ferret (*Mustela nigripes*). According to Biggins et al. (1989), active burrow density is strongly correlated with potential prairie dog density. The USFWS defines a prairie dog colony as a group of prairie dog burrows whose density meets or exceeds 8 burrows/acre (20 burrows/ha) (USFWS 1989). They suggest viewing a colony as a group of 5-ha (12.35- acre) parcels, each of which must contain at least 100 burrows to be considered as potential black-footed ferret habitat. This implies that colonies smaller than 5 ha (12.35 acres) would not support black footed ferrets, and can therefore be eliminated from the survey.

The USFWS defines a prairie dog complex as two or more neighboring prairie dog colonies that are less than 7 km (4.34 miles) from each other (USFWS 1989; K. Erwin, USFWS, pers. comm., Sept. 2002). White-tailed prairie dog towns or complexes that are greater than 200 acres and have a minimum density of 8 burrows/acre (20 burrows/ha) have the potential to support black-footed ferrets, and therefore, must be surveyed for ferrets prior to approval of any surface disturbance or other land use that could adversely affect the species (USFWS 1989; K. Erwin, USFWS, pers. comm., Sept. 2002).

2.0 METHODS

2.1 Aerial Survey for Identifying Prairie Dog Colonies

To determine whether prairie dog colonies were present within the WRPA, an aerial survey was conducted by B&A on April 16 and17, 2003. The surveys included the WRPA and a two-mile buffer zone. The aerial survey was conducted using a Cessna 180 with dual GPS capabilities. The survey protocol consisted of early-morning, low-level flights (250 ft.) to document general locations of white-tailed prairie dog colonies. When colonies were identified, beginning and ending points were marked while flying forty-five second longitude-spaced transects over the colony. These points were then used as rough boundaries for subsequent ground transects.

2.2 Prairie Dog Colony Mapping and Burrow Density Estimates

Three-meter x 1000-meter (0.3 ha.) strip transects were used to obtain representative samples of active burrow densities within each prairie dog colony both in and adjacent to the WRPA. The number of transects surveyed varied based on the overall acreage of individual colonies. According to Biggins et al.(1989), 3m x 1000 m transects allow for a sufficient colony sample size of ±5 percent of the colony. Dividing the 5 percent sample size into the 3 meter-wide transect width provides 60-meter spacing between transects, resulting in even distribution of transects within each colony. Colonies larger than 1000 meters required end-to-end transects with a spacing of 60 meters between the end of one transect and the beginning of the next.

East/west or north/south transects were established, based upon the guidance in Biggins et al. (1989). Hand-held GPS units were used to mark the beginning latitude or longitude coordinate at the starting point of each transect. Moving east/west or north/south allowed the biologists to maintain the same latitude/longitude along each transect. Keeping the transects as straight as possible reduced the possibility of overlapping transects and resulted in the most accurate samples. The endpoint of each transect was also marked by GPS. By marking the endpoint of each transect, the GPS units could be used as odometers, allowing the biologists to determine when they had reached the next transect.

Each prairie dog burrow located within the 3-meter wide transect was documented as being active or inactive on a data sheet. Those burrows which appeared to be at least 50 percent within the transect were recorded as well. Most burrows were clearly active (burrows with fresh fecal pellets, open entrances, etc.). Other burrows required closer examination. Typical signs of inactive burrows include cobwebs completely covering the entrances of the burrows and soil-filled entrances. Those burrows which had cobwebs only partially covering the entrances were recorded as active, on the assumption that a prairie dog could pass between the web and the side of the burrow entrance.

The raw data recorded from these transects were then used to estimate burrow density and the potential of the colonies to support black-footed ferrets.

2.3 Wildlife Habitat Evaluations and Vegetation Community Delineation

In addition to the prairie dog burrow surveys, B&A also documented other wildlife species and habitats within the WRPA. Because vegetation communities are indicative of potential wildlife species in an area, the biologists identified dominant vegetation communities around the existing prairie dog colonies, as well as all wetland areas in the WRPA.

3.0 RESULTS

3.1 Colony Mapping

The eastern half of the WRPA contained little evidence of prairie dogs. The burrows observed in this area were only about one acre in size. Burrow density in these locations was low (5-15/acre).

A total of ten prairie dog colonies were located in the northwestern section of the WRPA or immediately adjacent to the WRPA boundaries (Appendix A). Two colonies (A and B) were immediately eliminated from analysis because colonies did not exceed 5 ha (12.35 acres) and were over 7 km from the main complex. All remaining colonies were examined via ground surveys. Two additional colonies (D and J) were removed after ground surveys because these colonies did not exceed 5 ha (12.35 acres). Ground surveys also revealed that colonies originally identified as F, E, and C were actually one large colony referred to as colony F. A total of 4 colonies (F, G, H, and I) were then surveyed for burrow density (Appendix B).

3.2 Active Prairie Dog Burrow Densities

Four prairie dog colonies consisting of 1,243 acres (503 ha) were surveyed on or adjacent to the WRPA. Seventy-six percent (660 acres/267 ha) of colony F existed within WRPA. Colonies G, H, and I were not in the WRPA. The approximate density of active prairie dog burrows in and adjacent to the Wind River WRPA is 10.3 burrows/acre (25.5 burrows/ha). This number was derived by dividing the total number of active burrows (566) by the total area surveyed (54.85 acres). No statistical corrections have been applied to this value. The 54.85 acres (22.2 ha) of transects comprises approximately 4.4 percent of the total 1,243 acres (503 ha) of prairie dog colonies illustrated on the map in Appendix B. The 4.4 percent of active burrows is a sufficient sample size, according to Biggens et al. (1989).

The resulting 10.3 burrows/acre (25.5 burrows/hectare) density of the WRPA exceeds the USFWS minimum threshold of 8 burrows/acre (20 burrows/hectare) (USFWS, 1989). Therefore, the prairie dog colonies within the WRPA are considered potential black-footed ferret habitat (Table J-1).

Table J-1. Wind River Project Area Prairie Dog Burrow Density Estimates.

Town	Area (Acre)	Area (Ha)	# Transects	Transect Area (Acre)	Transect Area (Ha)	# Active Burrows
F	868.81	351.6	46	34.1	13.8	383
G	118.61	48.0	11	8.15	3.3	60
H	176.19	71.3	9	6.67	2.7	67
I	79.32	32.1	8	5.93	2.4	56
Total	**1242.93**	**503.00**	**74**	**54.85**	**22.2**	**566**

Active Burrow/Acre =10.3
Active Burrow/ha = 25.5

Biggens et al.'s (1989) quantitative model was used to estimate the number of ferret families (*R)* that could be supported by a complex. In this model, a complex with a rating of R<1.0 is not expected to support ferrets. The Wind River Project Area complex has a rating of R= 1.9 (Table J-2). Raw field data from the proposed project are provided in Appendix C.

Table J-2. Wind River Project Area Prairie Dog Complex Ferret Family Estimate.

Colony	# Trans.	Size (ha)	Trans. Good Hab.	Good Hab.%	Ha Good Hab.	Burrows/ Ha	P.Dogs/H a	Total P.Dogs	R
F	46	351.6	24	0.5200	182.83	45	6.63	1213	1.56
G	11	48.0	4	0.3636	30.03	35	5.16	155	0
H	9	71.3	5	0.4285	13.75	50	7.37	101	0
I	8	32.1	3	0.5555	54.77	36	5.31	290	0.38
								Total	**1.94**

3.3 Vegetation Community

The WRPA falls within the Sagebrush Steppe vegetative community. Representative plants within this vegetative complex include Wyoming big sagebrush (*Artemisa tridentata wyomingensis*), prairie June grass (*Koeleria macrantha*), Indian rice grass (*Oryzoisis hymenoides*), blue grama (*Boutelua gracilis*), buffalo grass (*Buchloe dactyloides*), and prickly pair cactus (*Opuntia polyacanta*).

Dominant vegetation in and around prairie dog colonies consisted of blue grama (*Boutelua gracilis*), buffalo grass (*Buchloe dactyloides*), and prickly pair cactus (*Opuntia polyacanta*), with some occasional winterfat (*Eurotia lanata*), cheat grass (*Bromus tectorum*), and Russian thistle (*Salsola kali*) along roadways.

Dominant vegetation in wetland areas included Russian olive (*Eleagnus angustifolia*), broad-leafed cattail (*Typha latifolia*), cordgrass (*Spartina pectinata*), showy milkweed (*Asclepia speciosa*), hoary cress (*Cardaria draba*), cheat grass (*Bromus tectorum*), spikerush species (*Eleocharis sp.*) ,willow species (*Salix sp.*), salt ceder (*Tamarix sp.*), sedges (*Carex sp.*), and Canada thistle (*Alopecurus arqualis*).

3.4 Wildlife Observations

Shallow clay-loam and sandy clay-loam soils typically create islands of short vegetation. Within this vegetation type, prairie dog colonies are commonly found along with other wildlife species. The mountain plover (*Charadrius montanus*), which is proposed for listing as Threatened under the Endangered Species Act (ESA), is associated with short-grass habitat. This species' breeding habitat includes short-grass prairie and shrub-steppe landscapes; dryland, cultivated farms; areas of recent surface disturbance (e.g. well pads); and primarily, prairie dog towns. Plovers usually nest on sites where vegetation is sparse or absent as a result of grazing by herbivores, including domestic livestock and prairie dogs. Positive indicators for suitable mountain plover habitat includes level terrain, prairie dogs, bare ground, and *Opuntia* species, all of which exist within and adjacent to the WRPA. Mountain plovers were observed and photographed in the WRPA (Colonies F and H) during the prairie dog survey (Appendix D).

All wildlife sightings during the prairie dog survey and wetland plant inventories are listed in Table J-3.

Table J-3. Wildlife observations during prairie dog survey and wetland plant inventories.

Species
Pronghorn Antelope (*Antilocapra americana*)
Mule Deer (*Odocoileus hemionus*)
White-tailed Jackrabbit (*Lepus townsendii*)
Cottontail (*Sylvilagus sp.*)
Coyotes (*Canis latrans*)
Red-tailed Hawk (*Buteo jamaicensis*)
Sandhill Crane (*Grus canadensis*)
American Avocet (*Recurviostra americana*)
Pintail Duck (*Anas sp.*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Canada Goose (*Branta canadensis*)
Common Raven (*Corvus brachyrhynchus*)
Western Meadowlark (*Sturnella neglecta*)
Horned Toad (*Phrynusoma douglesii*)

4.0 RECOMMENDATIONS

Because the 10.3 burrow/acre (25.5 burrow/hectare) density and total acreage (1243 acres/503 ha) exceeds the USFWS minimum threshold of 8 burrows/acre (20 burrows/hectare) and 200 total acres, ferret surveys will be required in any prairie dog colony potentially affected by activities related to the Wind River Natural Gas Development Project. Should ferrets be documented within the WRPA, the BIA must enter into Section 7 Consultation with the USFWS regarding the potential impacts of the proposed project on the species.

Although mountain plovers were observed during the surveys, the proposed expansion would not adversely affect the species if construction is timed outside the nesting season. However, if construction is proposed within prairie dog colonies between April 10 and July 10, surveys for mountain plovers should be conducted according to the USFWS protocol (USFWS 1989).

REFERENCES

Biggens, D.E., A. Dood, A. Farmer, B. Miller, B. Oakleaf, and R. Crete. 1989. A System For Evaluating Black-Footed Ferret Habitat. Report Prepared For The Interstate Coordinating Committee. 1-13 pp.

Erwin, K. US Fish and Wildlife Service, personal communication with D. Martin, B&A, Sept. 2002.

U.S. Fish and Wildlife Service. 1989. Black-Footed Ferret Survey Guidelines for Compliance with the Endangered Species Act. U.S. Fish and Wildlife Service, Denver, Colorado and Albuquerque, New Mexico. April 1989.

APPENDIX A:

Aerial Survey White-tailed Prairie Dog (*Cynomys leucurus*) Colony Delineation

APPENDIX B:

Ground Survey White-tailed Prairie Dog (*Cynomys leucurus*) Colony Delineation

APPENDIX C:

Field Datasheets

APPENDIX D:

Photos

Photo 1. White-tailed prairie dog (*Cynomys leucurus*) Colony F.

Photo 2. Typical Sagebrush Steppe vegetative community found on the WRPA.

Photo 3. Mountain plover (*Charadrius montanus*) located on the Wind River Project Area within White-tailed prairie dog Colony F.

Photo 4. Horned toad (*Phymusoma douglesii*) located adjacent to the WRPA within White-tailed prairie dog Colony H.

Photo 5. Sandhill cranes (*Grus canadensis*) located at the depression on the Sand Mesa section of the WRPA.

Photo 6. Pronghorn antelope (*Antilocapra americana*) at depression on the Sand Mesa portion of the WRPA.

Photo 7. American avocet (*Recurviostra americana*) located on wetland on the WRPA.

Photo 8. Muddy Creek and associated wetland vegetation.

Photo 9. Five Mile Creek and associated wetland vegetation.

WIND RIVER INDIAN RESERVATION

FISHERIES & WILDLIFE SURVEY

August-September 2003

Environmental Legacy, LLC
Fort Washakie, Wyoming

on behalf of

Buys & Associates Inc.
Littleton, Colorado

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1 Introduction

This report details the results of a Fisheries & Wildlife Survey carried out during August and September 2003 by Environmental Legacy LLC, on behalf of Buys & Associates Inc., Littleton Colorado. The survey is a contribution to a wider Environmental Assessment Study being carried out in connection with a proposed gas and oil exploration by Tom Brown Inc. at various locations on the Wind River Indian Reservation, Wyoming (see Figure 1). Prior to carrying out this exploration on federal land, the federal landowner is required to comply with the National Environmental Policy Act (NEPA) as outlined in 40 CFR Section 1500.

A number of people and agencies contributed information and assistance to the project, including personnel in the U.S. Fish & Wildlife Service, Wyoming Game & Fish Department, Wind River Environmental Quality Commission, Wyoming Natural Diversity, and other environmental organizations and individuals. Specific individuals who provided information and assistance include: Dave Skates, Scott Roth and Pat Hnilicka of the U.S. Fish & Wildlife Service; Kevin Johnson, Reg Rothwell and staff of the Wyoming Game & Fish Department; Baptiste Weed of the Wind River Environmental Quality Commission; John and Pam Boaze of Fish & Wildlife Associates, and Rob Malpas of the Conservation Development Centre, Nairobi, Kenya. We thank all these individuals and others not mentioned here for their generous assistance.

2 Materials and Methods

2.1 Fish Sampling

Qualitative fisheries surveys were conducted at the following sites (see Figure 1):

- five sites on Fivemile Creek (G50, G50a, G50b, and at upstream sites 3 and 4);
- five sites on Muddy Creek (G52, G52a, G52 and upstream sites 1 and 2);
- one site on the lower portion of Cottonwood Creek. Other potential sites on Cottonwood Creek were found to be dry.

Fish communities in all habitat types such as pools, riffles, and runs were sampled using a seine (4' X 20') and/or fish trap (7"X 17"). All captured fish were identified to species in the field and recorded into 20 mm total length size groups.

Stocking records were obtained from Wyoming Game and Fish Departmen for information about the fish assemblage in Middle Depression Reservoir. No collections were made from the lake.

2.2 Wildlife survey

A survey of the wildlife species present within the study area during the late summer was carried out by transversing the area along established roadways and identifying all game and nongame species of birds and mammals observed. Each bird or mammal noted was identified to species and enumerated, and the habitat that was being used by each species was recorded for later tabulation.

3 Results

3.1 Fish sampling

Table 1 gives the map coordinates and the habitat description for each site, while Figures 2-12 present a photo description of each site looking upstream and downstream. Of all the stations sampled, Fivemile Creek Station G50 contained the best habitat, with a well-defined series of pools, riffles, and runs, clear water and good stream substrate (see Figure 5).

Table 2 presents the species of fish collected at each of the stations, while Table 3 shows the species and number in 20 mm total length groups for each of the stations sampled.

There were 10 species of fish collected during the survey. Cottonwood Creek exhibited the highest species richness (six species), while the upper station (Site 4) on Fivemile Creek was the next highest with five species. Two of the five sites on Muddy Creek produced four fish species. Of the sites sampled, only Site 2 on Muddy Creek failed to produce any fish.

Overall, Muddy Creek had the most diverse fish fauna with eight species. Both Cottonwood Creek and Fivemile Creek each produced six species.

Longnose dace (*Rhinichthys cataractae*) was the most common species collected. It occurred at eight (8) of the 10 stations sampled.

No fish species accorded Federal and/or State concern status were found in the study area (Table 4). Also, no game fish were collected during this survey (Table 5). However, game species have been previously recorded in Fivemile Creek, and their absence in this survey can be attributed to high water volumes in the Creek that prevented data collection at the two lower stations, G50a and G50b.

Table 6 lists the species stocked by Wyoming Game and Fish in Middle Depression Reservoir. However, the sampling data available from the agency is too dated - 1970's and early 1980's – to be of any assistance in determining the current fish assemblage.

3.2 Wildlife survey

Table 7 presents the results of the late summer wildlife inventory for the project area. The most common observed mammal within the project area was the pronghorn antelope. The brown-headed cowbird headed the list of the most frequently observed bird. While there were seven habitat types in the study area, more species were observed in the vicinity of the agricultural lands than any other habitat (Table 8).

The Principal Investigator's list of birds and mammals observed over 30 years of working and a lifetime of living on the Wind River Indian Reservation is contained in Table 9. No attempt was made to qualify the numbers of each species that have been noted over time.

Only one species of bird accorded Federal and/or State concern status was found within the study area, the Merlin (*Falco columbarius*) (Table 7).

Most of the study area falls within Wyoming Antelope Hunting Area #97 and Deer Hunting Area #157. Hunting takes place in the area during the month of September for Pronghorn antelope, and October and November for Whitetail and Mule deer.

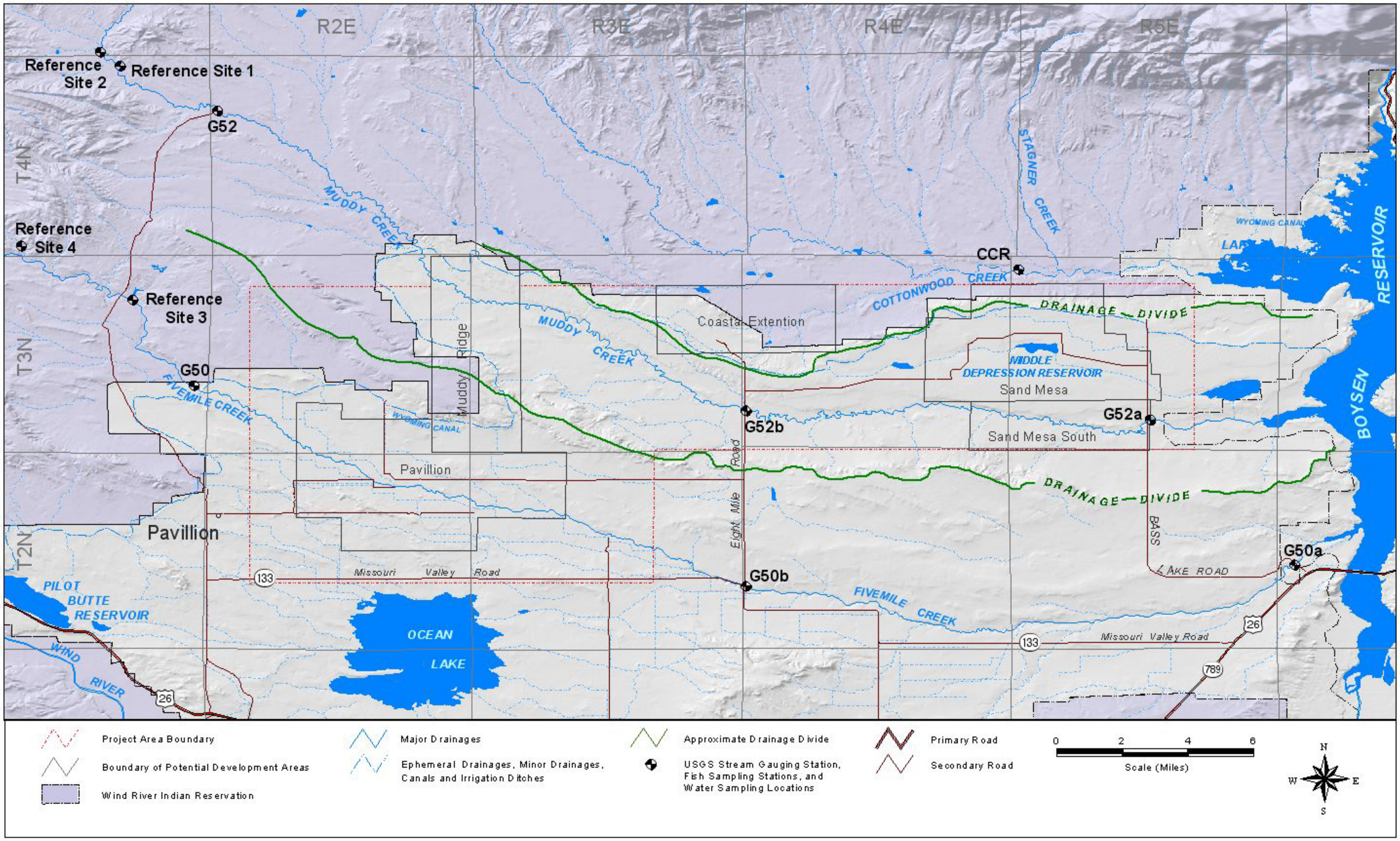

Figure 1. Wind River Area, showing the fisheries sampling sites and the location of present and future development areas

FISHERIES DATA

Table 1. Fish sampling stations, coordinates and habitat for the Fishery Survey of the Wind River Project, Fremont County, Wyoming, September 16-20, 2003

STREAM/STATION	COORDINATES	HABITAT	SUBSTRATE	DEPTH
Cottonwood Creek	N 43^{o} 21' 06" W 108^{o} 20' 47"	Pool, riffle, runs, undercut banks	Sand, gravel, clay	8" – 2'
Five-Mile Creek				
Station G50a	N 43^{o} 13' 34" W 108^{o} 13' 08"	Runs only, high water 300 cfs	*Not able to determine	4'+
Station G50b	N 43^{o} 12' 48" W 108^{o} 27' 37"	Runs only, high water	*Not able to determine	4'+
Station G50	N 43^{o} 18' 10" W 108^{o} 42' 12"	Riffle, run, pool undercut banks	Sand, gravel, some cobble	4" – 3'
Reference Site 3	N 43^{o} 20' 29" W 108^{o} 44' 03"	Run, riffle, limited pool, undercut banks	Clay, some gravel	10" – 3'
Reference Site 4	N 43^{o} 21' 47" W 108^{o} 46' 41"	Riffle, run, deep pool	**Not able to determine	1' – 8'
Muddy Creek				
Station G52a	N 43^{o} 17' 19" W 108^{o} 16' 59"	Pool, riffle, sandy bank eddy	Sand, clay	6" – 3'
Station G52b	N 43^{o} 17' 36" W 108^{o} 27' 37"	Pool, riffle, undercut banks, shallows	Sand, clay	1' – 4'

Table 1 continued

STREAM/STATION	COORDINATES	HABITAT	SUBSTRATE	DEPTH
Muddy Creek				
Station G52	N 43° 25' 22" W 108° 41' 32"	No flow, interspersed pools	Clay, cobble	8"
Reference Site 1	N 43° 26' 34" W 108° 44' 08"	Pool, run, undercut bank	Clay, stream choked with Chara	10" – 3'
Reference Site 2	N 43° 26' 54" W 108° 44' 33"	Multi-channeled, beaver dams, pool	Clay	up to 8"

* Fast, turbid, deep water
** Deep, narrow channel with turbid water

Table 2. Fishes collected by station, Fremont County, WY. September 16-20, 2003

Species	Cottonwood Creek	Site 2	Site 1	Muddy Creek Upper	Muddy Creek Middle	Muddy Creek Lower	Site 4	Site 3	Five Mile Creek Upper	Five Mile Creek Middle	Five Mile Creek Lower
Creek chub	X	-	-	-	-	-	-	-	X	-	-
Flathead chub	X	-	-	-	X	X	-	-	-	-	-
Johnny darter	X	-	-	-	-	-	-	-	-	-	-
Lake chub	X	-	X	X	-	-	X	X	X	-	-
Longnose dace	X	-	X	X	X	X	X	X	X	-	-
Plains Killifish	-	-	-	X	-	-	-	-	-	-	-
Mountain sucker	-	-	-	-	X	-	-	-	X	-	-
White sucker	X	-	-	-	X	X	X	X	X	-	-
Common carp	-	-	-	-	-	X	-	-	-	-	-
Fathead minnow	-	-	X	-	-	-	-	X	-	-	-
No. of species	6	0	3	3	4	4	3	4	5	*	*

* Unable to sample due to high water

Table 3. Fish Collected From Cottonwood, Muddy, and Fivemile Creeks

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
Cottonwood Creek	Creek chub	*Semotilus atromaculatus*	20 - 39	9
			40 - 59	7
			60 - 79	4
			80 - 99	4
			120 - 139	1
			Total:	*25*
	Flathead chub	*Platygobio gracilis*	20 - 39	10
			40 - 59	5
			60 - 79	4
			120 - 139	1
			Total:	*20*
	Johnny darter	*Etheostoma nigrum*	60 - 79	1
			Total:	*1*
	Lake chub	*Couesious plumbeus*	40 - 59	2
			60 - 79	1
			Total:	*3*
	Longnose dace	*Rhinichthys cataractae*	20 - 39	1
			40 - 59	1
			Total:	*2*
	White sucker	*Semotilus atromaculatus*	60 - 79	1
			160 - 179	2
			180 - 199	1
			Total:	*4*

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
Lower Muddy Creek G52a	Flathead chub	*Platygobio gracilis*	40 - 59	1
			60 - 79	4
			140 - 159	1
			160 - 179	1
			Total:	*7*
	Longnose dace	*Rhinichthys cataractae*	40 - 59	2
			60 - 79	3
			80 - 99	1
			Total:	*6*
	White Sucker	*Semotilus atromaculatus*	100 - 119	2
			Total:	*2*
	Common Carp	*Cyprinus carpio*	80 - 99	1
			Total:	*1*
Middle Muddy Creek G52b	Flathead chub	*Platygobio gracilis*	100 - 119	1
			120 - 139	6
			Total:	*7*
	Longnose dace	*Rhinichthys cataractae*	40 - 59	1
			60 - 79	1
			80 - 99	1
			Total:	*3*
	Mountain sucker	*Catostomus platyrhynchus*	120 - 139	1
			Total:	*1*

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
	White sucker	*Semotilus atromaculatus*	160 - 179	1
			Total:	*1*
Upper Muddy Creek G52	Lake chub	*Couesious plumbeus*	60 - 79	1
			Total:	*1*
	Longnose dace	*Rhinichthys cataractae*	60 - 79	1
			Total:	*1*
	Plains killifish	*Fundulus zebrinus*	40 - 59	16
			60 - 79	12
			Total:	*28*
Muddy Creek Reference Site 1	Lake chub	*Couesious plumbeus*	40 - 59	21
			60 -79	31
			80 - 99	9
			100 - 119	9
			Total:	*70*
	Longnose dace	*Rhinichthys cataractae*	40 - 59	8
			60 - 79	16
			Total:	*24*
	Fathead minnow	*Pimephales promelas*	20 - 39	1
			40 - 59	3
			Total:	*4*

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
Muddy Creek Reference Site 2	No Fish Collected[1]			
Lower Fivemile Creek G50a	No Fish Collected[2]			
Middle Fivemile Creek G50b	No Fish Collected			
Upper Fivemile Creek G50	Creek chub	*Semotilus atromaculatus*	20 - 39	2
			40 - 59	2
			Total:	*4*
	Lake chub	*Couesious plumbeus*	20 - 39	1
			60 - 79	20
			80 - 99	3
			100 - 119	2
			Total:	*26*
	Longnose dace	*Rhinichthys cataractae*	20 - 39	6
			40 - 59	10
			60 - 79	1
			80 - 99	1
			Total:	*18*
	Mountain sucker	*Catostomus platyrhynchus*	100 - 119	1
			Total:	*1*

[1] At this site, the stream was not free-flowing and only isolated pools remained, preventing fish movements.
[2] At this site, high water flows prevented sampling.

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
	White sucker	*Semotilus atromaculatus*	100 - 119	1
			120 - 139	1
			Total:	*2*
Fivemile Creek Reference Site 3	Lake chub	*Couesious plumbeus*	40 - 59	2
			60 - 79	12
			80 - 99	1
			Total:	*15*
	Flathead minnow	*Pimephales promelas*	40 - 59	1
	Longnose dace	*Rhinichthys cataractae*	40 - 59	2
			60 - 79	4
			Total:	*6*
	White sucker	*Semotilus atromaculatus*	60 - 79	2
			80 - 99	2
			100 - 119	1
			140 - 159	1
			160 - 179	1
			Total:	*7*
Fivemile Creek Reference Site 4	Lake chub	*Couesious plumbeus*	60 - 79	5
			80 - 99	24
			100 - 119	3
			Total:	*32*
	Longnose dace	*Rhinichthys cataractae*	80 - 99	1
			Total:	*1*

Sampling Location	Species (Common Name)	Species (Scientific Name)	Total Length by 20 mm Groups	Number
	White Sucker	*Semotilus atromaculatus*	140 - 159	1
			Total:	*1*

Table 4. Threatened, Endangered, or Species of Fish that may occur in Fremont Co. WY

(From: Wyoming Natural Diversity Database, July 25, 2002[3])

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
Hornyhead chub	*Nocomis biguttatus*	G5/S2	WYGF NSS1	ALB, CAR, CON, FRE, GOS, NAT, PLA, SUB	W periph. Disjunct

[3] http://uwadmnweb.uwyo.edu/wyndd/Fish/fish.htm

Table 5. List of Game and Non-game fishes occurring in Wyoming

(From: WY Game and Fish, Cheyenne, WY)

Common name	Game/nongame	Scientific name
Arctic grayling	Game	*Thymallus arcticus*
Bigmouth shiner	Nongame	*Notropis dorsalis*
Black bullhead	Game	*Ameiurus melas*
Bluehead sucker	Nongame	*Catostomus discobolus*
Brassy minnow	Nongame	*Hybognathus hankinsoni*
Burbot	Game	*Lota lota*
Central stoneroller	Nongame	*Campostoma anomalum*
Channel catfish	Game	*Ictalurus punctatus*
Common shiner	Nongame	*Luxilus cornutus*
Creek chub	Nongame	*Semotilus atromaculatus*
Cutthroat trout	Game	*Oncorhynchus clarki*
Fathead minnow	Nongame	*Pimephales promelas*
Finescale dace	Nongame	*Phoxinus neogaeus*
Flannelmouth sucker	Nongame	*Catostomus latipinnis*
Flathead chub	Nongame	*Platygobio gracilis*
Goldeye	Nongame	*Hiodon alosoides*
Hornyhead chub	Nongame	*Nocomis biguttatus*
Iowa darter	Nongame	*Etheostoma exile*
Johnny darter	Nongame	*Etheostoma nigrum*
Lake chub	Nongame	*Couesius plumbeus*
Leatherside chub	Nongame	*Gila copei*
Longnose dace	Nongame	*Rhinichthys cataractae*
Longnose sucker	Nongame	*Catostomus catostomus*
Mottled sculpin	Nongame	*Cottus bairdi*
Mountain sucker	Nongame	*Catostomus platyrhynchus*
Mountain whitefish	Game	*Prosopium williamsoni*
Orangethroat darter	Nongame	*Etheostoma spectabile*
Paiute sculpin	Nongame	*Cottus beldingi*
Pearl dace	Nongame	*Margariscus margarita*
Plains killifish	Nongame	*Fundulus zebrinus*
Plains minnow	Nongame	*Hybognathus placitus*
Plains topminnow	Nongame	*Fundulus sciadicus*
Quillback	Nongame	*Carpiodes cyprinus*
Red shiner	Nongame	*Cyprinella lutrensis*
Redside shiner	Nongame	*Richardsonius balteatus*
River carpsucker	Nongame	*Carpiodes carpio*

Common name	Game/nongame	Scientific name
Roundtail chub	Nongame	*Gila robusta*
Sand shiner	Nongame	*Notropis stramineus*
Sauger	Game	*Stizostedion canadense*
Shorthead redhorse	Nongame	*Moxostoma macrolepidotum*
Shovelnose sturgeon	Game	*Scaphirhynchus platorynchus*
Speckled dace	Nongame	*Rhinichthys osculus*
Stonecat	Game	*Noturus flavus*
Sturgeon chub	Nongame	*Macrhybopsis gelida*
Suckermouth minnow	Nongame	*Phenacobius mirabilis*
Utah chub	Nongame	*Gila atraria*
Utah sucker	Nongame	*Catostomus ardens*
Western silvery minnow	Nongame	*Hybognathus argyritis*
White sucker	Nongame	*Catostomus commersoni*

Table 6. Summary of fish stocked in Middle Depression Reservoir, Fremont County, WY, 1986-2003

Year	Species	Number
1986	Eagle Lake Rainbow	8000
1987	Eagle Lake Rainbow Kremmerer City Rainbow	10320 2076
1988	Eagle Lake Rainbow	5100
1989	Eagle Lake Rainbow Fall Rainbow	2538 4511
1990	Eagle Lake Rainbow Fall Rainbow	6750 2016
1991	Eagle Lake Rainbow Fall Rainbow Brown Trout	5045 2321 2016
1992	Eagle Lake Rainbow	5073
1993	Eagle Lake Rainbow	4965
1994	Brown Trout Eagle Lake Rainbow	7100 5008
1995	Eagle Lake Rainbow	5074
1996	Eagle Lake Rainbow Brown Trout	5040 7742
1997	Eagle Lake Rainbow	5200
1998	Eagle Lake Rainbow Brown Trout	5073 4998
1999	Brown Trout	4500
2000	Brown Trout Eagle Lake Rainbow	5004 5118
2001	Eagle Lake Rainbow Brown Trout	5000 5490
2002	Eagle Lake Rainbow Fall Rainbow	3150 16005
2003	Eagle Lake Rainbow Fall Rainbow	3230 17589

WILDLIFE DATA

Table 7. Mammals and Birds Observed in Wind River Project Area September 2003

Common Name	*Latin Name*	Management Status	Number Observed in Project Area	Habitat Observed
Mammals				
Beaver	*Castor canadensis*	FB	2	Wetlands, Riparian
Coyote	*Canis latrans*	PD	2	Sagebrush-Grasslands
Desert Cottontail	*Sylvilagus auduboni*	SG	6	Sagebrush-Grasslands
Mule Deer	*Odocoileus hemionus*	BG	19	Agricultural lands, Riparian
Pronghorn	*Antilocapra americana*	BG	265	Agricultural lands, Sagebrush-Grasslands
Raccoon	*Procyon lotor*	PD	2	Riparian
White-tailed Jackrabbit	*Lepus townsendii*	PD	3	Sagebrush-Grasslands
White-tailed Prairie Dog	*Cynomys leucurus*	NG	8	Sagebrush-Grasslands
Birds				
American Kestrel	*Falco sparverius*	NTMB F	22	Agricultural lands, Sagebrush-Grasslands
American Robin	*Turdus migratorius*	NTMB	1	Agricultural lands
American White Pelican	*Pelecanus eythrorhynchos*	SSC3	4	Lakes
American Coot	*Fulica americana*	Game Bird	37	Lakes
Black-Billed magpie	*Pica pica*	N/A	2	Riparian
Blue-Winged Teal	*Anas discors*	GB	7	Lakes
Brown-headed Cowbird	*Molothrus ater*	NTMB	571	Agricultural lands
Canada Goose	*Branta Canadensis*	GB	45	Lakes
Common Grackle	*Quiscalus quiscula*	N/A	137	Agricultural lands

Common Name	*Latin Name*	Management Status	Number Observed in Project Area	Habitat Observed
Common Raven	*Corvus corax*	N/A	9	Agricultural land, Sagebrush-Grasslands
Eastern Kingbird	*Tyrannus tyrannus*	NTMB	95	Agricultural lands
European Starling	*Stumus vulgaris*	N/A	92	Agricultural lands
Ferruginous Hawk	*Buteo regalis*	SSC3 NTMB F	1	Sagebrush-Grasslands
Gadwall	*Anas strepera*	GB	6	Lakes
Great Blue Heron	*Ardea herodias*	SSC4	2	Lakes
Lark Bunting	*Calamospiza melanocorys*	NTMB	1	Agricultural lands
Mallard	*Anas platyrhynchos*	GB	23	Lakes
Merlin	*Falco columbarius*	SSC3 NTMB F	1	Agricultural lands
Mourning Dove	*Zenaida macroura*	GB NTMB	158	Agricultural lands
Northern Flicker	*Colaptes auratus*	N/A	8	Agricultural lands
Northern Harrier	*Circus cyaneus*	NTMB F	2	Wetlands
Peregrine Falcon	*Falco peregrinus*	SSC3 NTMB Endangered	1	Agricultural lands
Red-tailed Hawk	*Buteo jamaicensis*	NTMB F	3	Sagebrush-grasslands, Rock outcrops
Red-winged Blackbird	*Agelaius phoeniceus*	NTMB	18	Riparian, wetlands
Rock Dove	*Columba livia*	N/A	105	Agricultural lands

Common Name	*Latin Name*	Management Status	Number Observed in Project Area	Habitat Observed
Ruddy Duck	*Oxyura jamaicensis*	GB	1	Lakes
Sandhill Crane	*Grus canadensis*	GB	50	Agricultural lands, Grasslands
Say's Phoebe	*Sayornis saya*	NTMB	2	Agricultural lands, rock outcrops
Sharp-shinned Hawk	*Accipiter striatus*	NTMB F	1	Agricultural lands/ Wetlands
Tree Swallow	*Tachycineta bicolor*	NTMB	95	Riparian
Turkey Vulture	*Carthartes aura*	NTMB	1	Agricultural lands
Western Meadowlark	*Sturnella neglecta*	NTMB	31	Sagebrush-grasslands
Western Bluebird	*Sialia mexicana*	NTMB	18	Sagebrush-grasslands
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	NTMB	62	Wetlands

Acronyms and Abbreviations

BG	Big Game
F	Taken for Falconry
FB	Furbearer
N/A	Not Applicable
NG	Nongame Species
NTMB	Neotropical Migratory Bird
PD	Predator
SG	Small Game
SSC1	1996 Nongame Bird and Mammal Plan Species of Special Concern 1
SSC2	1996 Nongame Bird and Mammal Plan Species of Special Concern 2
SSC3	1996 Nongame Bird and Mammal Plan Species of Special Concern 3
TG	Trophy Game
*	Reported by WG&F Database

Table 8. Wildlife habitats in the Potential Development Areas, Wind River Project, Fremont County, Wyoming, September 2003

Habitat Type	Pavillion	Muddy Ridge	Coastal Extension	Sand Mesa	Sand Mesa South
Agricultural lands	Present	Present	Present	Present	Present
Sagebrush-grasslands	Present	Present	Present	Present	Present
Sandy bare areas	Present	Present	Present	Present	Present
Rock outcrops	Present	Present	Present	Present	Present
Riparian	Present	Present	Present	Present	Present
Wetlands	Present	Not Present	Present	Present	Present
Lakes	Not Present	Not Present	Present	Present	Present

Table 9. Incidental observations of wildlife over the last 30 years in Fremont County, WY

(Richard Baldes, Biologist, ret. US FWS. Personal Communications)

Scientific Name	Common Name
Birds	
Aechmophorus occidentalis	Western Grebe
Phalacrocorax auritus	Double-crested Cormorant
Chen caerulescens	Snow Goose
Anas crecca	Green-winged Teal
Anas acuta	Northern Pintail
Anas cyanoptera	Cinnamon Teal
Anas clypeata	Northern Shoveler
Anas americana	American Wigeon
Aythya americana	Redhead
Mergus merganser	Common Merganser
Haliaeetus leucocephalus	Bald Eagle
Aquila chrysaetos	Golden Eagle
Buteo lagopus	Rough-legged Hawk
Perdix perdix	Gray Partridge
Alectoris chukar	Chukar
Phasianus colchicus	Ring-necked Pheasant
Centrocercus urophasianus	Sage-Grouse
Charadrius vociferus	Killdeer
Recurvirostra americana	American Avocet
Numenius americanus	Long-billed Curlew
Phalaropus tricolor	Wilson's Phalarope
Bubo virginianus	Great Horned Owl
Chordeiles minor	Common Nighthawk
Eremophila alpestris	Horned Lark
Tachycineta thalassina	Violet-green Swallow
Petrochelidon pyrrhonota	Cliff Swallow
Pooecetes gramineus	Vesper Sparrow
Passer domesticus	House Sparrow
Mammals	
Ondatra zibethicus	*Muskrat*
Erethizon dorsatum	*Porcupine*
Vulpes vulpes	Red Fox
Taxidea taxus	Badger
Mephitis mephitis	Striped Skunk
Cervus elaphus	Elk
Alces alces	Moose

Table 10. Threatened, Endangered, or Species of Birds and Mammals that may occur in Fremont Co. WY.

From: Wyoming Natural Diversity Database, July 25, 2002.

Birds

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
Common loon	*Gavia immer*	G5/S2B,SZN	USFS R2 Sensitive, USFS R4 Sensitive, WYGF SSC1	**FRE?,** PAR, SUB?, TET	Breed: S periph
Clark's grebe	*Aechmophorus clarkii [Achemophorus occidentalis]*	G5/S2B,SZN	WYGF SSC4	ALB?, BIG, CAR, **FRE**, NAT, SWE	Breed: core
American bittern	*Botaurus lentiginosus*	G4/S2B,SZN	USFS R2 Sensitive, WYGF SSC3	ALB, CAR, CON, **FRE**, GOS, LIN, PLA, SHE, SWE, TET, UIN	Breed: core
Ring-necked duck	*Aythya collaris*	G5/S3B,S3?N		BIG, CAR, **FRE**, LAR, PAR, SHE, SUB, TET	Breed: S periph. Year-round: interior periph. Winter: interior periph.
Harlequin duck	*Histrionicus histrionicus*	G4/S1B,SZ?N	USFS R2 Sensitive, USFS	BIG, **FRE**, HOT,	Breed: S periph

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
			R4 Sensitive, WYGF SSC3	LIN, PAR, SUB, TET	
Bald eagle	*Haliaeetus leucocephalus*	G4/S2B,S3N	USFWS Threatened (proposed for delisting), WYGF SSC2	ALB, BIG, CAM, CAR, CON, CRO, **FRE**, GOS, HOT, JOH, LIN, NAT, NIO, PAR, PLA, SHE, SUB, SWE, TET, UIN	Breed; S periph. Year-round: S periph. Winter: core
Northern goshawk	*Accipiter gentilis*	G5/S23B,S4N	USFS R2 Sensitive, USFS R4 Sensitive, Wyoming BLM Sensitive, WYGF SSC4	ALB, BIG, CAM, CAR, CRO, **FRE**, JOH, LIN, NAT, PAR, SHE, SUB, SWE, TET, UIN, WAS	Year-round: core
Merlin	*Falco columbarius*	G5/S2B,SZN	USFS R2 Sensitive, WYGF SSC3	ALB, CAM, CAR, CON, CRO,	Breed: S periph. Year-round: S periph. Winter: N

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				FRE, HOT, JOH, LIN, NAT, PAR, SHE, SUB, SWE, TET, UIN, WAS, WES	periph.
American peregrine falcon	*Falco peregrinus anatum*	G4T3/S1B,S2N	Recently de-listed by USFWS, Wyoming BLM Sensitive, WYGF SSC3	ALB, CAR, CON, CRO, **FRE**, JOH, LIN, PAR, SUB, SWE, TET	Breed: core Winter: N periph.
White-tailed ptarmigan	*Lagopus leucurus*	G5/S1		ALB, HOT?, **FRE**, LIN, PAR, TET	Year-round: S periph.
Whooping crane	*Grus americana*	G1/S1N	USFWS Endangered	**FRE**, LIN, PAR, SUB, SWE, TET	(summer nonbreeding aggregation)
Snowy plover	*Charadrius alexandrinus*	G4/S1B,S2?N	USFS R2 Sensitive	ALB, CAR, CRO,	Breed: N periph

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				FRE, NAT, SWE	
Piping plover	*Charadrius melodus*	G3/SHB,S2N	USFWS Threatened	CRO, GOS, **FRE**?, NAT	Breed: SW periph
Mountain plover	*Charadrius montanus*	G2/S2B,SZN	USFWS Proposed Threatened	ALB, BIG, CAM, CAR, CON, **FRE**, GOS, LAR, LIN, NAT, PAR, SWE, SUB	Breed: reg. Endm
Long-billed curlew	*Numenius americanus*	G5/S3B,SZN	USFS R2 Sensitive, Wyoming BLM Sensitive, WYGF SSC3	ALB, BIG, CAM, CAR, CON, CRO, **FRE**, GOS, HOT, LIN, NAT, NIO, PAR, SHE, SUB, SWE, TET, UIN, WES	Breed: core
Wilson's phalarope	*Phalaropus tricolor*	G5/S3B,S3N		(all counties)	Breed: core
Ring-billed gull (Breeding colonies	*Larus delawarensis*	G5/S1B,SZN		**FRE**, PAR, TET	Breed: S periph. Winter: interior periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
only)					
Caspian tern	*Sterna caspia*	G5/S1B,SZN	WYGF SSC3	ALB, CAR, **FRE**, NAT, TET, PAR	Breed: interior periph.
Forster's tern	*Sterna forsteri*	G5/S1B,SZN	WYGF SSC3	ALB, CAR, **FRE**, LIN	Breed: core
Black-billed cuckoo	*Coccyzus erythropthalmus*	G5/S2B,SZN		BIG, **FRE**, GOS, HOT, NAT, PLA, SHE, WAS	Breed: SW periph.
Short-eared owl	*Asio flammeus*	G5/S2S3		(all counties)	Year-round: core
Northern pygmy-owl	*Glaucidium gnoma*	G5/S2	WYGF SSC4	**FRE**, LIN, TET	Year-round: E periph.
Burrowing owl	*Athene cunicularia [Speotyto cunicularia]*	G4/S3B,SZN	USFS R2 Sensitive, Wyoming BLM Sensitive, WYGF SSC4	(all counties)	Breed: core
Great gray owl	*Strix nebulosa*	G5/S2	USFS R4 Sensitive, WYGF SSC4	CAR, **FRE**, LIN, PAR, SUB, TET	Year-round: S periph.
Boreal owl	*Aegolius funereus*	G5/S2	USFS R2 Sensitive, USFS R4 Sensitive,	ALB, CAR, **FRE**, LIN, PLA?,	Year-round: S periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
			WYGF SSC4	TET, UIN	
Williamson's sapsucker	*Sphyrapicus thyroideus*	G5/S3B,SZN		ALB, CAR, **FRE**, JOH, LIN, SHE, SUB, TET, UIN	Breed: core
Three-toed woodpecker	*Picoides tridactylus*	G5/S3	USFS R2 Sensitive, USFS R4 Sensitive	ALB, BIG, CAR, CRO, **FRE**, JOH, LIN, NAT, PAR, PLA, SHE, SWE, TET, UIN, WAS	Year-round: S periph.
Hammond's flycatcher	*Empidonax hammondii*	G5/S3B,SZN		CAR, **FRE**, GOS?, LIN, NAT, PAR, SHE, SUB, SWE, TET	Breed: SE periph.
Cassin's kingbird	*Tyrannus vociferans*	G5/S3B,SZN		ALB, CON, CRO, **FRE**, LAR, NIO,	Breed: N periph

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				PLA, WES	
Black-throated gray warbler	*Dendroica nigrescens*	G5/S2B,SZN		**FRE**, HOT, SWE	Breed: E periph.
Sage sparrow	*Amphispiza belli*	G5/S3B,SZN	Wyoming BLM Sensitive	ALB, BIG, CAM, CAR, CON, **FRE**, GOS, HOT, JOH, LIN, NIO, NAT, PLA, SHE, SWE, SUB, TET, WAS, WES, UIN	Breed: reg. endm.
Brewer's sparrow	*Spizella breweri*	G5/S3B, SZN	Wyoming BLM Sensitive	(all counties)	Breed: core
McCown's longspur	*Calcarius mccownii*	G5/S3B,SZN		ALB, CAM, CAR, CON, **FRE**, GOS, JOH, LAR, NAT, NIO, PAR, PLA, SHE, SWE, WES	Breed: reg. endm.
Bobolink	*Dolichonyx oryzivorus*	G5/S3B,SZN		CAR, CRO, **FRE**,	Breed: SW periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				GOS, PAR, SHE, TET	
White-winged crossbill	*Loxia leucoptera*	G5/S1B,S2N		PAR, TET, **FRE**	Breed: S periph. Winter: S periph.

Mammals

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
Long-eared myotis	*Myotis evotis*	G5/S1B, S1?N	Wyoming BLM Sensitive, WYGF SSC2	BIG, CAM, CAR, CON, CRO, **FRE**, GOS, HOT, JOH, LAR, LIN, NAT, PAR, PLA, SHE, SUB, SWE, TET, WAS, WES	Breed: core Winter: N periph.
Fringed myotis	*Myotis thysanodes*	G5/S1B,S1N	USFS R2 Sensitive, Wyoming BLM Sensitive, WYGF SSC2	ALB, BIG, CAR, CRO, **FRE**, GOS, JOH, LAR, NAT, PAR, PLA,	Breed: E periph. Winter: N periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				SHE, SUB, SWE, WAS, WES	
Hoary bat	*Lasiurus cinereus*	G5/S2B, SZ?N		ALB, BIG, CAM, CAR, CON, CRO, **FRE**, HOT, LAR, LIN, NAT, PAR, PLA, SHE, SUB, SWE, TET, WAS, WES	Breed: core
Spotted bat	*Euderma maculatum*	G4/S1B, SZ?N	USFS R2 Sensitive, USFS R4 Sensitive, Wyoming BLM Sensitive, WYGF SSC2	BIG, CON, **FRE**, HOT, JOH, PAR, SWE, WAS	Breed: E periph.
Townsend's big-eared bat	*Corynorhinus townsendii [Plecotus townsendii]*	G4/S1B,S2N	USFS R2 Sensitive, USFS R4 Sensitive, Wyoming BLM Sensitive, WYGF SSC2	ALB, BIG, CAR, CON, CRO, **FRE**, GOS, HOT, JOH, LAR, NAT,	Breed: Core Winter: N periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				NIO, PAR, PLA, SHE, SWE, WAS	
Pallid bat	*Antrozous pallidus*	G5/S1B,SZ? N	WYGF SSC2	ALB, **FRE**, GOS, HOT, SWE, WAS	Breed: E periph
Pygmy rabbit	*Brachylagus idahoensis [Sylvilagus idahoensis]*	G4/S2	Wyoming BLM Sensitive, WYGF SSC3	**FRE**?, LIN, SUB, SWE, UIN	E periph. Disjunct?
Allen's thirteen-lined ground squirrel	*Spermophilus tridecemlineatus alleni*	G5T1Q/S1	USFS R2 Sensitive	BIG?, **FRE**, HOT, SUB?, WAS	State endm.
White-tailed prairie dog (Large towns only)	*Cynomys leucurus*	G4/S2S3	Wyoming BLM Sensitive	ALB, BIG, CAR, **FRE**, HOT, JOH, LIN, NAT, PAR, SUB, SWE, UIN, WAS	Reg. endm.
Water vole (statewide)	*Microtus richardsoni [Arvicola richardsoni]*	G5/S2S3	USFS R2 Sensitive, WYGF SSC3	BIG, **FRE**, HOT, JOH, LIN,	E periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
				PAR, SHE, SUB, TET, WAS	
Gray wolf	*Canis lupus*	G4/S2	USFWS Endangered	**FRE**, PAR, TET, SUB?	Historic: core Extant: S periph. Reintroduced
Swift fox	*Vulpes velox*	G3/S2S3	USFS R2 Sensitive, Wyoming BLM Sensitive, WYGF SSC3	ALB, CAM, CAR, CON, CRO?, **FRE**?, GOS, JOH, LAR, NAT, NIO, PLA, SWE, WAS, WES	Core
Common gray fox	*Urocyon cinereoargenteus*	G5/S2		CAR, CAM, CON, CRO, **FRE**?, GOS, NAT, NIO, PLA, WES	NW periph
Grizzly bear	*Ursus arctos*	G4/S2	USFWS Threatened	**FRE**, HOT, PAR, SUB, TET	Historic: core Extant: S periph.
Fisher	*Martes pennanti*	G5/S1	USFS R2 Sensitive, USFS R4 Sensitive	**FRE**?, PAR, TET	S periph
Wolverine	*Gulo gulo [Gulo luscus]*	G4/S2	USFS R2	BIG?, **FRE**,	S periph.

Common Name	Species	Heritage Rank	Federal and State Status	County	Range notes
			Sensitive, USFS R4 Sensitive, WYGF SSC3	LIN, PAR, SHE?, SUB, TET	
Western spotted skunk	*Spilogale gracilis [Spilogale putorius]*	G5/S2?		CAR?, **FRE**?, PAR, SWE	E periph**.**
River otter	*Lontra canadensis [Lutra canadensis]*	G5/S3		ALB, BIG, CAR, **FRE**, HOT, JOH, LIN, NAT, PAR, SHE, SUB, SWE, TET, UIN	Core
Canada lynx [North American lynx]	*Lynx canadensis [Felis lynx]*	G5/S1	USFWS Threatened	BIG?, **FRE**, LIN, PAR, SUB, TET, UIN	S periph.

HABITAT PHOTOS

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Figure 2. Cottonwood Creek Upstream (above) and Downstream (below)

Figure 3. Five-Mile Creek Station G50a Upstream (above) and Downstream (below)

Figure 4. Five-Mile Creek Station G50b Upstream (above) and Downstream (below)

Figure 5. Five-Mile Creek Station G50 Upstream (above) and Downstream (below)

Figure 6. Five-Mile Creek Site 3 Upstream (above) and Downstream (below)

Figure 7. Five-Mile Creek Site 4 Upstream (above) and Downstream (below)

Figure 8. Muddy Creek Station G52a Upstream (above) and Downstream (below)

Figure 9. Muddy Creek Station G52b Upstream (above) and Downstream (below)

Figure 10. Muddy Creek Station G52 Upstream (above) and Downstream (below)

Figure 11. Muddy Creek Site 1 Upstream (above) and Downstream (below)

Figure 12. Muddy Creek Site 2 Upstream (above) and Downstream (below)

Table J-4. Macroinvertebrates Collected from Fivemile and Muddy Creeks in Spring 2002 and 2003.

LOCATION/ STATION #	DATE	CLASS	ORDER/ FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
Upper Fivemile Creek/G50	**05/16/02**	**Crustacea**			**17**	**2.05%**	
			Amphipoda/Talitridae	*Hyalella azteca*	17		A
		Gastropoda			**1**	**0.12%**	
			Pulmonata/Physidae	*Physa utahensis*	1		A
		Insecta			**387**	**46.68%**	
			Coleoptera/Dryopidae	*Postelichus* sp. 1	3		A
			Coleoptera/Dytiscidae	*Agabus* sp. 1	3		L
				Agabus sp. 2	1		A
				Laccophilus maculosus	1		AM
				Stictotarsus aequinoctialis	1		A
			Coleoptera/Halipidae	*Haliplus leechi*	1		A
			Diptera/Ceratopogonia	*Bezzia/Palpomyia* spp. 1	178		Late
				Culicoides sp. 2	6		L
			Diptera/Chironomidae	*Cricotopus (Cricotopus) trifascia*	14		L, P
				Cryptochironomus sp. 615	23		L
				Cryptotendipes sp. 674	32		L
				Micropsectra sp. 409	3		L
				Orthocladius sp. 595	23		L
				Orthocladius sp. 633	3		L
				Orthocladius? sp. 87	6		L
				Parakiefferiella bathophila	11		L, P
				Paramerina sp. 579	3		L
				Parametriocnemus lundbeckii	49		L
				Polypedilum sp. 616	3		L
				Tvetenia sp. 505	3		L
			Diptera/Simuliidae	*Simulium arcticum?*	3		L
			Diptera/Tipulidae	*Ormosia* sp. 2	3		L
			Hemiptera/Naucoridae	*Ambrysus mormon*	2		A
			Odonata/Gomphidae	*Ophiogomphus sevrus*	3		N
			Trichoptera/ Hydropsychidae	*Cheumatopsyche* sp. 1	3		L

LOCATION/ STATION #	DATE	CLASS	ORDER/ FAMILY	SPECIES	No. Individuals/	% TOTAL	LIFE STAGE
			Trichoptera/ Hydroptilidae	*Hydroptila* sp. 1	3		L
			Trichoptera/ Limnephilidae	*Hesperophylax* sp. 1	3		P
		Oligochaeta			**424**	**51.15%**	
			Tubificida/Tubificidae	*Tubifex tubifex*	424		A
Middle Fivemile Creek/G50	**04/16/03**	**Chelicerata**			**11**	**1.11%**	
			Acari/Sperchonidae	*Sperchon* sp. 1	11		A
		Crustacea			**6**	**0.60%**	
			Ostracoda/Cypridae	*Cadona* sp. 1	6		A
		Gastropoda			**6**	**0.60%**	
			Pulmonata/Physidae	*Physa utahensis*	6		A
		Insecta			**556**	**56.05%**	
			Coleoptera/Elmidae	*Dubiraphia* sp. 1	9		L, A
			Diptera/Ceratopogonia	*Bezzia/Palpomyia* sp. 1	9		L
			Diptera/Chironomidae	*Brillia retifinis*	6		L
				Chironomus sp. 631	3		L
				Cricotopus (Cricotopus) trifascia	3		L
				Cricotopus sp. 490	54		L, P
				Cricotopus sp. 632	3		L
				Cryptochironomus sp. 615	52		L
				Diamesa leona	103		L
				Endochironomus sp. 482	6		L
				Micropsectra sp. 409	54		L
				Orthocladius sp. 595	11		L
				Orthocladius sp. 86	23		L
				Orthocladius? sp. 87	37		L, P
				Parakiefferiella bathophila	34		L, P
				Parametriocnemus lundbeckii	17		L
				Rheocricotopus sp. 496	3		L
				Tanytarsus (Tanytarsus) sp. 656	32		L
			Diptera/Simuliidae	*Simulium (Psilozia) vittatum*	11		L, P
			Diptera/Tipulidae	*Tipula* sp. 2	1		L

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
			Ephemeroptera/ Tricorythidae	*Tricorythodes minutus*	34		N
			Hemiptera/Corixidae	*Sigara* sp. 1	2		AF
			Hemiptera/Naucoridae	*Ambrysus mormon*	1		N
			Odonata/ Coenagrionidae	*Coenagrion resolutum*	2		N
			Odonata/Gomphidae	*Ophiogomphus sevrus*	11		N
			Trichoptera/ Hydropsychidae	*Hydropsyche* sp. 3	34		L
			Trichoptera/ Limnephilidae	*Hesperophylax* sp. 1	1		L
		Oligochaeta			**413**	**41.63%**	
			Plesiopora/Tubificidae	*Limnodrilus hoffmeisterii*	149		A
			Tubificida/Tubificidae	*Tubifex tubifex*	258		A
			UNID/Lumbricidae	*Eiseniella tetraedra*	6		A
Lower Fivemile Creek/G50A	**04/25/02**	**Chelicerata**			**48**	**2.57%**	
			Acari/Lebertiidae	*Lebertia* sp. 2	9		A
			Acari/Sperchonidae	*Sperchon* sp. 1	39		A
		Crustacea			**5**	**0.27%**	
			Amphipoda/ Gammaridae	*Gammarus lacustris*	1		A
			Amphipoda/Talitridae	*Hyalella azteca*	4		A
		Insecta			**1422**	**76.21%**	
			Coleoptera/Elmidae	*Stenelmis* sp. 1	13		L
			Diptera/Ceratopogonia	*Probezzia* sp. 2	22		L
			Diptera/Chironomidae	*Cricotopus (Cricotopus) trifascia*	43		L
				Cricotopus sp. 490	116		L
				Diamesa sp. 554	13		L
				Endochironomus sp. 482	17		L
				Eukiefferiella? Sp. 495	13		L
				Micropsectra? Sp. 481	13		L
				Orthocladius sp. 654	9		L, L/P
				Parakiefferiella bathophila	34		L

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
				Polypedilum sp. 492	26		L
				Polypedilum sp. 616	9		L
				Rheocricotopus sp. 496	17		L
				Tanytarsus Tanytarsus sp. 656	9		L
				Tvetenia sp. 505	30		L
			Diptera/Simuliidae	*Simulium Psilopelmia venator*	17		L
			Diptera/Tipulidae	*Tipula* sp. 2	4		L
			Ephemeroptera/ Baetidae	*Baetis tricaudatus*	817		N
			Ephemeroptera/ Ephemerellidae	*Ephemerella infrequens*	13		N
			Ephemeroptera/ Tricorythidae	*Tricorythodes minutus*	9		N
			Hemiptera/Naucoridae	*Ambrysus mormon*	2		
			Plecoptera/Perlodidae	*Cultus* sp. 1	9		N
			Trichoptera/ Brachycentridae	*Micrasema* sp. 1	34		L
			Trichoptera/ Glossosomatidae	*Glossosoma* sp. 1	4		L
			Trichoptera/ Hydropsychidae	*Hydropsyche* sp. 1	129		L
		Oligochaeta			**391**	**20.95%**	
			Plesiopora/ Tubificidae	*Limnodrilus hoffmeisterii*	387		A
			UNID/ Lumbricidae	*Eiseniella tetraedra*	4		A
Upper Muddy Creek/G52	**05/16/02**	**Crustacea**			**91**	**7.05%**	
			Amphipoda/Talitridae	*Hyalella azteca*	5		A
			Ostracoda/Cypridae	*Cadona* sp. 1	86		A
		Gastropoda			**9**	**0.70%**	
			Pulmonata/Physidae	*Physa utahensis*	9		A
		Insecta			**618**	**47.91%**	
			Coleoptera/Dytiscidae	*Agabus* sp. 1	9		L
			Diptera/Ceratopogonia	*Culicoides* sp. 2	26		L
				Probezzia sp. 1	34		L

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
			Diptera/Chironomidae	*Cryptochironomus* sp. 615	4		L
				Cryptotendipes sp. 674	52		L
				Dicrotendipes sp. 675	9		L
				Micropsectra sp. 409	168		L
				Orthocladius? sp. 87	22		L
				Paramerina sp. 579	9		L, P
				Polypedilum sp. 616	4		L
				Procladius sp. 658	17		L, P
				Tanytarsus Tanytarsus sp. 656	4		L
			Diptera/Simuliidae	*Simulium (Eusimulium) aureum*	9		L
			Diptera/Tabanidae	*Chrysops* sp. 1	4		L/P
			Ephemeroptera/ Baetidae	*Paracloeodes minutus*	9		N
			Ephemeroptera/ Caenidae	*Caenis youngi*	194		N
			Hemiptera/Naucoridae	*Ambrysus mormon*	1		A
			Hemiptera/ Notonectidae	*Notonecta/spinosa*	1		AM
			Odonata/ Aeshnidae	*Aeshna multicolor*	4		N
			Odonata/ Coenagrionidae	*Coenagrion resolutum*	34		N
			Trichoptera/ Limnephilidae	*Limnephilus* sp. 3	4		L
		Oligochaeta			**572**	**44.34%**	
			Plesiopora/Tubificidae	*Limnodrilus hoffmeisterii*	262		A
			Tubificida/Tubificidae	*Tubifex tubifex*	310		A
Middle Muddy Creek/G52B	**04/16/03**	**Nematoda (phylum)**			**4**	**1.06%**	
				Unidentified Nematoda	4		A
		Chelicerata			**81**	**21.43%**	
			Acari/Lebertiidae	*Lebertia* sp. 2	4		A
			Acari/Sperchonidae	*Sperchon* sp. 1	77		A
		Crustacea			**13**	**3.44%**	
			Amphipoda/Talitridae	*Hyalella azteca*	13		A

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
		Insecta			**806**	**68.07%**	
			Coleoptera/Elmidae	*Dubiraphia* sp. 1	13		L, A
				Optioservus sp. 1	4		A
				Stenelmis sp. 1	9		L
			Coleoptera/Helophoridae	*Helophorus* sp. 2	9		A
			Diptera/Ceratopogonia	*Bezzia/Palpomyia* sp. 1	30		L
			Diptera/Chironomidae	*Cricotopus* sp. 480	9		L
				Cricotopus sp. 490	56		L, P
				Cryptochironomus sp. 615	13		L
				Endochironomus sp. 482	13		L
				Eukiefferiella sp. 593	13		L
				Micropsectra sp. 409	22		L, P
				Odontomesa sp. 330	13		L
				Orthocladius sp. 86	9		L
				*Orthocladius? s*p. 87	13		L, Px
				Parakiefferiella bathophila	13		L
				Tanytarsus Tanytarsus sp. 656	26		L
				Tokunagaia rowensis	4		L
				Tvetenia sp. 505	4		L
			Diptera/Simuliidae	*Simulium (Psilozia) vittatum*	9		L, P
			Diptera/Tipulidae	*Ormosia* sp. 2	4		L
				Ormosia sp. 3	4		L
				Tipula sp. 2	5		L
			Ephemeroptera/ Baetidae	*Baetis tricaudatus*	52		N
			Ephemeroptera/ Tricorythidae	*Tricorythodes minutus*	253		N
			Hemiptera/Corixidae	*Sigara* sp. 1	4		AM
			Hemiptera/Naucoridae	*Ambrysus mormon*	4		A
			Lepidoptera/Pyralidae	*Petrophila* sp. 1	4		L
			Odonata/Gomphidae	*Ophiogomphus sevrus*	3		N
			Plecoptera/Perlodidae	*Cultus* sp. 1	4		N
			Trichoptera/ Hydropsychidae	*Hydropsyche* sp. 5	176		L

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
			Trichoptera/Leptoceridae	*Triaenodes* sp. 1	4		L
			Trichoptera/ Limnephilidae	*Amphicosmoecus canax*	2		L
				Hesperophylax sp. 1	1		L
				Limnephilidae UNID	4		L
		Oligochaeta			**280**	**74.07%**	
			Plesiopora/Tubificidae	*Limnodrilus hoffmeisterii*	250		A
			Tubificida/Tubificidae	*Tubifex tubifex*	26		A
			UNID/Lumbricidae	*Eiseniella tetraedra*	4		A
Lower Muddy Creek/G52a	**04/25/02**	**Nematoda (phylum)**			**2**	**0.55%**	
				Unidentified Nematoda	2		A
		Chelicerata			**8**	**2.20%**	
			Acari/Lebertiidae	*Lebertia* sp. 2	1		A
			Acari/Sperchonidae	*Sperchon* sp. 1	7		A
		Insecta			**340**	**93.66%**	
			Coleoptera/Elmidae	*Dubiraphia* sp. 1	1		L
				Stenelmis sp. 1	36		L, A
			Diptera/Ceratopogonia	*Probezzia* sp. 2	4		L
			Diptera/Chironomidae	*Chironomus* sp. 677	1		P
				Conchapelopia sp. 578	1		L
				Cricotopus sp. 490	33		L, P, A
				Cryptochironomus sp. 615	11		L
				Diamesa leona	1		L
				Endochironomus sp. 482	4		L
				Eukiefferiella (Claripennis Group) sp. 671	2		L
				Micropsectra sp. 409	1		L
				Microtendipes sp. 504	1		L
				Orthocladius sp. 86	7		L, P
				*Orthocladius? s*p. 87	16		L, P
				Paracladopelma sp. 665	2		L

LOCATION/ STATION #	DATE	CLASS	ORDER/FAMILY	SPECIES	No. Individuals/ m^2	% TOTAL	LIFE STAGE
				Parakiefferiella bathophila	36		L, P, A
				Parametriocnemus lundbeckii	12		L, P
				Paratanytarsus sp. 481	4		L
				Polypedilum sp. 616	2		L
				Tvetenia sp. 505	1		L
			Diptera/Empididae	*Chelifera* sp. 1	1		L
			Diptera/Simuliidae	*Simulium (Psilozia) vittatum*	12		L, P
			Ephemeroptera/ Baetidae	*Baetis tricaudatus*	28		N
			Ephemeroptera/ Tricorythidae	*Tricorythodes minutus*	48		N
			Odonata/Gomphidae	*Ophiogomphus sevrus*	6		N
			Plecoptera/Perlodidae	*Cultus* sp. 1	1		N
			Trichoptera/ Brachycentridae	*Brachycentrus occidentalis*	1		P
			Trichoptera/ Hydropsychidae	*Cheumatopsyche* sp. 1	10		L
				Hydropsyche sp. 3	55		L
			Trichoptera/ Limnephilidae	*Limnephilus* sp. 3	2		L
		Oligochaeta			**13**	**3.58%**	
			Plesiopora/Tubificidae	*Limnodrilus hoffmeisterii*	12		A
			Tubificida/Tubificidae	*Tubifex tubifex*	1		A

L=Larva; A=Adult; P=Pupa; N=Nauplius; Late=Late Larval stage; A=Adult; AM=Adult, mixed.

APPENDIX K
USFWS LETTERS/MEMOS ON T/E AND PROPOSED SPECIES

APPENDIX L
BIOLOGICAL ASSESSMENT

BIOLOGICAL ASSESSMENT FOR THE WIND RIVER NATURAL GAS FIELD DEVELOPMENT PROJECT, FREMONT COUNTY, WYOMING

Prepared for:

Bureau of Indian Affairs
Wind River Agency
Fort Washakie, Wyoming

Prepared by:

Buys & Associates
Littleton, Colorado

June 2003

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1.0 INTRODUCTION

The Operators (Tom Brown, Inc., Samson Resources Company and Saba Energy of Texas) have notified the Wind River Agency of the Bureau of Indian Affairs (BIA) that they intend to drill 325 exploration and development wells in Fremont County, Wyoming in Townships 3 and 4 North and Ranges 2 through 5 East as shown in Figure 1. The topographic maps for this area include Pavillion Butte, Harris Bridge, Mexican Pass SW, Mexican Pass SE, Pavillion, and Ocean Lake. The Wind River Project Area (WRPA) presently contains three fields with producing wells, the Muddy Ridge, Pavillion, and Sand Mesa fields. The existing fields contain 178 producing wells, with accompanying production facilities, roads, compressors and pipelines.

1.1 ENDANGERED SPECIES ACT REQUIREMENTS

Section 7(c) of the Endangered Species Act (ESA) of 1973 requires that a Biological Assessment (BA) be prepared for any major Federal action to determine the effects of the proposed action on Federally listed species. If, based on the results of the biological assessment, it is determined that the proposed project "may affect, is likely to adversely affect" any listed species, formal consultation would be initiated with the USFWS. If it is concluded that the project "may affect, is not likely to adversely affect," an informal consultation will be requested with the USFWS to request the agency's concurrence with the determination.

In 2002, the U.S. Fish and Wildlife Service (USFWS) determined that six threatened or endangered species, or species proposed for listing under the ESA, may be present in the WRPA and needed to be evaluated in the BA. Since the letter from the USFWS was written (2002), the mountain plover was removed from the list of "proposed" species (USFWS 2003b). Table 1 identifies these species and their federal status.

Table 1. Threatened, Endangered, and Proposed Species that may be Present in the WRPA (from USFWS 2002a).

COMMON NAME	LATIN NAME	STATUS	EXPECTED OCCURRENCE
Black-footed ferret	*Mustela nigripes*	Endangered (experimental, non-essential population)	Prairie dog colonies
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Found throughout the State
Grizzly bear	*Ursus arctos horribilis*	Threatened	Montane areas
Gray wolf	*Canis lupus*	Threatened (experimental, non-essential population)	Greater Yellowstone ecosystem
Canada lynx	*Lynx canadensis*	Threatened	Montane forests
Mountain plover	*Charadrius montanus*	Proposed[1]	Grasslands

[1]removed from list of proposed species in September 2003 (68 FR 53083).

This Biological Assessment (BA) discusses the potential effects of the proposed development on species that are listed as threatened, endangered, or proposed for listing under the ESA. The BA also presents recommendations to ensure that the construction and subsequent operation of the proposed project will not jeopardize the continued existence of threatened and endangered species and species proposed for listing or result in the destruction or adverse modification of their critical habitat, if any has been designated. Analysis of the effects of the proposed Wind River Gas Development Project on these species complies with the provisions of the ESA.

1.2 CONSULTATION HISTORY

Previous Environmental Assessments and Biological Assessments have been conducted for oil and gas development by Tom Brown, Inc. for the following proposed projects.

- EA for Tom Brown, Inc., Pavillion North Oil/Gas Leasing Proposal Wind River Indian Reservation, Fremont County, Wyoming (BIA 1992)
- EA for Tom Brown, Inc., Haymaker Creek, Indian Butte, Little Dome and Owl Creek Oil/Gas Lease Option Proposals located within the Wind River Indian Reservation of Fremont County, Wyoming (BIA 1994)
- Tom Brown, Inc. and Brownlie, Wallace, Armstrong & Bander Exploration Wind River Oil and Gas Exploration License Agreement Environmental Assessment and Finding of No Significant Impact (BIA 1996)

Figure 1. Map Showing Location of WRPA.

2.0 PROJECT DESCRIPTION

Four alternatives have been developed for the proposed development project: Proposed Action (325 new wells), Alternative A (485 new wells), Alternative B (233 new wells), and Alternative C (No Action). Each of these alternatives is discussed below.

2.1 PROPOSED ACTION – 325 NEW WELLS

The Operators are proposing to drill up to 325 new wells in the Wind River Project Area (WRPA). Economic conditions and the evaluation of the drilling results will determine the actual number of wells to be drilled. Some of the wells may be classified as exploration or delineation wells because natural gas production potential has not been fully defined due to geological uncertainties. Where production potential is better known, wells would be classified as in-fill or development wells. Drilling is expected to last for approximately 20 years, with the life of the project anticipated to be 20-40 years. The Proposed Action would require the construction of the following primary components on private, federal, and tribal lands within the WRPA:

- 325 new wells and associated lease roads (excluding 178 existing wells)
- 164 miles of new natural gas pipeline (excluding 101 existing miles), and
- 32,800hp of new compression (excluding 14,600 hp of existing compression).

The WRPA consists of approximately 91,520 acres. During the drilling and construction phase the proposed well pads, pipelines and roads would occupy approximately 1,605 acres or 1.75 percent of the total surface area in the WRPA. Following the completion of drilling operations, well pads would be reduced in size and pipeline right-of-ways (ROWs) would be restored.

An existing road network developed to service existing drilling and production activities currently accesses the WRPA. The Operators anticipate that the drilling of additional wells within the WRPA would require the construction of additional roads. Existing pipelines and new pipelines, including new gathering lines, loop lines and tie-in lines to existing interstate pipelines, would transport the produced gas within and from the WRPA.

2.2 ALTERNATIVE A – 485 NEW WELLS

Alternative A would consist of an increased number and density of wells to 485 wells at 485 locations, assuming an overall success rate of 76 percent (i.e., 369 new wells). Section 2.4 of the EIS provides a detailed description of Alternative A. During the construction phase, Alternative A would disturb up to 2,928 acres or 3.18 percent of the WRPA. With implementation of reclamation under Alternative A, disturbance would be reduced to 275 acres, or about 0.30 percent of the WRPA.

2.3 ALTERNATIVE B – 233 NEW WELLS

Alternative B would consist of a decreased number and density of new wells to 233 wells at 233 locations. Section 2.5 of this EIS provides a detailed description of Alternative B.

Assuming a success rate of 78 percent, the Operators anticipate that 182 of the 233 wells will be producing gas wells. During the construction phase, Alternative B would result in surface disturbance of 1,167 acres or 1.27 percent of the WRPA. With implementation of reclamation under Alternative B, impacts would be reduced to 144 acres, or about 0.16 percent of the WRPA.

2.4 ALTERNATIVE C – NO ACTION

This alternative would allow Applications for Permit to Drill (APDs) and ROW applications to be granted by the Wyoming Oil and Gas Conservation Commission (WOGCC) on private lands within the WRPA. Additional wells would be developed as needed to the prevent drainage of Tribal minerals. Under the No Action Alternative, approximately 100 new gas wells at 100 locations would be developed. Assuming a success rate of 100 percent, there would be 100 producing wells. Section 2.6 provides a detailed description of Alternative C. With implementation of Alternative C, approximately 216 acres of surface disturbance would result, or 0.24 percent of the WRPA. After reclamation, total disturbance would be reduced to 43 acres or 0.05 percent of the WRPA.

3.0 METHODS

The assessment and recommendations contained in this Biological Assessment are based on information obtained from various sources identified below.

3.1 MEETINGS, PERSONAL COMMUNICATIONS, PUBLISHED AND UNPUBLISHED DATA

In preparation for this BA, meetings were held with wildlife biologists from the US Fish and Wildlife Service in Cheyenne and Lander, WY; U.S. Forest Service; Wyoming Department of Game and Fish, Lander and Cheyenne; Wyoming Department of Environmental Quality, Lander; Wind River Fish and Game, Ft. Washakie; Wind River Environmental Quality Commission, Ft. Washakie; the Bureau of Land Management, Lander; and the Bureau of Reclamation, Casper.

Wildlife biologists at the state and federal agencies that provided information on threatened, endangered, proposed species, and species of concern include Kathleen Erwin (USFWS, Cheyenne), Charlie Dillahunty (Wind River Agency, BIA; Ft. Washakie), Greg Anderson (Wyoming Game and Fish Department, Lander), Bob Oakleaf (Wyoming Game and Fish Department, Lander), Pat Hnilicka (USFWS, Lander), Preston Smith (Wind River Agency, BIA, Ft. Washakie), Mark Hogan (USFWS, Lander), Scott Ross (Wyoming Game and Fish Department, Lander), Andrea Surrowsky (Wyoming Game and Fish Department, Cheyenne), Connie Breckenridge (Bureau of Land Management, Lander), Mike Jimenez (USFWS, Wolf Management Program), Tavis Eddy (Wyoming Department of Environmental Quality, Lander), Terry Root (USFWS, Cody), Kevin Johnson (Wyoming Game and Fish Department, Lander), and the staff of the Wind River Environmental Quality Commission.

Published and unpublished documents were obtained from the USFWS, Wyoming Game and Fish Department, Wind River Agency, and Bureau of Land Management. Information was also obtained from the Wyoming Natural Diversity Database (WYNDD) and from the Internet sites of the WYNND, USFWS endangered species, and other relevant sites.

3.2 AERIAL SURVEY OF WRPA

Aerial surveys were conducted on April 16 and 17, 2003 to identify suitable habitat of threatened/endangered species, species proposed for listing, State sensitive species and habitats potentially in the WRPA (Buys & Associates 2003a). The surveys were conducted for the presence of sage grouse (*Centrocercus urophasianus*) leks, bald eagle and other raptor nests, white-tailed prairie dog (*Cynomys leucurus*), game species and other wildlife and wildlife habitat in and adjacent to WRPA. The survey was conducted using a Cessna 180 with dual GPS capabilities. The survey protocol consisted of early morning, low-level flights (200-250 feet) to document sage grouse strutting grounds (leks); the status and locations of two previously documented golden eagle (*Aquila chrysaetos*) nests, as well as any new raptor nests within the WRPA; presence of mountain plover (*Charadrius montanus*) habitat; and locations and dimensions of white-tailed prairie dog colonies in the area to determine if black-footed ferret surveys would be necessary. While flying above the WRPA, presence of other wildlife was documented as well as the wildlife habitat in the area.

A large portion of the WRPA is currently being used for agriculture. There are several canals winding through the area, all of which appeared to be used for irrigating adjacent agricultural fields. The majority of the western portion of the WRPA consists of large irrigated crop circles and large fields, which appeared to be arranged so they could be flooded using the nearby canals. The land north of these crop fields appears to consist of roughly 20 percent short grasses, and 80 percent bare ground. This land was not being used by prairie dogs and did not look like suitable sage grouse habitat. However, it did appear to be suitable habitat for the mountain plover. The creeks running though the WRPA, including Muddy Creek and Fivemile Creek and their associated wetlands, as well as Boysen Reservoir and it's associated wetlands, did not appear to contain any obligate wetland species that could be identified from the air. The few trees observed in the WRPA primarily surrounded houses, and likely served as windbreaks (Buys & Associates 2003a).

Existing oil and gas wells are located within the boundaries of the WRPA. The majority of the wells are in the southwestern portion of the area, north of Ocean Lake. There are numerous gas wells, storage tanks, and access roads in this area. There are also a few oil well locations visible from the air.

4.0 CURRENT STATUS OF THREATENED, ENDANGERED AND PROPOSED SPECIES

The life history and range-wide distribution of the six threatened, endangered, or proposed species identified by the USFWS as potentially being present in the WRPA, are provided below.

4.1 BLACK-FOOTED FERRET AND WHITE-TAILED PRAIRIE DOG

The black-footed ferret is considered to be one of the most endangered mammals in North America (FWS 1988) and was listed as endangered on the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001 - USFWS 1967).

4.1.1 Life History

The black-footed ferret is one of five members of the genus *Mustela* in North America. The ferret has a slender yellowish-brown body ranging from 18 to 24 inches in length, with short legs, rounded ears and bright “button-like” eyes, and a distinct black facemask and black feet (BLM 2002; Wassink 1993). The black-footed ferret has strong front limbs, large front paws, sharp claws, and slender bodies that are well-adapted for excavating and burrowing (King 1990). Other members of the genus *Mustela* include the mink (*Mustela vison*), which is smaller and dark brown in color; and the long-tailed weasel (*Mustela frenata*), which is approximately half the size of the ferret and does not have the distinct black face mask and feet.

The black-footed ferret is an obligate associate of the prairie dog. The range of the ferret is essentially identical with that of three species of prairie dogs: black-tailed prairie dog, Gunnison prairie dog, and white-tailed prairie dog. The white-tailed prairie dog is the species that is present in the WRPA. The black-footed ferret depends almost exclusively on the prairie dog ecosystem for food and shelter. Ninety percent of the ferret’s diet consists of prairie dogs. Other prey include cottontail rabbits, ground squirrels, voles, mice, and birds (USFWS 1988, USFWS 1998; BLM 2002). The black-footed ferret utilizes abandoned prairie dog burrows or burrows of prairie dogs they have killed for shelter, nesting, and rearing of young. The species is primarily nocturnal, with peak activity occurring after sunset and again between 0400 and 0600 hours (USFWS 1988; BLM 2002).

Black-footed ferrets are solitary predators, except during the breeding season. Female ferrets reach sexual maturity at one year of age. Breeding activity generally occurs in March or April, and after a 41-45 day gestation period, a litter of three or four young (kits) are born. Male black-footed ferrets do not assist in raising the young and generally stay with the female only until breeding occurs. Life expectancy of ferrets in the wild is generally less than five years.

The primary threats to ferret survival include accidents, starvation, injury, canine distemper, sylvatic plague, parasites, and predators (e.g., coyotes, great-horned owls, badgers).

4.1.2 Current Status and Range-wide Distribution

Black-footed ferrets were once found throughout the prairie ecosystem of the Great Plains from foothills of the Rocky Mountains eastward through the grasslands of Kansas, Nebraska, the Dakotas, Oklahoma, and Texas (USFWS 1988; USFWS 1998; BLM 2002). The ferret’s range is closely associated with that of prairie dogs, which were once abundantly distributed through the North American prairie. When the plains were settled and large tracts of prairie were tilled for agriculture, prairie dog and ferret habitat were destroyed. Poisoning campaigns in the early 1900's further reduced prairie dog and ferret populations (BLM 2002, NGPC 1996). Merriam (1902) and the USFWS (1988) estimated that in the late 1800's, prairie dogs occupied from 250 to 700 million acres of the plains. Recent studies indicate that today, prairie dogs occupy only about 1.5 million acres (NGPC

1996). These present day colonies of prairie dogs are smaller and more isolated than those found in the 1800's (NGPC 1996). As a result, black-footed ferret habitats are also smaller and more isolated (USFWS 1988; Reading et. al. 1996).

In the 1950's, ferrets were thought to occur in low densities throughout most of their historic range, but populations continued to disappear as a result of poisoning campaigns and diseases, such as plague and canine distemper (Reading et al. 1996). The last known wild population of black-footed ferrets was discovered in 1981 on a ranch in Meeteetse, Wyoming. The Meeteetse colony was studied for several years until canine distemper reduced the population's numbers to 18 known individuals (Reading et al. 1996). By 1987, these 18 ferrets had been taken into captivity to begin propagation program at Sybille Wildlife Center in Wyoming. Current recovery efforts emphasize the reintroduction of ferrets back into the wild from captive bred stock (USFWS 1998).

Currently, captive-bred ferrets have been released into the wild at six release sites: the Shirley Basin of Wyoming; Charles M. Russell National Wildlife Refuge and Fort Belknap Indian Reservation in Montana; Badlands/Buffalo Gap, South Dakota; Aubrey Valley, Arizona; Coyote Basin Primary Management Zone in Uintah County, Utah; and the Wolf Creek and Coyote Basin Black-footed Ferret Management Areas in Moffat and Rio Blanco counties, Colorado. All of the released ferrets, including those found in the Shirley Basin in Wyoming, are considered parts of experimental, non-essential populations (USFWS 1998). Although the number of captive black-footed ferrets has increased and ferrets have been reintroduced into six sites within their former range, no wild population, apart from the experimental, non-essential populations, is known to exist (Reading et. al. 1996).

4.1.3 White-tailed Prairie Dog Survey

Buys & Associates (2003b) completed quantitative white-tailed prairie dog (*Cynomys leucurus*) colony surveys in and adjacent to the Wind River Natural Gas Development Project Area. Aerial surveys of the WRPA and a two-mile buffer zone were conducted on April 16 and17, 2003. These surveys identified the locations of the prairie dogs, and determined areas for ground surveys. Ground surveys, consisting of colony mapping and burrow density estimates, were conducted on July 10 and 11, 2003. These surveys were conducted at all prairie dog colonies meeting USFWS (1989) requirements located within 2 miles of the WRPA. These areas included the following Townships (T) and Ranges (R) of Fremont County, Wyoming: T3N - R1E, T4N - R1E, T4N - R2E, and T5N - R2E.

The overall goal of these surveys was to determine if the prairie dog colonies could provide potential habitat for the endangered black-footed ferret (*Mustela nigripes*). According to Biggins et al. (1989), active burrow density is strongly correlated with potential prairie dog density. The U.S. Fish and Wildlife Service (USFWS) defines a prairie dog colony as a group of prairie dog burrows whose density meets or exceeds 8 burrows/acre (20 burrows/ha) (USFWS 1989). They suggest viewing a colony as a group of 5-ha (12.35-acre) parcels, each of which must contain at least 100 burrows to be considered as potential black-footed ferret habitat. This implies that colonies smaller than 5 ha (12.35 acres) would not support black footed ferrets, and can therefore be eliminated from the survey.

The USFWS defines a prairie dog complex as two or more neighboring prairie dog colonies which are less than 7 km (4.34 miles) from each other (USFWS 1989; K. Erwin, USFWS, pers. comm., Sept. 2002). White-tailed prairie dog towns or complexes that are greater than 200 acres and have a minimum density of 8 burrows/acre (20 burrows/ha) have the potential to support black-footed ferrets, and therefore, must be surveyed for ferrets prior to approval of any surface disturbance or other land use that could adversely affect the species (USFWS 1989; K. Erwin, USFWS, pers. comm., Sept. 2002).

Four prairie dog colonies consisting of 1,243 acres (503 ha) were surveyed on or adjacent to the WRPA. The approximate density of active prairie dog burrows in and adjacent to the WRPA is 10.3 burrows/acre (25.5 burrows/ha). This number was derived by dividing the total number of active burrows (566) by the total area surveyed using transects (54.85 acres). No statistical corrections have been applied to this value. The 54.85 acres (22.2 ha) of transects evaluated comprises approximately 4.4 percent of the total 1,243 acres (503 ha) of prairie dog colonies illustrated in Figure 2. The 4.4 percent of active burrows is a sufficient sample size, according to Biggens et al. (1989).

The resulting 10.3 burrows/acre (25.5 burrows/hectare) density in the WRPA exceeds the USFWS minimum threshold of 8 burrows/acre (20 burrows/hectare) (USFWS, 1989). Therefore, the prairie dog colonies within the WRPA are considered potential black-footed ferret habitat (Table 2). Biggens et al.'s (1989) quantitative model was used to estimate the number of ferret families (*R)* that could be supported by a complex. In this model, a complex with a rating of R<1.0 is not expected to support ferrets. The Wind River WRPA complex has a rating of R= 1.9 (Table 3).

Table 2. Wind River WRPA Prairie Dog Burrow Density Estimates

Town	Area (Acre)	Area (Ha)	# Transects	Transect Area (Acre)	Transect Area (Ha)	# Active Burrows
F	868.81	351.6	46	34.1	13.8	383
G	118.61	48.0	11	8.15	3.3	60
H	176.19	71.3	9	6.67	2.7	67
I	79.32	32.1	8	5.93	2.4	56
Total	**1242.93**	**503.00**	**74**	**54.85**	**22.2**	**566**

Active Burrow/Acre =10.3
Active Burrow/ha = 25.5

Table 3. Wind River WRPA Prairie Dog Complex Ferret Family Estimate

Colony	# Trans.	Size (ha)	Trans. Good Hab.	Good Hab.%	Ha Good Hab.	Burrows/Ha	P.Dogs/Ha	Total P.Dogs	R
F	46	351.6	24	0.5200	182.83	45	6.63	1213	1.56
G	11	48.0	4	0.3636	30.03	35	5.16	155	0
H	9	71.3	5	0.4285	13.75	50	7.37	101	0
I	8	32.1	3	0.5555	54.77	36	5.31	290	0.38
								Total	**1.94**

Figure 2. Locations of White-tailed Prairie Dog Colonies.

4.2 BALD EAGLE

The bald eagle was listed as endangered in all areas of the U.S. south of the 40th parallel in 1967, on the List of Endangered Species issues by the Office of Endangered Species on March 11, 1967 (32 FR 4001 - USFWS 1967). It was re-listed as endangered under the Endangered Species Act of 1973 on July 4, 1976. As a result of the recovery of the bald eagle in the lower 48 States, its status was changed from endangered to threatened in July 1995. The USFWS is presently evaluating the removal of the bald eagle from the endangered species list. When the bald eagle is removed from the endangered species list, it will continue to be protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Rutledge 2003).

4.2.1 Life History

The bald eagle (*Haliaeetus leucocephalus*) is a member of the Accipitridae family, which includes hawks, kites, and old-world vultures. The coloration of the adult bald eagle is brownish-black on the back and breast with a white head, neck and tail, and yellow feet and bill. Juvenile bald eagles are a mixture of brown and white, with a black bill. The adult plumage develops when the eagles are sexually mature at about 4-5 years of age. The female bald eagle is slightly larger than the male at 35-37 inches in length, with a wingspan of 79-90 inches. Bald eagles weigh from 10-14 lbs and are estimated to live as long as 30 years, with an average lifespan of 15-20 years (Rutledge 2003).

Bald eagles begin breeding at four years of age and remain with the same mate for life. The eagles build large nests, which are often reused year after year (USFWS 2002a). The female lays 2-3 eggs and incubates them for about 35 days. Both the male and female incubate the eggs. The nests are generally built in large trees in riparian habitat along rivers or streams. A typical nest is around 5 feet in diameter. Nests are also built on cliffs or on the ground, if no other suitable nesting habitat is available. The nesting territory of the bald eagle ranges from 1-2 mi^2. The young eaglets are generally flying within three months. However, disease, lack of food, weather, or human interference may kill eaglets and sometimes only about 50 percent of the young will survive their first year (USFWS 2002a; Rutledge 2003). The nesting season of the bald eagle varies by region. In the Great Plains and western mountain region, breeding generally occurs from January through March.

The bald eagle is associated with aquatic ecosystems throughout most of its range. Nesting almost never occurs further than 3 km (2 mi) from water. Fish predominate in the typical diet of eagles. Many other types of prey are also taken, including waterfowl and small mammals, depending on location, time of year, and population cycles of the prey species. Dead animals or carrion, especially in wintering areas, are also taken when available (60 FR 3600ff - USFWS 1995).

In the fall, when the northern lakes and rivers begin to freeze, most bald eagles migrate south to areas with sufficient food, and return north in the spring to breed (Rutledge 2003). The eagles in the southern portion of the U.S. do not migrate, but remain in the same area year-round (Rutledge 2003). During the winter months, bald eagles communally roost in cottonwoods and other large trees along rivers and forage in upland habitats for carrion and small mammals.

A bald eagle winter roost site has been reported at the north end of Ocean Lake about 20 miles south of the proposed WRPA. The eagles could potentially roost in the proposed WRPA, although no roost sites have been reported there (P. Hnilicka, USFWS, pers. comm., June 2003). The home range of the bald eagle varies from 1,700 to 120,000 acres. Home ranges are smaller where food is present in large quantities (Rutledge 2003).

4.2.2 Current Status and Range-wide Distribution

Historically the bald eagle ranged throughout North America, with the exception of extreme northern Alaska and Canada and central and southern Mexico. The species nested on both the Atlantic and Pacific coasts from Florida to Baja California, in the south, and from Labrador to the western Aleutian Islands, Alaska in the north. In many of these areas bald eagles were abundant. They inhabited large rivers and lakes throughout North America and nested in 45 of the 48 lower 48 States. It is estimated that before European settlers colonized the United States, bald eagles may have numbered 500,000. As the European settlers moved westward, the habitat of the eagles was rapidly destroyed leaving the eagles fewer areas for hunting and nesting. This resulted in a sharp decline in the bald eagle population by the late 1800s. Between 1917 and 1953 commercial fisherman in Alaska, killed more than 100,000 bald eagles, because of concerns that the eagles would reduce the economically valuable salmon population. The dramatic decline in the population of bald eagles led to the passage of the Bald Eagle Act in 1940 (Rutledge 2003).

The bald eagle population further decreased after the use of the pesticide DDT became widespread. The high concentration of DDT in the reproductive organs of the adult eagles caused thinning of the developing eggshells, which resulted in the eggs being crushed during incubation. Large quantities of DDT were also stored in fatty tissue, including gonadal tissue, which may have also caused the eagles to become infertile.

As a result of the listing of the species as endangered in 1967, the banning of DDT in 1972, the initiation of recovery and reintroduction programs, and increased public awareness, the bald eagle population began to recover. Today bald eagles are reported in nearly every state in the lower 48 states, either as spring and summer residents, winter residents, or migrants. In the State of Wyoming, the bald eagle is reported to be common (International Birding Information Resource Data 2000). The bald eagle population has increased to 70,000 individuals, with half of the North American population in Alaska and 20,000 in British Columbia (Rutledge 2003). More than 6,000 breeding pairs of bald eagles have recently been reported in North America (Eliot 2002). Although the bald eagle has made significant recovery since the 1970s, habitat loss continues to remain a threat to the bald eagle's full recovery.

4.2.3 Aerial Survey for Bald Eagles and other Raptors

4.2.3.1 Methods

An aerial survey for the bald eagle and other raptors was conducted on April 16 to 17, 2003. The aircraft flew over all habitat that appeared to be suitable for raptors to construct a nest, including cliff faces of the dominant ridges and any other bluffs or structures that could potentially support a raptor nest. The aircraft flew above and around all aspects of a bluff or ridge edge to allow sufficient observation of the habitat for existing raptor nests. When a nest was observed, the location was recorded with a hand-held GPS unit in order to mark the nest location on a map. Nest occupancy or signs of occupancy, such as white-wash, feathers, or eggs was recorded (Buys & Associates 2003a).

4.2.3.2 Results

Although no bald eagle nests were observed during the survey, two active raptor nests were documented within the survey area. These included one red-tailed hawk nest and one nest of an unknown raptor species. The nest of this unidentified species was potentially that of a prairie falcon or another red-tailed hawk. The active red-tailed hawk nest was located on the north side of Muddy Ridge in the SE/SW 1/4 of Section 14 in T4N:R2E. One adult was present at this nest, but it was not evident if any eggs or fledglings were also in the nest. The second active nest of the unidentified raptor was located in the SE/SE 1/4 of Section 9 in T4N:R2E on a south facing exposure, underneath a rock ledge of Muddy Ridge.

Three other raptor nests were located during the aerial survey. However, all of them appeared to be inactive red-tailed hawk nests. The first was located in the SE/NE 1/4 of Section 23 in T4N:R2E and contained soil inside and showed no evidence of recent use. The second nest located was in the NE/SW 1/4 of Section 29 in T4N:R3E and also showed no evidence of recent use. The third nest was found in the NE/SW 1/4 of Section 28 in T4N:R3E. This nest appeared to be older and was only partially intact. All three of these inactive nests were located on north-facing exposures of Muddy Ridge.

Two locations of historical golden eagle nests were provided to Buys & Associates by the Wyoming Game and Fish Department, prior to beginning the aerial surveys. Inserting these latitude/longitude coordinates into the GPS unit allowed the aircraft to fly directly over the locations of these nests. No sign of either of the two nests was observed. Both of these nests were originally located on south-facing aspects of a small bluff running east and west in Section 10 (T3N:R2E).

During the aerial survey there were two separate observations of golden eagles, perched on top of bluffs in the western portion of Muddy Ridge. The second observation was approximately six miles west of the first observation, along the same bluff ridge. Because the eagle that was first observed was no longer at the original location, it is not clear whether the second observation was another eagle or the same eagle. Both eagle observations were located approximately one-half mile to one mile south of the proposed WRPA.

4.3 GRIZZLY BEAR

The grizzly bear (*Ursus arctos horribilis*) was listed as threatened on July 28, 1975 (USFWS 1975). Since then, much effort has been expended by various Federal and State land and wildlife agencies, tribal governments, and segments of the public to conserve this species (USFWS 1993).

4.3.1 Life History

Grizzly bears are generally larger than black bears and can be distinguished by longer, curved claws, humped shoulders, and a face that appears to be concave. A wide range of coloration from light brown to nearly black is common. Guard hairs are often paled at the tips; hence the name "grizzly." In the lower 48 states, the average weight of grizzly bears is 400-600 lbs for males and 250-350 lbs for females. Adults stand 3.5-4.5 feet at the hump, when on all fours, and may reach more than eight feet in height when they rear up on their hind legs. Grizzly bears are relatively long-lived, and individuals have been known to live 40 years (USFWS 1993).

Grizzly bears have solitary patterns of behavior, except when caring for young or breeding. The mean density of grizzly bears in productive habitat is estimated to be one bear per eight square miles. In the Northern Continental Divide Ecosystem, the density is estimated to be one bear per 15-23 square miles (USFWS 1993).

Breeding appears to occur from late May through mid-July, with a peak in mid-June. Litter size varies from one to four cubs, with an average of two cubs. The gestation period is between 229 to 266 days with birth occurring around February 1st. Upon emergence from the den, the grizzly bears move considerable distances from high, snow-covered elevations to lower elevations to reach palatable, emerging vegetation, or to feed on winter-killed or weakened ungulates on foothill winter ranges. Reproductive intervals for females average three years. The limited reproductive capacity of grizzly bears precludes any rapid increase in the population (USFWS 1993).

The size of the home range of grizzly bears varies in relation to food availability, weather conditions, and interactions with other bears. In addition, individual bears may extend their range seasonally or from one year to the next (USFWS 1993).

4.3.2 Current Status and Range-wide Distribution

The grizzly bear has a wide range of habitat tolerance. Historically, the grizzly bear was distributed in various habitats from the mid-plains and throughout Western North America, and from Central Mexico to the Arctic Ocean. The westward expansion of European settlers in the U.S and urban development caused a rapid decrease in distribution and numbers of grizzly bears. Between 1800 and 1975, grizzly bear populations in the lower 48 States decreased from estimates of over 50,000 to less than 1,000. Grizzly bears were exterminated from Texas by about 1890, and by 1922 the last of the grizzly bears in California had disappeared. Settlement of the western U.S., logging, livestock grazing, unregulated hunting, and protection of human life were responsible for the exterminations (USFWS 1993).

Today the Grizzly bear distribution has been reduced to less than 2 percent of its historical range in the lower 48 States. Only five areas in the lower 48 States in mountainous regions, national parks, and wilderness areas of Washington, Idaho, Montana, and Wyoming currently contain either self-perpetuating or remnant populations. One of the areas occupied by the grizzly bear is the area within and surrounding Yellowstone National Park, which includes Grand Teton National Park, John D. Rockefeller Memorial Parkway, large contiguous portions of the Shoshone, Bridger-Teton, Targhee, Gallatin, Beaverhead, and Custer National Forests, BLM lands, and more than 222 km^2 (86 mi^2) of State and private lands in Montana, Wyoming, and Idaho. The population estimate in this area is approximately 236 bears (USFWS 1993).

Contiguous, relatively undisturbed mountainous habitat having a high level of topographic and vegetative diversity characterizes the habitat where grizzly bears are found today. However, habitat loss, changes to important components within their habitat, and direct and indirect human-caused mortality continue to cause decline in the grizzly bear population (FWS 2002). Since grizzly bears are attracted to carrion and waste products of construction camps, recreational camps and sprawling residential areas that have encroached into their habitat, human-bear interactions have continued to increase (USFWS 1993). Currently the two leading challenges in grizzly bear conservation are the reduction of human-caused mortality and the conservation of the remaining habitat (USFWS 2002).

4.3.3 Grizzly Bear Recovery Plan

The original Grizzly Bear Recovery Plan was approved in 1982 and revised in 1993 (USFWS 1993). The goal of the revised recovery plan is to identify actions necessary for the conservation and recovery of the grizzly bear. The Plan defines a sequence of actions that will provide for the conservation and recovery of the grizzly bear in selected areas of the lower 48 States. They include the following:

- Minimize sources of human-bear conflict.
- Limit habitat loss or degradation resulting from human actions such as road building, timber harvest, oil and gas exploration and development, mining, and recreations.
- Improve habitat and or security, where applicable.
- Determine the relationship between bear density and habitat value to better understand limiting factors.

- Develop techniques to successfully move bears where the populations are in need of augmentation.
- Improve public relations and education to develop better support for and understanding of the species and to minimize adverse human interactions.
- Continue grizzly bear and habitat research to ensure adequate scientific knowledge is available on which to base management decisions.

4.4 GRAY WOLF

Gray wolves were originally classified as four separate subspecies. The eastern timber wolf (*Canis lupus lycaon*) was listed as endangered in Minnesota and Michigan (USFWS 1974) and the northern Rocky Mountain wolf (*C.l. irremotus*) was listed as endangered in Montana and Wyoming in May 1974 (USFWS 1974). The Mexican wolf (*C. lupus baileyi*) was listed as endangered in April 1976 (USFWS 1976a) and the gray wolf (*C. l. monstrabilis*) was listed as endangered in Arizona, New Mexico, and Texas (USFWS 1976b). On March 9, 1978 the gray wolf was re-listed as endangered at the species level (*Canis lupus*) throughout the conterminous 48 states and Mexico, except for Minnesota, where the gray wolf was reclassified as threatened (USFWS 1978). Critical habitat for the gray wolf was also designated in the 1978 FR notice. On November 22, 1994 portions of gray wolf habitat in Idaho, Montana, and Wyoming were designated as “nonessential experimental populations” in order to initiate gray wolf reintroduction in central Idaho and the Greater Yellowstone Area (59 FR 60252ff). Today, there are two species of wolves protected by the endangered species act, the gray wolf and the red wolf (*C. rufus*) (68 FR 15804).

On April 1, 2003, the gray wolf in the Western Distinct Population Segment (DPS) and Eastern DPS was reclassified from endangered to threatened, except where they were already classified as threatened or as an experimental population (68 FR 15802 - USFWS 2003a). They were also removed from the list of endangered and threatened wildlife in all or parts of 16 southern and eastern States where the gray wolf historically did not occur.

All wolves within Wyoming are considered part of the nonessential experimental population. Although these wolves remain listed and protected under the ESA, additional flexibility is provided for their management under the provisions of the final rule and special regulations promulgated for the nonessential experimental population on November 22, 1994 (59 FR 60252). Requirements for interagency consultation under Section 7 of the Act differ based on land ownership and/or management responsibility where the animals occur (USFWS 2002a). Additional flexibility is provided for managing wolves inhabiting the National Park or National Wildlife Refuge System (e.g., Forest Service lands). Wolves that are designated as nonessential experimental populations in these areas are treated as “proposed” rather than listed species (USFWS 2002a).

4.4.1 Life History

The gray wolf is the largest wild member of the dog family (Canidae), with adults ranging from 18-80 kg (40-175 lbs), depending on sex and subspecies (68 FR p. 15804, April 1, 2003). In the northern Rocky Mountains adult male gray wolves average 45 kg (100 lbs), while females weigh slightly less. The fur color of wolves is frequently a grizzled gray, but it can vary from pure white to coal black. Wolves may appear similar to coyotes (*Canis latrans*) and some domestic breeds such as the German shepherd or Siberian husky. However, their longer legs, larger feet, wider head and snout, and straight tail distinguish them from both coyotes and dogs.

Wolves are primarily predators of medium-sized and large mammals. Typical prey species in North America include white-tailed deer and mule deer, moose, elk, woodland caribou, and barren ground caribou, bison, muskox, bighorn sheep and Dall sheep, mountain goat, beaver, and snowshoe hare, with small mammals, birds, and large invertebrates occasionally being taken. In the midwest wolves have also killed domestic animals including horses, cattle, sheep, goats, llamas, pigs, geese, ducks, turkeys, chickens, pheasants, dogs, and cats (FR 2003).

Wolves are social animals, normally living in packs of 2-12 wolves, although two packs within Yellowstone National Park were reported to have 22 and 27 members in 2000. Packs are primarily family groups consisting of a breeding pair, their pups from the current year, offspring from the previous year, and occasionally an unrelated wolf. Packs typically occupy, and defend from other packs and individual wolves, a territory of 50-550 sq km (20-214 mi^2). In the northern Rocky Mountains territories tend to be larger, usually from 520 to 1040 km^2 (200 to 400 mi^2) (68 FR 15804 - USFWS 2003a).

Normally only the top-ranking male and female in each pack breed and produce pups. Litters are born from early April into May and range from 1-11 pups, averaging 4-6 pups. Normally a pack has a single litter annually, but occasionally 2-3 litters have been documented. Yearling wolves frequently disperse from their natal packs and may become nomadic, covering large areas as lone animals or they may locate suitable unoccupied habitat and a member of the opposite sex and begin their own territorial pack. Dispersal movements of 800 km (500 mi) have been documented (68 FR 15804 - USFWS 2003a).

4.4.2 Current Status and Range-wide Distribution

In North America, gray wolves formerly occurred from northern Alaska, Canada and Greenland to the central mountains and high interior plateau of southern Mexico. European settlers in North America and their cultures often had superstitions and fears of wolves. Their attitudes, coupled with perceived and real conflicts between wolves and human activities along the frontier, led to widespread persecution of wolves. Poisoning, trapping, and shooting spurred by the Federal, State, and local government bounties resulted in the extirpation of this once widespread species from more than 95 percent of its range in the lower 48 states. At the time of the passage of the ESA in 1973, it is likely that only several hundred wolves remained in northeastern Minnesota and on Isle Royale, Michigan, and possibly a few scattered wolves in the upper Peninsula of Michigan, Montana, and the Southwest. The gray wolf was extirpated from Wyoming by the 1930s, and from that time until the early 1990s there were occasional wolf sightings in Wyoming, but no reproduction was documented (Wyoming Game and Fish Department 2002).

4.4.3 Gray Wolf Recovery Program

With the goal of reestablishing a sustainable gray wolf population in the northern Rocky Mountains (Wyoming, Idaho, and Montana), the USFWS reintroduced 31 wolves to Yellowstone National Park and 35 wolves to central Idaho in 1995 and 1996. The northern Rocky Mountain wolf population consists of three recovery areas: Northwest Montana, Central Idaho, and the Greater Yellowstone Area. The Greater Yellowstone recovery area includes all of Wyoming, including Yellowstone National Park, Grand Teton National Park, the National Elk Refuge, and adjacent parts of Idaho and Montana.

The USFWS has defined a viable and recovered wolf population in the northern Rocky Mountains as one containing at least 30 breeding pairs of wolves, with an equitable and uniform distribution throughout Wyoming, Idaho, and Montana for three years (USFWS 2002a). The USFWS determined that 2001 was the second year in which at least 30 breeding pairs of wolves inhabited the northern Rocky Mountain recovery area. If the wolf population remains at current levels or increases in number and distribution, and state management plans are in place, delisting may be proposed within the next two years (Wyoming Game and Fish Department 2002).

4.5 CANADA LYNX

Much of the regulatory action related to the Canada lynx in the lower 48 States is associated with litigation. On December 30, 1982 the Canada lynx was classified as category 2 candidate species, indicating that more information was necessary to determine whether the species' population was declining. On October 6, 1992 the USFWS published a notice in the Federal Register stating that it did not have sufficient information to indicate that listing the North Cascades population of the lynx was warranted. A lawsuit was filed challenging the finding. On December 27, 1994, the USFWS published a notice stating that listing the Canada lynx in the lower 48 states was not warranted, because of the lack of residency in the lower 48 states and inability to substantiate threats to its continued existence. This determination was challenged in a lawsuit. After additional lawsuits and legal decisions, the USFWS published a notice in the Federal Register on March 24,2000 listing the Canada lynx as threatened in the contiguous U.S. (65 FR 10652 - USFWS 2000).

4.5.1 Life History

The Canada lynx (*Lynx canadensis*) is one of three major species of wildcats found in North America. The lynx is a medium-sized cat with long legs; large, well-furred paws; long tufts on the ears; and a short, black-tipped tail (65 FR 16502ff - USFWS 2000). Adult males weigh an average of 10 kg (22 lbs), are 85 cm (33.5 in) head to tail, while females average 8.5 kg (19 lbs) and 82 cm (32 in.) in length. The long legs and large feet of the Canada lynx make it highly adapted for hunting in deep snow.

The Canada lynx breeds between March and April in the north (Lynx Biology Team 2000). Kittens are born in May to June in south central Yukon. The male lynx does not help with rearing of the young. Yearling females give birth during periods when snowshoe hares, the primary food, are abundant. Few, if any, live kittens are born during the low phase of the hare cycle. During periods of hare abundance in the northern taiga, liter size averages 4 to 5 kittens (Lynx Biology Team 2000). Lynx use large woody debris, such as downed logs and windfalls to provide denning sites with security and thermal cover for kittens. A den site in Wyoming was located in a mature subalpine fir/lodgepole pine forest with abundant downed logs and a high amount of horizontal cover (65 FR 16052 - USFWS 2000).

Canada lynx are highly specialized predators whose primary prey is the showshoe hare *(Lepus americanus*). It has evolved to survive in areas that receive deep snow. Snowshoe hares use forests with dense understory that provides forage, cover to escape from predators, and protection during extreme weather. The association between lynx and snowshoe hare is considered a classic predator-prey relationship; in northern Canada and Alaska, lynx populations fluctuate on approximately 10-year cycles that follow the cycles of the hare populations (65 FR 16052 - USFWS 2000). Lynx also prey opportunistically on other small mammals and birds, particularly when hare populations decline. However, a shift to alternate food sources may not compensate for the decrease in hares consumed. In the northern habitats, when hare densities decline, the lower quality diet causes sudden decreases in the productivity of adult female lynx and decreases survival of kittens, which causes the number of breeding lynx to level off or decrease. In southern forests, where the densities of snowshoe hares are lower, and predation of the hare by other animals is higher, the potential for high-density hare populations with extreme cyclic fluctuations is reduced. Therefore, lynx densities at the southern part of their range never achieve the high densities that occur in the northern boreal forest (65 FR 16052ff - USFWS 2000).

The dependence of lynx on snowshoe hare has been described in Washington, Montana, and Canada. In Alberta, lynx productivity was related to prey availability, particularly snowshoe hare (Nellis et al. 1978, Brand and Keith 1979). Other studies of lynx food habits in Canada reveal that lynx prey on other species including tree and ground squirrels (Moore 1976, van Zyll de Jong 1966), small rodents (Van Zyll de Jong 1966), grouse (van Zyll de Jong 1966, Brand et al 1976, Nellis et al. 1978), and carrion (Saunders 1963, Brand et al. 1976, Nellis et al. 1978).

The size of the lynx home range varies by the animal's gender, abundance of prey, season, and density of lynx populations. Documented home ranges vary from 8 to 800 sq km (3-300 sq mi.) and are much larger at the southern than portions of the ranges. The home range of the lynx in the southern extent of the species' range is large compared to those in the northern portion of the range (USFWS 2000).

4.5.2 Current Status and Range-wide Distribution

Historic lynx data in the contiguous U.S. are scarce and exist primarily in the form of trapping records. Many States did not differentiate between bobcats and lynx in trapping records. Therefore, long-term lynx trapping data are not available for most states. Surveys designed specifically for lynx were rarely conducted, and many reports of lynx were collected incidental to other activities. The lack of data makes it difficult to draw definitive conclusions about lynx population trends (65 FR 165052 - USFWS 2000).

The historical and present range of the Canada lynx north of the contiguous U.S. includes Alaska and the part of Canada that extends from the Yukon and Northwest Territories south across the U.S. border and east to New Brunswick and Nova Scotia. In the contiguous 48 states, the lynx historically occurred in the Cascades Range of Washington and Oregon, the Rocky Mountain Range in Montana, Wyoming, Idaho, eastern Washington, eastern Oregon, northern Utah, and Colorado; the western Great Lakes Region; and the northeastern U.S. from Maine southwest to New York (USFWS 2000).

In the contiguous U.S. the distribution of the lynx is associated with the southern boreal forests, comprising of sub-alpine coniferous forest in the West and primarily mixed coniferous/ deciduous forest in the East. In Canada and Alaska the lynx inhabit the boreal forest ecosystem known as the taiga (65 FR 10652 - USFWS 2000).

4.5.3 Distribution in Wyoming

Historically, lynx have been observed in every mountain range in the State. Concentrations of observations occur in western Wyoming in the Wyoming and Salt River ranges and continuing north through the Tetons and Absaroka ranges in and around Yellowstone National Park. Most records of Canada lynx have also come from the western slope of the Wind River Range, with fewer observations in the Bighorn and Uinta Mountains (USFWS 2002a). Only 30 verified records of lynx have been reported Statewide since 1856 (USFWS 2000). Documented reported of lynx in the Yellowstone National Park are rare, and no recent verified records exist from the Greater Yellowstone Ecosystem (USFWS 2000). The Canada lynx has also been reported from the Big Horn Mountains in north-central Wyoming. Until 1957, there were bounties on the lynx in Wyoming. Since 1973, the lynx has been listed as a protected non-game species and its harvest was closed.

In Wyoming, the Canada lynx lives in subalpine/coniferous forests of mixed age and structural classes. Mature forests with downed logs and windfalls provide cover for denning sites, escape, and protection from severe weather. Early successional forest stages provide habitat for the lynx's primary prey, the snowshoe hare. The home range of the lynx in Wyoming ranges from 5 to 94 mi^2. Individuals are capable of moving extremely long distances in search of food (USFWS 2002A).

In 1996 the Wyoming Game and Fish Department began a lynx study in west-central Wyoming and production of kittens was documented in 1998. Based on available information, it was not possible to determine the status or trend of lynx throughout Wyoming (65 FR 16052ff) (USFWS 2000).

In north-central Washington and northwestern Montana, Canada lynx mainly prey on snowshoe hares (Koehler et al. 1979, Koehler 1990). In each study area, snowshoe hares were closely associated with forests dominated by lodgepole pine (*Pinus contorta*) and/or spruce-fir (*Picea engelmannii - Abies lasiocarpa*), and lynx locations and/or sightings were likewise associated with the same cover types (Koehler et al. 1979, Koehler 1990). Records of lynx in Wyoming also indicate that most lynx or lynx sign between 1973 and 1986 were in lodgepole pine (18%) and spruce-fir (41%) communities (Reeve et al. 1986). According to Reeve et al. (1986), more than 50 percent of lynx records in Wyoming occurred in the northwestern region of the state.

The proposed WRPA does not contain high elevation lodgepole pine/spruce-fir habitat types preferred by this species and does not support a population of snowshoe hares (WGFD 2000). There are also no recorded sightings in the vicinity of the proposed WRPA (T. Root, USFWS, pers. comm., June 2003). Therefore, it is unlikely that Canada lynx occur on or near the proposed WRPA.

4.6 MOUNTAIN PLOVER

The plover was petitioned for listing as threatened on July 7, 1997. On February 16, 1999, the FWS filed a notice of a proposal to list the mountain plover as a threatened species pursuant to the ESA (64 FR 7587) (USFWS 1999). The comment period for the listing proposal was re-opened on December 5, 2002 (67 FR 234) (USFWS 2002b). On September 9, 2003, a notice was published in the Federal Register (68 FR 53083) stating that the mountain plover would be removed list of proposed species, since the threats to the species, as identified in the proposed rule, were not as significant as earlier believed.

4.6.1 Life History

The mountain plover (*Charadrius montanus*) is a small, compact bird approximately 7-9 inches tall, with light brown back and lighter underparts, lacking the contrasting dark breast-rings typical of many other plover species. In flight, the mountain plover's underwings are white. Breeding plumage differs only by the addition of a dark line between the bill and eyes, which contrast with a pale forehead and a distinct black cap (USFWS 1999).

Mountain plovers are rarely found near water and show a preference for previously disturbed areas or modified habitat. The birds occupy suitable breeding habitat in many of the great Plains states from Canada south to Texas from late March through July (USFWS 2002a). The breeding habitat of the mountain plover typically includes short-grass prairies and shrub-steppe landscapes; dryland, cultivated farms; and prairie dog colonies. Mountain plovers usually breed and build nests in areas with sparse vegetation or bare ground, which are conditions that can be created by prairie dogs, domestic cattle or other herbivores (USFWS 1999). Nests have also been documented on bare ground created by oil and gas development activities (USFWS 2002b). Vegetation in short-grass prairie nesting habitats is typically less than four inches in height (Knopf 1994; USFWS 2002b). Nest sites within the shrub-steppe community are found within areas of little or no vegetation.

The breeding season begins in late March or early April, soon after mountain plovers arrive from wintering grounds in south Texas and northern Mexico (USFWS 1999). Some research indicates that plovers will sometimes lay two clutches, one brooded by the male and the other by the female (USFWS 1999). Breeding plovers exhibit close site fidelity, often returning to the same territory in subsequent years (Knopf 1996; USFWS 1999).

Mountain plovers are insectivorous, with grasshoppers, beetles, ants, flies, and crickets as their principal food items (USFWS 1999). The dependency of mountain plovers is probably tied to two factors: habitat and food (Dinsmore 2001). The barren, open ground created by prairie dogs provides ideal nesting habitat for the mountain plover. Prairie dog colonies generally also harbor more insects for the plover, as compared to surrounding habitats (Dinsmore 2001; Knopf 1996).

4.6.2 Current Status and Range-wide Distribution

Historically, the mountain plover was considered numerous on breeding grounds in eastern Colorado, Montana and Wyoming, western Nebraska and South Dakota, and western and central Kansas and Oklahoma (USFWS 1999). Available data indicate that population numbers of plovers have declined range-wide by more than 50 percent since 1966 to fewer than 10,000 birds (Grunau and Wunder 2001). Identified or suspected reasons for the species' decline include conversion of short-grass and shrub-steppe habitats, changes in range management to emphasize uniform grass cover, declines in native ungulates and burrowing animals (e.g., prairie dogs), habitat loss and fragmentation caused by residential, commercial and industrial development, and possibly population sinks created by certain agricultural practices (USFWS 1999).

Today, mountain plovers occupy suitable breeding habitat in many of the Great Plains states from Canada south to Texas from late March through July. Colorado, Montana and Wyoming have the majority of breeding plovers, but some breed in Kansas, Nebraska, New Mexico, and Oklahoma (USFWS 1999). Wintering areas are concentrated in the central valley of California, Texas and Mexico (USFWS 1999).

Excellent mountain plover habitat occurs within the proposed WRPA (Dana 2001). A mountain plover survey was conducted in May and June 2001, at a site of a proposed well and access road (Tribal Pavillion #13-5) and one mountain plover was observed during the survey (Dana 2001).

4.7 SAGE GROUSE

Another species of concern that may occur in the WRPA is the sage grouse. Although the sage grouse is not a Federally listed as threatened or endangered at this time, it is a species of high interest among Federal and State agencies and several petitions for listing the sage grouse have been submitted to the USFWS (K. Erwin, USFWS, pers. comm., June 2003).

4.7.1 Life History

The sage grouse (*Centrocercus urophasianus*) is the largest North American grouse and occurs in areas containing sagebrush. Both sexes have narrow, pointed tails, feathering to the base of the toes and a diverse pattern of grayish brown, buff, and black on the upper body. The flanks are pale gray and white, and there is a large dark patch extending across the lower breast and abdomen. Adult sage grouse have dark-green toes. The males are larger and more colorful than females (2-3 kg) and have a black throat and bib, white feathers along the sides of the neck, and a large white ruff of the breast. Males also exhibit two large frontally directed air sacs of olive-green skin and yellow-superciliary combs; both are enlarged during breeding display. The smaller females (1-2 kg) lack black and white feathers on the neck and instead have grayish-white upper throats. The average life span of sage grouse is 1-1.5 years. However, sage grouse can survive up to 10 years in the wild (Royal British Columbia Museum 1995).

Female sage grouse are sexually mature their first fall and nest the following spring. Males are sexually mature their first spring after hatching. The breeding season generally begins the same time each year, but ultimately depends on weather and vegetative conditions. Mating begins after males and females congregate on a lek. Hens form a cluster near centrally-located dominant males, and these few males participate in most of the mating (Royal BC Museum 1995).

Leks are the focal point of the breeding season and range in size from 0.04 to 40 ha. Leks are generally in the vicinity of nesting areas and winter and summer habitat. Most leks contain a central area that is barren, and a surrounding area containing sagebrush with a canopy cover of 20-50 percent. Gravel pits, burned areas, plowed fields, air strips, abandoned homesteads, roads, bare ridges, grassy swales, natural and irrigated meadows void of grass knolls, small buttes, openings in sagebrush stands, dry-lake beds and areas stripped of vegetation by livestock may be used a lek. Visibility is important on a lek as is necessary for females to observe displaying males, and for all sage grouse to observe predators. Water is not necessary on a lek (Royal BC Museum 1995).

After mating, sage grouse hens leave the lek to nest approximately 2-6 km from leks. They nest under sage brush with an average height of 40.4 cm and a canopy cover of 20-40 percent. They devote most of their time to building nests, laying eggs, raising chicks. Males do not assist in these activities. Females build nests, approximately 10 days after mating, in shallow depressions on ground sparsely lined with grass and sheltered by sagebrush or clumps of grass. Females lay one egg every 1.3 days for approximately 9 days. The clutch of 7-8 eggs is incubated for 25 to 27 days from mid-March to mid-June. After hatching, chicks wait until they are dry, then leave the nest. Females typically lay one brood in a season. Hens spend considerable time keeping chicks warm and guarding them for the first 4-5 weeks, but the chicks feed themselves. By the end of the second week, chicks can fly several yards and by the eighth week several hundred yards. After hatching, chicks remain with hens until late summer or early fall, until they congregate with other sage grouse in winter flocks for migration (Royal BC Museum 1995).

Wintering habitat consists of dense sagebrush with a canopy cover greater than 20 percent standing an average of 25 cm above the snow. Wintering habitat is typically the most limited seasonal habitat within the range of the sage grouse (Royal British Columbia Museum 1995).

Sagebrush is the most important component of the sage grouse diet, but forbs and grasses are also a significant food source. Insects are eaten, but compose only a small proportion of the diet of adult sage grouse. In the first weeks of life broods rely heavily on insects for food. However, in the fall the diet shifts to one dominated by sagebrush (Royal BC Museum 1995).

Predation, especially during nesting, egg laying, and brood rearing, limits the growth of sage grouse populations. Approximately 50 percent of sage grouse mortality is caused by predators. Adults are more vulnerable to predators in the winter because the snow makes them more visible. The primary predators of the sage grouse are raptors and crows; ground predators include coyotes, bobcats, minks, badgers, and round squirrels (Royal British Columbia Museum 1995).

4.7.2 Current Status and Range-wide Distribution

Sage grouse evolved with the plants after which they are named and their occurrence is limited to the higher sagebrush plains (Royal British Columbia Museum 1995). When Louis and Clark encountered the sage grouse on their journey west, it was estimated that there were two million individuals. The present number of sage grouse in the United States is estimated to be 200,000 (Smithsonian Magazine 2001). The decline of the sage grouse is primarily attributed to agriculture, excessive livestock grazing, sagebrush control using herbicides, and fires. Irrigation projects, commercial, industrial and power development have also resulted in the loss of sagebrush habitat. Predation, hunting, disease, and parasitism also result in sage grouse mortality (Royal British Columbia Museum 1995). The present range of the sage grouse includes Wyoming, Montana, western Colorado, Utah, southern Idaho, northern Nevada, southeastern Oregon, central Washington, and the northeastern corner of California. (Peterson 1990).

4.7.3 Aerial Surveys for Sage Grouse Leks

4.7 3.1 Methods

The aerial surveys for sage grouse leks were conducted from April 16 to 17, 2003 (Buys & Associates 2003a). The survey began before sunrise, when there was sufficient light to see the ground and existing vegetation. The pre-determined protocol for the surveys was to fly north-south transects, spaced at approximately 3/4 of a minute longitude (approximately 0.62 mile). The purpose of flying transects north-to-south and vice versa, rather than east-to-west was to have the sun shining on the sage grouse so they could be more easily observed from the air. The transects were flown at approximately 250 feet above the ground during the surveys. Because sage grouse only strut on the leks in early morning, the surveys for these leks were concluded within two hours from when they were commenced.

4.7.3.2 Results

No sage grouse leks were identified in the WRPA during the aerial surveys. Although there was some sage grouse habitat within the area, the majority of the area did not appear to be suitable habitat for sage grouse. The most suitable sage grouse habitat was found immediately south of the proposed WRPA boundary, north of Fivemile Creek and south of the west end of Muddy Ridge. The areas that were suitable habitat for sage grouse consisted of approximately 50-60 percent sagebrush (*Artemisia* spp.), 10-15 percent short grasses, and the remaining area bare ground; however, no sage grouse leks were observed (Buys & Associates 2003a)

5.0 DIRECT AND INDIRECT IMPACTS OF THE PROPOSED DEVELOPMENT PROJECT

The threatened and endangered wildlife identified by the USFWS (2002a) as potentially inhabiting the proposed WRPA include the bald eagle, black-footed ferret, Canada lynx, gray wolf, and grizzly bear. The mountain plover and sage grouse are evaluated here, since the mountain plover was proposed for listing as threatened in 1999 (rescinded on September 9, 2003) and the sage grouse has been petitioned for listing under the Endangered Species Act. The potential impacts of the proposed gas development project to these threatened and endangered species is discussed below for the Proposed Action, Alternative A, Alternative B, and Alternative C (No Action).

5.1 PROPOSED ACTION

An additional 325 wells may be drilled in the proposed Wind River WRPA. Some of these wells may be classified as exploration or delineation wells because natural gas production potential has not been fully defined due to geological uncertainties. Where production potential is known, wells will be classified as in-fill or development wells. Drilling is expected to continue for approximately 20 years, with a life-of-project of 20-40 years.

The drilling of new wells will require the construction of additional roads. Existing pipelines and new pipelines, including new gathering lines, loop lines and tie-ins to existing interstate pipelines will transport the produced gas within the WRPA. The exact number of additional wells to be drilled, locations of the wells, and timing of the drilling will depend on various factors, including success of development drilling, production technology, and economic considerations. Although the total acres of disturbance from the proposed project is estimated to be 1,605 acres during the life of the project, the exact locations of the wells have not be determined.

5.1.1 Bald Eagle

Bald eagles are known to occur in the general vicinity of the WRPA and have been reported to roost at Ocean Lake in the winter, which is about 2 miles to the south of the WRPA (P. Hnilicka, USFWS, pers. comm., January 2003). Thus, there is the potential of bald eagles to roost in the WRPA in the winter (USFWS 2002a). However, no bald eagles or bald eagle nests were observed in the WRPA and the two-mile buffer during the aerial survey conducted in late April 2003 (Buys & Associates 2003a). The closest known bald eagle nest is located at Diversion Dam approximately 30 miles to the west of the WRPA (P. Hnilicka, USFWS, pers. comm., June 2003).

The bald eagle may be directly and/or indirectly affected by the proposed Wind River Gas Development Project. Since bald eagles feed on carrion, the presence of road-killed big game carcasses on access roads could attract bald eagles and other raptors. If bald eagles are injured or killed as a result of vehicle collisions while feeding on the carrion, it would result in a “take,” which is prohibited by the Endangered Species Act. If the avoidance and minimization measures, discussed in Section 7 of this BA, are followed, impacts to the bald eagle are unlikely to occur.

5.1. 2 Black-footed Ferret

Based on the white-tailed prairie dog survey, a total of four white-tailed prairie dog colonies, covering 1,243 acres, occur in and adjacent to the area of the Proposed Action. The approximate density of active prairie dog burrows in and adjacent to the WRPA is 10.3 burrows/acre (25.5 burrows/hectare). This exceeds the USFWS minimum threshold of eight burrows/acre (20 burrows/hectare) (USFWS 1989). The number of ferret families that could be supported by the prairie dog colonies was calculated using a model developed by Biggens et al (1989). The prairie dog colonies had a rating of 1.9, which was greater than the minimum rating of 1.0 needed to support black-footed ferrets.

The Proposed Action could result in direct disturbance of some portions of these prairie dog colonies. Since there is a potential that black-footed ferrets could be associated with the prairie dog colonies, a black-footed ferret survey will be conducted prior to any disturbance of prairie dog colonies. If black-footed ferrets are found to be present in the prairie dog colonies, then no disturbance to the prairie dog colonies would be allowed, since any damage to the prairie dog burrows could result in a “take” of black-footed ferrets.

5.1.3 Canada Lynx

Significant threats to the lynx that have been identified by the USFWS include: 1) loss and/or modification of its habitat; 2) past commercial harvest (trapping), which is partially responsible for the extremely small lynx population; 3) inadequate regulatory mechanisms to protect lynx and their habitat; and 4) increased human access into suitable habitat and human-induced changes in the habitat that allow other species (e.g., bobcats and coyotes) to move into lynx habitat and compete with them (USFWS 2002a).

In Wyoming, the Canada lynx lives in subalpine/coniferous forests of mixed age and structural classes. Mature forests with downed logs and windfalls provide cover for denning sites, escape, and protection from severe weather. Early successional forest stages provide habitat for the lynx’s primary prey, the snowshoe hare (USFWS 2002a). Since subalpine/coniferous forests are not found in the WRPA, Canada lynx are not expected to be present. There have been no reports of Canada lynx observations in the WRPA (P. Hnilicka, USFWS, January 2003). Therefore, implementation of the Proposed Action is unlikely to impact the Canada lynx or its habitat.

5.1.4 Gray Wolf

Gray wolves, once common in the Greater Yellowstone Ecosystem, have recently been reintroduced into the area. Although the gray wolf is officially listed as threatened, all gray wolves within Wyoming are now considered part of a nonessential experimental population. The gray wolves remain protected by the Endangered Species Act, but additional flexibility is provided for their management under the provisions of the final rule and special regulations promulgated for nonessential experimental populations (59 FR 60253, November 22, 1994). Further management flexibility is provided for wolves outside the National Park or National Wildlife Refuge System. Wolves designated as nonessential experimental populations are treated as “proposed,” rather than listed.

The presence of a collared gray wolf was reported between and Kinnear and Ocean Lake, which is near the WRPA (P. Hnilicka, USFWS, pers. comm., June 2003). A wolf feeding on a carcass of big game species (e.g., pronghorn antelope, mule deer and other game species) could be accidentally killed by collision with a vehicle driven by construction crews. If the avoidance measures described in Section 7 are followed, impacts to the gray wolf are unlikely to occur from the Proposed Action.

5.1.5 Grizzly Bear

The grizzly bear has a wide range of habitat tolerance, but is mainly found in relatively undisturbed contiguous mountainous habitat having a high level of topographic and vegetative diversity. Bears are attracted to carrion, waste products of construction camps, recreational areas and sprawling residential areas that have encroached into the bear habitat resulting in increased human-bear interactions (USFWS 1993). Although the habitat in the WRPA is not typical grizzly bear habitat, there have been occasional reports of sitings. However, those observations have not been confirmed (P. Hnilicka, USFWS, pers. comm., June 2003). If the avoidance measures described in Section 7 are followed, impacts to the grizzly bear from the Proposed Action are unlikely to occur.

5.1.6 Mountain Plover

Although a large portion of the WRPA is currently being used for agricultural purposes, mountain plover habitat is present within the WRPA. It has been reported that excellent plover habitat exists in the WRPA, and the presence of a mountain plover was reported at one of the well locations (Tribal Pavillion 13-5) (Dana 2001). Since the plovers often nest near roads, feed on or near roads, and use roads as travel corridors (USFWS 1999), adults or fledglings could be killed by vehicle traffic. Disturbance (e.g., noise) from vehicles and other development-related operations could also result in disturbance of nesting activities and mortality of the fledglings. If avoidance and minimization measures described in Section 7 are followed, the potential for adverse effects to the mountain plover from the Proposed Action is minor.

5.1.7 Sage Grouse

No sage grouse leks were identified during the aerial surveys. Although some sage grouse habitat is present in the WRPA, the majority of the area appears to be marginal for sage grouse. The area that appears to contain the most suitable sage grouse habitat is directly south of the WRPA boundary, north of Fivemile Creek and south of the west end of Muddy Ridge. This area consists of approximately 50-60 percent sagebrush, 10-15 percent short grasses, with the remaining area bare ground.

Since sage grouse are found in open areas where road construction and vehicular traffic could occur there is a potential for direct effects (i.e., mortality) or indirect effects (e.g., effects on reproductive success) from road construction, vehicular traffic and other development activities. If avoidance and minimization measures described in Section 7 are followed, adverse effects to the sage grouse resulting from the Proposed Action would be minor.

5.1.9 Fish Species

The USFWS (2002a) did not identify the WRPA as potential habitat for threatened and endangered fish species, since many of the streams in the WRPA are shallow or intermittent. The limited amount of water would likely preclude the presence of the large endangered fish species.

5.1.10 Plant Species

Little is known about the presence of endangered and sensitive plant species in the WRPA. However, threatened or endangered plant species are not expected to be present in the WRPA (USFWS 2002a).

5.2 ALTERNATIVE A

Under Alternative A approximately 2,928 acres or 3.18 percent of wildlife habitat in the WRPA would be disturbed over the next 20 years. Reclamation actions would decrease the disturbance to 275 acres or 0.30 percent of the WRPA.

5.2. 1 Bald Eagle

Under Alternative A, the disturbance to potential bald eagle habitat would be 1,323 acres greater than the disturbance under the Proposed Action. However, if the mitigation measures, described in Section 7, are implemented, potential impacts to the bald eagle would be greatly reduced.

5.2.2 Black-footed Ferret and Associated White-tailed Prairie Dog

Alternative A may result in direct disturbance of some portions of the prairie dog colonies within the WRPA. Since there is a potential that black-footed ferrets could be associated with the prairie dog colonies, a black-footed ferret survey will be conducted prior to any disturbance of prairie dog colonies. If black-footed ferrets are found to be present in the prairie dog colonies, then no disturbance to the prairie dogs would be allowed. Any damage to the prairie dog burrows could result in a “take” of black-footed ferrets.

5.2.3 Canada Lynx

Since Canada lynx habitat is not present in the WRPA, Alternative A is not expected to impact the Canada lynx.

5.2.4 Gray Wolf

Under Alternative A, the disturbance to potential gray wolf habitat would be 1,323 acres greater than the disturbance under the Proposed Action. However, if the mitigation measures described in Section 7 are implemented, potential impacts to the gray wolf would be greatly reduced.

5.2.5 Grizzly Bear

Under Alternative A, the disturbance to potential grizzly bear habitat would be 1,323 acres greater than the disturbance under the Proposed Action. However, if the mitigation measures described in Section 7 are implemented, potential impacts to the grizzly bear would be greatly reduced.

5.2.6 Mountain Plover

Under Alternative A, the disturbance to potential mountain plover habitat would be 1,323 acres greater than the disturbance under the Proposed Action. However, if the mitigation measures described in Section 7 are implemented, potential impacts to the mountain plover would be greatly reduced.

5.2.7 Sage Grouse

Under Alternative A, the disturbance to potential sage grouse habitat would be 1,323 acres greater than the disturbance under the Proposed Action. However, if the mitigation measures described in Section 7 are implemented, potential impacts to the sage grouse would be greatly reduced.

5.2.8 Fish Species

The USFWS (2002a) did not identify the WRPA as potential habitat for threatened and endangered fish species, since many of the streams in the area of the Alternative A are shallow or intermittent. The limited amount of water would likely preclude the presence of endangered fish species.

5.2.9 Plant Species

Threatened or endangered plant species are not expected to be present in the WRPA. Therefore, Alternative A is unlikely to affect these plant species.

5.3 ALTERNATIVE B

Under Alternative B a total of 233 new wells would be drilled, resulting in disturbance of 1,167 acres. This initial disturbance would be 438 acres less than under the Proposed Action. Residual disturbance under Alternative B would be 144 acres or 47 acres less than the Proposed Action.

5.3.1 Bald Eagle

Under Alternative B, the disturbance to potential bald eagle habitat would be 1,167 acres or 438 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the bald eagle would be greatly reduced.

5.3.2 Black-footed Ferret

Alternative B may result in direct disturbance of some portions of these prairie dog colonies. Since there is a potential that black-footed ferrets could be associated with the prairie dog colonies, a black-footed ferret survey will be conducted prior to any disturbance of prairie dog colonies. If black-footed ferrets are found to be present in the prairie dog colonies, then no disturbance to the prairie dogs would be allowed. Any damage to the prairie dog burrows could result in a "take" of black-footed ferrets.

5.3.3 Canada Lynx

Since Canada lynx habitat is not present in the WRPA, Alternative B is not expected to impact the Canada lynx.

5.3.4 Gray Wolf

Under Alternative B, the disturbance to potential gray wolf habitat would be 438 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the gray wolf would be reduced.

5.3.5 Grizzly Bear

Under Alternative B, the disturbance to potential grizzly bear habitat would be 438 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the grizzly bear would be reduced.

5.3.6 Mountain Plover

Under Alternative B, the disturbance to potential mountain plover habitat would be 438 acres less than the disturbance under the Proposed Action. However, if the mitigation measures, described in Section 7, are implemented, potential impacts to the mountain plover would be greatly reduced.

5.3.7 Sage Grouse

Under Alternative B, the disturbance to potential greater sage grouse habitat would be 438 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the sage grouse would be reduced.

5.4 ALTERNATIVE C (NO ACTION)

Under Alternative B (No Action), the proposed development project would be denied. Drilling would only be permitted on private minerals and on tribal minerals only to offset potential drainage of the tribal minerals. It is anticipated that a total of 100 wells would be drilled resulting in disturbance of 216 acres. This disturbance is 1,389 less than the disturbance under the Proposed Action. After reclamation a total of 43 acres would remain impacted.

The residual disturbance under Alternative C would be 148 acres less than under the Proposed Action.

Individual APDs would be approved on a case-by-case-basis. Wildlife and vegetation resources would continue to be impacted, when individual wells are drilled. In terms of magnitude, such impacts would be less than for the Proposed Action, Alternative A, or Alternative B. However, there could be an increased probability of occurrence of unexpected adverse impacts, since overall field development would not occur in a well-planned and monitored manner.

5.4.1 Bald Eagle

Under Alternative C, the disturbance to potential bald eagle habitat would be 1,389 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the bald eagle would be further reduced.

5.4.2 Black-footed Ferret

Alternative C may result in direct disturbance of some portions of these prairie dog colonies. Since there is a potential that black-footed ferrets could be associated with the prairie dog colonies, a black-footed ferret survey will be conducted prior to any disturbance of prairie dog colonies. If black-footed ferrets are found to be present in the prairie dog colonies, then no disturbance to the prairie dogs would be allowed. Any damage to the prairie dog burrows could result in a "take" of black-footed ferrets.

5.4.3 Canada Lynx

Since Canada lynx habitat is not present in the WRPA, Alternative C is not expected to impact the Canada lynx.

5.4.4 Gray Wolf

Under Alternative C, the disturbance to potential gray wolf habitat would be 1,389 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the gray wolf would be further reduced.

5.4.5 Grizzly Bear

Under Alternative C, the disturbance to potential grizzly bear habitat would be 1,389 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the grizzly bear would be further reduced.

5.4.6 Mountain Plover

Under Alternative C, the disturbance to potential mountain plover habitat would be 1,389 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the mountain plover would be further reduced.

5.4.7 Sage Grouse

Under Alternative C, the disturbance to potential sage grouse habitat would be 1,389 acres less than the disturbance under the Proposed Action. If the mitigation measures, described in Section 7, are implemented, potential impacts to the sage grouse would be further reduced.

6.0 CUMULATIVE IMPACTS

Cumulative impacts as defined by Section 7(c) of the ESA are the incremental impacts of future State or private activities that are reasonably certain to occur within, or in proximity to, the WRPA (USFWS 1998). The geographic area considered in the cumulative impacts analysis for the threatened and endangered species under the Proposed Action and alternatives is the Boysen Reservoir watershed. Future activities that are likely to occur in and near the WRPA include agriculture, other oil and gas development, livestock grazing, recreation, gravel mining, and residential and commercial development.

The WRPA is approximately 91,520 acres. The disturbance within the WRPA under the Proposed Action is expected to be 1,605 acres or 1.75 percent. Under Alternative A, 2,928 acres or 3.18 percent of the WRPA would be disturbed. Under Alternative B, a total of 1,167 acres or 1.27 percent of land would be disturbed. Under Alternative C (No Action) total disturbance would be 216 acres or 0.24 percent of the WRPA would be disturbed. The acreage of disturbance will be reduced after reclamation of the pipeline ROWs, unused portions of the drill pads, portions of the access roads, and cessation of other disturbances associated with the proposed oil and gas development project.

As lands surrounding the proposed Wind River Gas Development Project include Tribal, Bureau of Reclamation, State, and private lands, activities in these areas are likely to affect the wildlife within the area of the Proposed Action. Future land uses within these areas are likely to include oil and gas development, agriculture, livestock grazing, and residential and commercial development. Although these uses cannot be quantified, such use in addition to the Proposed Action, could have substantial direct and indirect impacts to the threatened or endangered wildlife species or species proposed for listing.

6.1 BLACK-FOOTED FERRET

The black-footed ferret may potentially be present within the white-tailed prairie dog colonies. If the avoidance measures described in Section 7.0 are followed, the potential for an increase in cumulative impacts as a result of the implementation of the Proposed Action or Alternatives A, B, or C (no action) is unlikely.

6.2 BALD EAGLE

Bald eagles nests were not observed within the WRPA, but may potentially use the area for roosting in the winter. If the avoidance measures described in Section 7.0 are followed, the potential for an increase in cumulative impacts as a result of the implementation of the Proposed Action or Alternatives A, B or C (no action) is unlikely.

6.3 CANADA LYNX

There is no suitable habitat for the Canada lynx in the WRPA. Therefore, implementation of the proposed project will not contribute to cumulative impacts to the Canada lynx.

6.4 GRAY WOLF

Gray wolf packs have not been reported within the proposed WRPA, but an individual wolf was reported in the general vicinity of the WRPA. If the avoidance measures described in Section 7.0 are followed, the potential for an increase in cumulative impacts as a result of the implementation of the Proposed Action, Alternatives A, B, or C (no action) is unlikely.

6.5 GRIZZLY BEAR

The habitat in the WRPA is not characteristic of grizzly bear habitat. However, there have been unconfirmed reports of grizzly bears in the area. If the avoidance and minimization measures described in Section 7.0 are followed, the potential for an increase in cumulative impacts as a result of the implementation of the Proposed Action, Alternatives A, B, or C is unlikely.

6.6 MOUNTAIN PLOVER

Mountain plovers are present in the WRPA and surrounding areas. Proposed development activities associated with construction of well pads, roads, could result in an increase in cumulative impacts to the mountain plover. However, if the avoidance and minimization measures described in Section 7.0 are followed, the potential for an increase in the cumulative impacts as a result of the implementation of the Proposed Action or alternatives is expected to be minor.

6.7 SAGE GROUSE

Sage grouse habitat is present in the proposed WRPA and surrounding areas. Proposed development activities associated with construction of well pads, roads, could result in an increase in cumulative impacts to the sage grouse. However, if the avoidance measures described in Section 7 are followed, the potential for an increase in the cumulative impacts as a result of the implementation of the Proposed Action or Alternatives A, B, or C (no action) is expected to be minor.

6.8 FISH SPECIES

There are no reports of the presence of endangered fish species within the WRPA. Therefore, implementation of the proposed action will not cumulatively impact endangered fish species habitat.

6.9 PLANT SPECIES

There are no reports of the presence of endangered plant species within the WRPA. Therefore, implementation of the Proposed Action or Alternatives A, B, or C (no action) will not cumulatively impact endangered plant species habitat.

7.0 MEASURES TO AVOID OR MINIMIZE ADVERSE IMPACTS

The measures provided below will be implemented to avoid or minimize potential adverse impacts from the proposed project to threatened/endangered species and species proposed for listing under the Endangered Species Act that may potentially be present in WRPA.

7.1 BALD EAGLE

Measures that should be implemented to avoid or reduce the potential of adverse effects to the bald eagle are provided below.

- A one-mile buffer should be established around bald eagle nests and winter roost sites.
- Animal carcasses should be removed from access roads, road shoulders, and ROWs to minimize the likelihood of vehicle collisions with bald eagles feeding on carrion.
- Drivers should undergo an educational program that discusses the potential of bald eagles to feed on road-killed animals. The training should include the following:
  - Training in understanding the requirements of the Endangered Species Act and the consequences of "take,"
  - Training to avoid collisions with bald eagles,
  - Reducing allowable speed of vehicles in the proposed WRPA,
  - Prohibition of unnecessary off-site activities of company personnel,
  - Removal of vehicle-killed carcasses from roads and ROWs to eliminate exposure of the eagles to carrion and potential vehicular accidents.

Implementation of these measures would avoid or minimize the potential of adverse effects to bald eagles from the Proposed Action or alternatives.

7.2 BLACK-FOOTED FERRET AND WHITE-TAILED PRAIRIE DOG

Measures that should be implemented to avoid or reduce the potential of adverse effects to the black-footed ferret are provided below.

- To determine whether black-footed ferret surveys are present in the proposed WRPA, surveys are required prior to the initiation of construction activities, if such activities are expected to occur within a prairie dog complex.
- Well pads, roads, facilities and equipment should be placed outside of prairie dog colonies, if possible.
- If black-footed ferrets are documented in a prairie dog complex located within the WRPA, all previously authorized project-related activities under way near the prairie dog colony should be suspended immediately,

- Training in understanding the requirements of the Endangered Species Act and the consequences of “take” should be conducted,
- Training should also be conducted on the potential of canine distemper to cause disease and mortality in the black-footed ferret, and employees should not be permitted to bring pets to the work site during or after hours,
- All suspected observations of black-footed ferrets, their sign, or carcasses on the proposed WRPA should be reported to the BIA and USFWS within 24 hours.

Implementation of these measures would avoid or minimize the potential of adverse effects to black footed-ferret from the Proposed Action or alternatives.

7.3 CANADA LYNX

Since there is no suitable habitat within the WRPA for the Canada lynx, no specific measures to avoid or minimize adverse effects will be necessary.

7.4 GRAY WOLF

Measures that should be implemented to avoid or reduce the potential of adverse effects to the gray wolf are provided below.

- Training in understanding the requirements of the Endangered Species Act and the consequences of “take,”
- Operators should be informed about the potential use of roads and adjacent areas by the gray wolf,
- Driving speeds should be reduced,
- Travel at night should be minimized to reduce the potential of interaction with the gray wolf.

Implementation of these measures would avoid or minimize the potential of adverse effects to the gray wolf from the Proposed Action or alternatives.

7.5 GRIZZLY BEAR

Measures that should be implemented to avoid or reduce the potential of adverse effects to the grizzly bear are provided below.

- Training in understanding the requirements of the Endangered Species Act and the consequences of “take,”
- Operators should be informed about the potential of use of roads and adjacent areas by the species,
- Driving speeds should be reduced,
- Travel at night should be minimized to reduce the potential of interaction with grizzly bears.

Implementation of these measures would avoid or minimize the potential of adverse effects to the grizzly bear from the Proposed Action or alternatives.

7.6 MOUNTAIN PLOVER

Measures that should be implemented to avoid or reduce the potential of adverse effects to the mountain plover are provided below.

- If construction activities for well pads, roads, pipelines, ROWs are expected to occur between April 10th and July 10th, within potential mountain plover habitat, surveys will be conducted in accordance with the current mountain plover survey guidelines (USFWS 2002c).
- If mountain plovers or occupied mountain plover nests are present within ¼ mile of the proposed construction area, construction activities will be postponed 37 days or 7 days post hatching (USFWS 2002c).
- Well pads, construction equipment and other equipment and facilities should be placed outside mountain plover habitat, where feasible.
- Traffic speeds and traffic volume should be reduced within ¼ mile of mountain plover occupied habitat between April 10th and July 10th, since adults and young may forage along roads during the night.
- To protect identified mountain plover occupied habitat, fences, storage tanks, and other elevated structures should be constructed as low as possible and/or perch-inhibitors should be incorporated into the design to eliminate a perch for predators.
- To minimize destruction of nests and disturbance to breeding mountain plovers, reclamation activities or other ground-disturbing activities should not occur between April 10th and July 10th in occupied plover habitat, unless surveys conducted in accordance with the USFWS guidance (USFWS 2002c) find that no plovers are nesting in the area.

Implementation of these measures would avoid or minimize the potential of adverse effects to the mountain plover from the Proposed Action or alternatives.

7.7 SAGE GROUSE

In order to avoid or minimize the potential of impacts to sage grouse the following measures should be taken:

- Operators should be informed about the potential of use of roads and adjacent areas by the sage grouse and the nesting season of this species,
- Driving speeds should be reduced to prevent collisions with the sage grouse,
- Travel at night should be minimized to reduce the potential of killing or injuring the sage grouse.

Implementation of these measures would avoid or minimize the potential of adverse effects to the sage grouse from the Proposed Action or alternatives.

7.8 FISH SPECIES

Endangered fish species are not expected to be present in the proposed WRPA, since there are only intermittent streams (P. Hnilicka, USFWS, pers. comm., January 2003). Therefore, no avoidance and minimization measures are required.

7.9 PLANT SPECIES

Threatened and endangered plant species are not expected to be present within the WRPA (P. Hnilicka, USFWS, pers. comm., January 2003. Therefore, no avoidance and minimization measures are required.

8.0 EFFECTS OF THE PROPOSED PROJECT ON THE STATUS OF THREATENED AND ENDANGERED SPECIES

If the avoidance and minimization measures described in Section 7 in this BA are implemented, the Proposed Action and alternatives are not expected to result in any change in the status of the threatened and endangered species during the implementation of the Wind River Gas Development Project.

9.0 DETERMINATION OF EFFECTS TO THREATENED, ENDANGERED, AND PROPOSED SPECIES

This section of the BA evaluates the potential of the Proposed Action, Alternative A, Alternative B, and Alternative C to result in adverse effects to endangered, threatened, and proposed species, including the bald eagle, black-footed ferret, Canada lynx, gray wolf, grizzly bear, mountain plover, and sage grouse. An effects determination statement of "no effect," "may affect, but not likely to adversely affect," or may affect, likely to adversely affect" is provided for each listed species.

9.1 BALD EAGLE

Based on the analysis of the Proposed Action and alternatives, the current status of the bald eagle in the WRPA, other existing and future land uses in the area, and incorporation of the avoidance or minimization measures recommended in Section 7 of this BA, it is determined that implementation of the Proposed Action, Alternative A, Alternative B or Alternative C "may affect, but is not likely to adversely affect" the threatened bald eagle.

9.2 BLACK-FOOTED FERRET

Based on the analysis of the Proposed Action and alternatives, the current status of the black-footed ferret in the proposed WRPA, other existing and future land uses in the area, and incorporation of avoidance or minimization measures recommended in this Biological Assessment, it is determined that implementation of the Proposed Action or Alternatives A, B or C "may affect, but is not likely to adversely affect" the endangered black-footed ferret.

9.3 CANADA LYNX

Based on the lack of suitable habitat in the WRPA, it is unlikely that Canada lynx would occur in the WRPA. Therefore, the Proposed Action or Alternatives A, B, or C will have “no effect” on the Canada lynx.

9.4 GRAY WOLF

Based on the analysis of the Proposed Action and alternatives, the current status of the gray wolf in the WRPA, other existing and future land uses in the area, and incorporation of avoidance or minimization measures recommended in this BA, it is determined that implementation of the Proposed Action, Alternative A, Alternative B, or Alternative C “may affect, but is not likely to adversely affect” the gray wolf.

9.5 GRIZZLY BEAR

Based on the analysis of the proposed project, the current status of the grizzly bear in the WRPA, other existing and future land uses in the area, and incorporation of avoidance or minimization measures recommended in this BA, it is determined that implementation of the Proposed Action or Alternatives A, B or C “may affect, but is not likely to adversely affect” the threatened grizzly bear.

9.6 MOUNTAIN PLOVER

Based on the analysis of the Proposed Action, the current status of the mountain plover in the WRPA, other existing and future land uses in the area, and incorporation of avoidance or minimization measures recommended in this BA, it is determined that implementation of the Proposed Action or Alternatives A, B or C would have minor impacts on the mountain plover.

9.7 SAGE GROUSE

Although the sage grouse is not proposed for listing at this time, this species may be proposed for listing in the near future. Based on existing and future land uses within the area and incorporation of avoidance or minimization measures recommended in this BA, it is determined that implementation of the Proposed Action, Alternative A, Alternative B, or Alternative C would have minor impacts on the sage grouse.

9.8 FISH SPECIES

The endangered fish species are not expected to be present in the WRPA, because the shallow or intermittent streams in the WRPA do not support the endangered fish species. Therefore, the Proposed Action, Alternative A, Alternative B or Alternative C will have “no effect” on endangered fish species.

9.9 PLANT SPECIES

Since no endangered plant species have been reported within the WRPA, the Proposed Action and alternatives will have “no effect” on endangered plant species.

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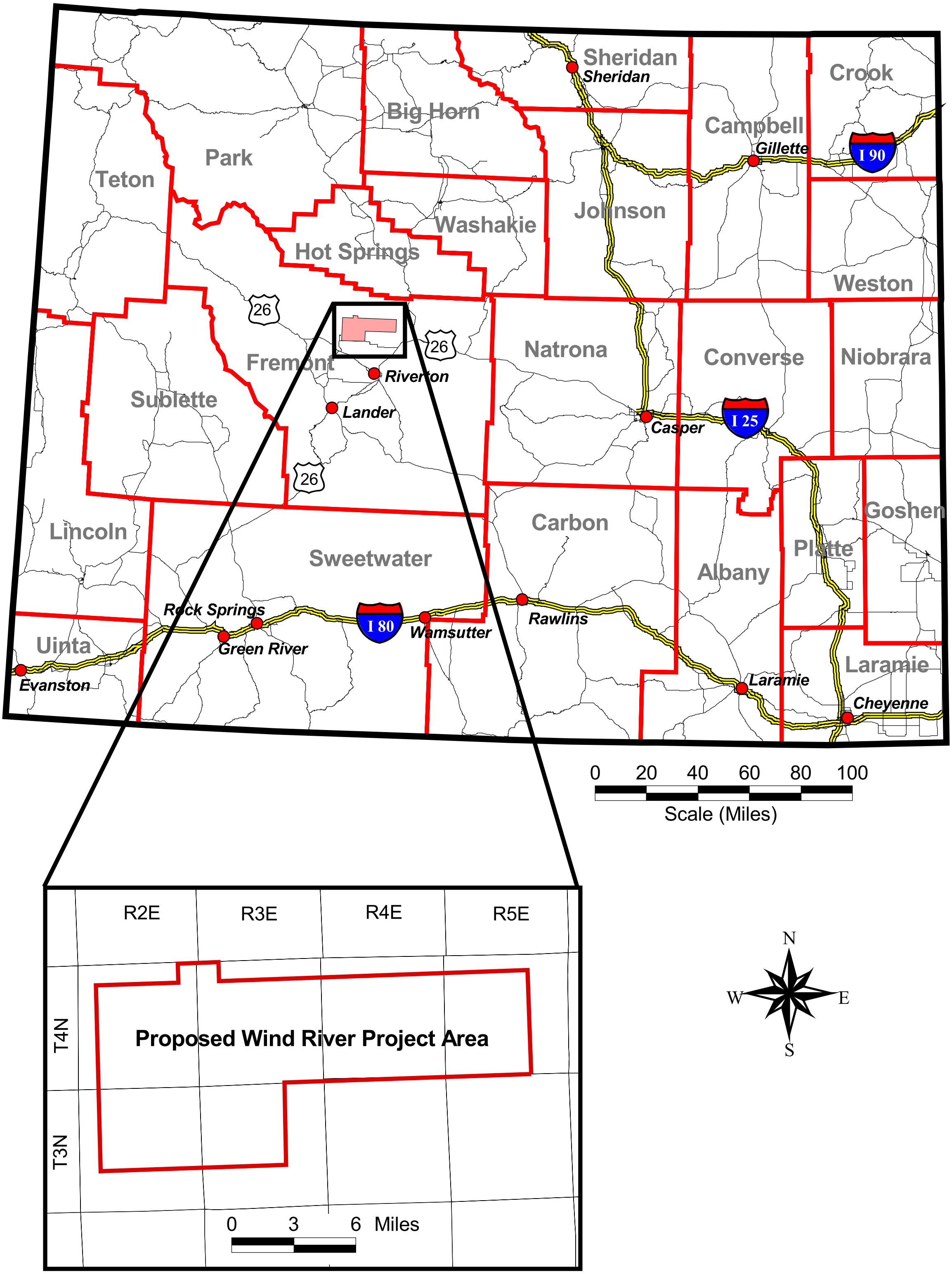

Figure 1. Location of Wind River Gas Development Project Area in Central Wyoming.

PRAIRIE DOG HABITAT

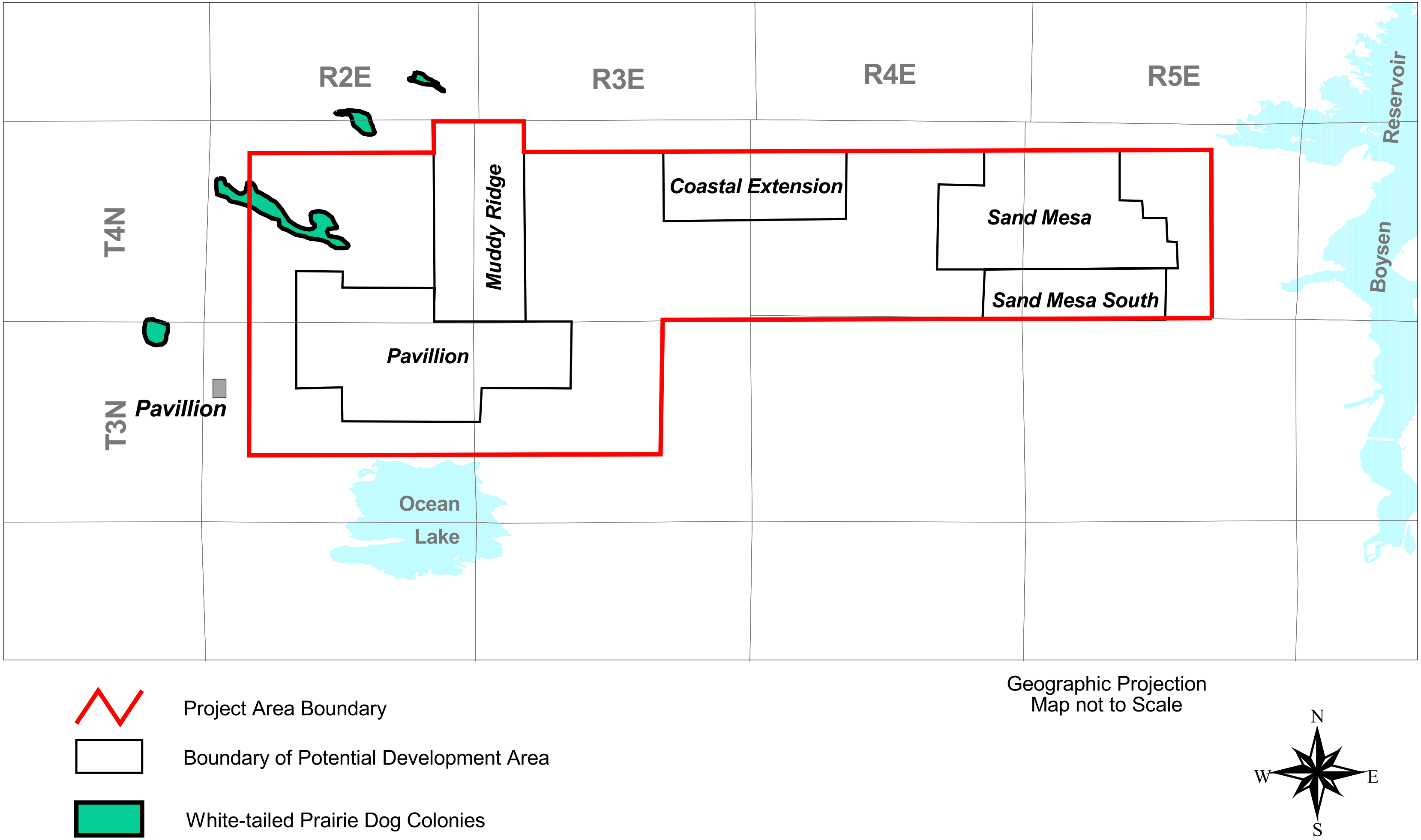

Figure 2. White-tailed Prairie Dog Colonies within and Adjacent to the Wind River Project Area (From Buys and Associates 2003).

APPENDIX M
CULTURAL RESOURCES DATA

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APPENDIX M - 1
CULTURAL RESOURCE SURVEYS IN THE WRPA

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 2.0E 1	*0-990 (36830)*	TRIBAL PAVILLION 13-1 WELL/ACC	PRIVATE LAND	*NESWNWNWSW C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*0-990 (36830)*	TRIBAL PAVILLION 13-1 WELL/ACC	PRIVATE LAND	*NENWSW NNESW* 0.0 (FR)	0
3.0N 2.0E 1	*0-1015 (37022)*	TRIBAL PAVILLION 24-1 WELL/ACC	SPLIT ESTATE	*SSNESW* 5.0 (FR)	5
3.0N 2.0E 1	*0-1015 (37022)*	TRIBAL PAVILLION 24-1 WELL/ACC	SPLIT ESTATE	*NSESW NNSSESW* 12.0 (FR)	12
3.0N 2.0E 1	*1-133 (36953)*	TRIBAL PAVILLION 33-1 WELL/ACC	SPLIT ESTATE	*SENENWSE* 0.0 (FR)	0
3.0N 2.0E 1	*1-133 (36953)*	TRIBAL PAVILLION 33-1 WELL/ACC	SPLIT ESTATE	*CNWSE C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-133 (36953)*	TRIBAL PAVILLION 33-1 WELL/ACC	SPLIT ESTATE	*NWNWNWSE SNWNESE* 0.0 (FR)	0
3.0N 2.0E 1	*1-134 (36955)*	TRIBAL PAVILLION 43-1 WELL/ACC	SPLIT ESTATE	*CNESE C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-134 (36955)*	TRIBAL PAVILLION 43-1 WELL/ACC	SPLIT ESTATE	*CNESE C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-134 (36955)*	TRIBAL PAVILLION 43-1 WELL/ACC	SPLIT ESTATE	*CNESE C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-257 (37528)*	TRIBAL PAVILLION 22-1 WELL/ACC/P	BLM LANDER	*NENWSESENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-257 (37528)*	TRIBAL PAVILLION 22-1 WELL/ACC/P	BLM LANDER	*WSWSESENW ENENESW* 0.0 (FR)	0
3.0N 2.0E 1	*1-257 (37528)*	TRIBAL PAVILLION 22-1 WELL/ACC/P	BLM LANDER	*WSWSWNE* 0.0 (FR)	0
3.0N 2.0E 1	*1-498 (37069)*	TRIBAL PAVILLION 12-1 W/ACC/PPL	PRIVATE LAND	*NWNWNENWSW NSSENW* 0.0 (FR)	0
3.0N 2.0E 1	*1-498 (37069)*	TRIBAL PAVILLION 12-1 W/ACC/PPL	PRIVATE LAND	*SENWSWNW SWSESWNW* 0.0 (FR)	0
3.0N 2.0E 1	*1-498 (37069)*	TRIBAL PAVILLION 12-1 W/ACC/PPL	PRIVATE LAND	*NWNESESWNW C STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-700 (38439)*	TRIBAL PAVILLION #34-1 WELL	SPLIT ESTATE	*WNWSWSE NNESESW* 0.0 (FR)	0
3.0N 2.0E 1	*1-700 (38439)*	TRIBAL PAVILLION #34-1 WELL	SPLIT ESTATE	*SENWSWSE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-1027 (39096)*	TRIBAL PAVILLION #31-1 WELL, PPL	SPLIT ESTATE	*NWSENWNE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-1027 (39096)*	TRIBAL PAVILLION #31-1 WELL, PPL	SPLIT ESTATE	*ESWNWNE ENWSWNE* 0.0 (FR)	0
3.0N 2.0E 1	*1-1027 (39096)*	TRIBAL PAVILLION #31-1 WELL, PPL	SPLIT ESTATE	*NESWSWNE* 0.0 (FR)	0
3.0N 2.0E 1	*1-1556 (40250)*	TRIBAL PAVILLION 21-1 W,ACC,PLN	BOR	*CNENW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 1	*1-1556 (40250)*	TRIBAL PAVILLION 21-1 W,ACC,PLN	BOR	*SNENW NESWNW* 0.0 (FR)	0
3.0N 2.0E 1	*1-1556 (40250)*	TRIBAL PAVILLION 21-1 W,ACC,PLN	BOR	*NWSWNE* 0.0 (FR)	0
3.0N 2.0E 1	*94-1627 (39778)*	PAVILLION WEST "8" LOOP PPLN	BOR	*SNESW NSENWSW* 0.0 (FR)	0
3.0N 2.0E 1	*94-1627 (39778)*	PAVILLION WEST "8" LOOP PPLN	BOR	*SNSE NNNESESE* 0.0 (FR)	0
3.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NW NWNE* 140.0 (FR)	140
3.0N 2.0E 2	*0-721 (34720)*	TRIBAL PAVILLION 13-2	PRIVATE LAND	*C NWSW C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*0-721 (34720)*	TRIBAL PAVILLION 13-2	PRIVATE LAND	*C NWSW C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*0-721 (34720)*	TRIBAL PAVILLION 13-2	PRIVATE LAND	*SNWNWSW* 0.0 (FR)	0
3.0N 2.0E 2	*0-721 (34720)*	TRIBAL PAVILLION 13-2	PRIVATE LAND	*SNWNWSW* 0.0 (FR)	0
3.0N 2.0E 2	*0-721-2 (35670)*	TRIBAL PAVILLION 13-2 REROUTE	SPLIT ESTATE	*SENENWSW SNWNESW* 0.0 (FR)	0
3.0N 2.0E 2	*0-722 (34721)*	TRIBAL PAVILLION 34-2	PRIVATE LAND	*NNESESWSE SSENESWSE* 0.0 (FR)	0
3.0N 2.0E 2	*0-722 (34721)*	TRIBAL PAVILLION 34-2	PRIVATE LAND	*CSWSE C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*0-728 (34728)*	TRIBAL PAVILLION 43-2	PRIVATE LAND	*SNESE SNENESE* 9.0 (FR)	9
3.0N 2.0E 2	*0-728 (34728)*	TRIBAL PAVILLION 43-2	PRIVATE LAND	*SENWNESE SENWSE* 1.0 (FR)	1
3.0N 2.0E 2	*1-136 (36963)*	TRIBAL PAVILLION 44-2 WELL/ACC	SPLIT ESTATE	*SSWSESE NWNWSESE* 0.0 (FR)	0
3.0N 2.0E 2	*1-136 (36963)*	TRIBAL PAVILLION 44-2 WELL/ACC	SPLIT ESTATE	*SENWSE* 0.0 (FR)	0
3.0N 2.0E 2	*1-136 (36963)*	TRIBAL PAVILLION 44-2 WELL/ACC	SPLIT ESTATE	*SWSENWSESE C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*1-419 (37938)*	TRIBAL PAVILLION #12-2 W/A/P	PRIVATE LAND	*NNENESW WNWSE* 0.0 (FR)	0

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 2.0E 2	*1-419 (37938)*	TRIBAL PAVILLION #12-2 W/A/P	PRIVATE LAND	*NNWSESWNW C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*1-419 (37938)*	TRIBAL PAVILLION #12-2 W/A/P	PRIVATE LAND	*ESESWNW SSWSENW* 0.0 (FR)	0
3.0N 2.0E 2	*1-1062 (39205)*	TRIBAL PAVILLION #24-2 WL/AC/PPL	SPLIT ESTATE	*NWSESESW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*1-1062 (39205)*	TRIBAL PAVILLION #24-2 WL/AC/PPL	SPLIT ESTATE	*NWNESESW WSENESW* 0.0 (FR)	0
3.0N 2.0E 2	*1-1158 (39389)*	TRIBAL PAVILLION #32-2 W/AC/PPLN	PRIVATE LAND	*ENESWNE NNWSENE* 0.0 (FR)	0
3.0N 2.0E 2	*1-1158 (39389)*	TRIBAL PAVILLION #32-2 W/AC/PPLN	PRIVATE LAND	*NWSESWNE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*2-1032 (43069)*	TRIBAL PAVILLION 22-02 W/A/P	PRIVATE LAND	*CSENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 2	*2-1032 (43069)*	TRIBAL PAVILLION 22-02 W/A/P	PRIVATE LAND	*WNWSENW NESWNW* 0.0 (FR)	0
3.0N 2.0E 2	*80-1317 (6000)*	TRIBAL 14-2	BOR	*SWSW* 40.0 (FR)	40
3.0N 2.0E 2	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNE NNSENE* 65.0 (FR)	65
3.0N 2.0E 2	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSSWSW* 2.0 (FR)	2
3.0N 2.0E 3	*0-726 (34725)*	TRIBAL PAVILLION 43-3	PRIVATE LAND	*SWNESE SNWNESE* 8.0 (FR)	8
3.0N 2.0E 3	*0-726 (34725)*	TRIBAL PAVILLION 43-3	PRIVATE LAND	*WSENESE* 2.0 (FR)	2
3.0N 2.0E 3	*1-154 (37057)*	TRIBAL PAVILLION 41-3 WELL/ACC	SPLIT ESTATE	*SSENENE* 0.0 (FR)	0
3.0N 2.0E 3	*1-154 (37057)*	TRIBAL PAVILLION 41-3 WELL/ACC	SPLIT ESTATE	*NENESWNENE C STAKE* 10.0 (FR)	10
3.0N 2.0E 3	*1-792 (38570)*	TRIBAL PAVILLION #42-3 WELL	PRIVATE LAND	*NSESENE* 0.0 (FR)	0
3.0N 2.0E 3	*1-792 (38570)*	TRIBAL PAVILLION #42-3 WELL	PRIVATE LAND	*SWNESENE CSTAKE* 10.0 (FR)	10
3.0N 2.0E 3	*1-1088 (39238)*	TRIBAL PAVILLION #43-3 WELL/ROAD	PRIVATE LAND	*SWSENESE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 3	*1-1088 (39238)*	TRIBAL PAVILLION #43-3 WELL/ROAD	PRIVATE LAND	*NESWNESE NWNESE* 0.0 (FR)	0
3.0N 2.0E 3	*1-1088 (39238)*	TRIBAL PAVILLION #43-3 WELL/ROAD	PRIVATE LAND	*WSWSENE NESESWNE* 0.0 (FR)	0
3.0N 2.0E 3	*1-1088 (39238)*	TRIBAL PAVILLION #43-3 WELL/ROAD	PRIVATE LAND	*SENESWNE* 0.0 (FR)	0
3.0N 2.0E 3	*1-1128 (39307)*	TRIBAL PAVILLION #22-03 WL/ACC	PRIVATE LAND	*NENWSENW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 3	*1-1128 (39307)*	TRIBAL PAVILLION #22-03 WL/ACC	PRIVATE LAND	*NNESENW NSWNE* 0.0 (FR)	0
3.0N 2.0E 3	*1-1128 (39307)*	TRIBAL PAVILLION #22-03 WL/ACC	PRIVATE LAND	*NESESWNE NWSWSENE* 0.0 (FR)	0
3.0N 2.0E 3	*2-574 (42365)*	TRIBAL PAVILLION #32-3	SPLIT ESTATE	*WWSENE SSNE* 0.0 (FR)	0
3.0N 2.0E 3	*2-574 (42365)*	TRIBAL PAVILLION #32-3	SPLIT ESTATE	*NWSESWNE C STAKE* 10.0 (FR)	10
3.0N 2.0E 3	*2-574 (42365)*	TRIBAL PAVILLION #32-3	SPLIT ESTATE	*SESWSWSENE* 1.0 (FR)	1
3.0N 2.0E 3	*2-728 (42591)*	SOUTH PAVILLION LOOP	BOR	*NESENESW WSWNWSE* 0.0 (FR)	0
3.0N 2.0E 3	*2-1283 (43737)*	TRIBAL PAVILLION 44-03C	PRIVATE LAND	*SENWNWSESE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 3	*2-1283 (43737)*	TRIBAL PAVILLION 44-03C	PRIVATE LAND	*WSENWSESE* 0.0 (FR)	0
3.0N 2.0E 3	*80-1316 (5999)*	TRIBAL 12-3	BIA	*SWNW* 40.0 (FR)	40
3.0N 2.0E 3	*88-653 (18430)*	FIKE TRIBAL #A-1 PPLN	BOR	*NWNWNWNWNE NNNNW* 0.0 (FR)	0
3.0N 2.0E 3	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SNW ENESW* 45.0 (FR)	45
3.0N 2.0E 3	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSE NWSE* 35.0 (FR)	35
3.0N 2.0E 3	*98-1035 (29755)*	TRIBAL PAVILLION 44-3 WELL/ROAD	BLM LANDER	*SWNESESE NWSESESE* 5.0 (FR)	5
3.0N 2.0E 3	*98-1035 (29755)*	TRIBAL PAVILLION 44-3 WELL/ROAD	BLM LANDER	*SNWSESE NSWSESE* 10.0 (FR)	10
3.0N 2.0E 3	*98-1035 (29755)*	TRIBAL PAVILLION 44-3 WELL/ROAD	BLM LANDER	*NESWSE* 0.0 (FR)	0
3.0N 2.0E 3	*98-1036 (29756)*	TRIBAL PAVILLION 33-3 WELL/ROAD	BOR	*SNWNWSE SWNWSE* 10.0 (FR)	10
3.0N 2.0E 3	*98-1036 (29756)*	TRIBAL PAVILLION 33-3 WELL/ROAD	BOR	*SWNENWSE WSENWSE* 5.0 (FR)	5
3.0N 2.0E 3	*98-1036 (29756)*	TRIBAL PAVILLION 33-3 WELL/ROAD	BOR	*NWNWSE ESESENW* 0.0 (FR)	0

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 2.0E 3	*98-1036 (29756)*	TRIBAL PAVILLION 33-3 WELL/ROAD	BOR	*SWNESENW ENWSENW* 0.0 (FR)	0
3.0N 2.0E 3	*99-64 (29964)*	PAVILLION BUTTE WELL	BIA	*NWSWNESE NESENWSE* 3.0 (FR)	3
3.0N 2.0E 4	*80-1316 (5999)*	TRIBAL 12-3	BIA	*SSSENW* 0.0 (FR)	0
3.0N 2.0E 4	*88-653 (18430)*	FIKE TRIBAL #A-1 PPLN	BOR	*NNNNE NENENENWNE* 0.0 (FR)	0
3.0N 2.0E 4	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SENWNE SNENE* 15.0 (FR)	15
3.0N 2.0E 4	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NSENE* 5.0 (FR)	5
3.0N 2.0E 8	*0-19 (31589)*	BROS-1000(10) BRDGS FRMNT CNTY	PRIVATE LAND	*SWNESENE* 1.0 (FR)	1
3.0N 2.0E 8	*80-1325 (6010)*	GULF OIL 1-8-1B TRIBAL	BOR	*NNE* 0.0 (FR)	0
3.0N 2.0E 8	*80-1325 (6010)*	GULF OIL 1-8-1B TRIBAL	BOR	*NENW* 40.0 (FR)	40
3.0N 2.0E 8	*80-1325-2 (6009)*	GULF 1-8-1B TRIBAL ACC REROUTE	BOR	*ENE* 0.0 (FR)	0
3.0N 2.0E 8	*84-1216 (14423)*	RIVERTON ROCK ART STUDY	BOR	0.0 (FR)	0
3.0N 2.0E 8	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SESENENE* 2.0 (FR)	2
3.0N 2.0E 8	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNSENE SSE* 75.0 (FR)	75
3.0N 2.0E 8	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NENE ENENWNE* 45.0 (FR)	45
3.0N 2.0E 8	*97-1702 (38213)*	NO. GEOPHYSICAL MTN SPR SEISMIC	BOR	*SSE* 0.0 (FR)	0
3.0N 2.0E 8	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*ESENESE* 1.0 (FR)	1
3.0N 2.0E 8	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*ESENESE* 1.0 (FR)	1
3.0N 2.0E 9	*78-816 (2088)*	UNIT 22-10	BLM RAWLINS	*EESENE* 0.0 (FR)	0
3.0N 2.0E 9	*78-823 (2095)*	UNIT 41-9	BLM RAWLINS	*NENE* 40.0 (FR)	40
3.0N 2.0E 9	*80-1318 (6001)*	TRIBAL 21-9	BIA	*NWSENW SWNW* 0.0 (FR)	0
3.0N 2.0E 9	*80-1318 (6001)*	TRIBAL 21-9	BIA	*NENW* 40.0 (FR)	40
3.0N 2.0E 9	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*SWNWNWSW WSWNWSW* 2.0 (FR)	2
3.0N 2.0E 10	*1-157 (37059)*	TRIBAL PAVILLION 34-10 WELL/ACC	SPLIT ESTATE	*SNESWSE SNWSESE* 0.0 (FR)	0
3.0N 2.0E 10	*1-157 (37059)*	TRIBAL PAVILLION 34-10 WELL/ACC	SPLIT ESTATE	*SENENWSWSE C STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*1-233 (37491)*	TRIBAL PAVILLION 34-10 PPL	PRIVATE LAND	*ENENWSWSE EESWNWSE* 0.0 (FR)	0
3.0N 2.0E 10	*1-704 (36358)*	TRIBAL PAVILLION #12-10	PRIVATE LAND	*SESWNW C. STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*1-984 (39025)*	TRIBAL PAVILLION #23-10W WELL	SPLIT ESTATE	*NESWNESW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*1-1157 (39388)*	TRIBAL PAVILLION #32-10B W/AC/PL	PRIVATE LAND	*NNESENE* 0.0 (FR)	0
3.0N 2.0E 10	*1-1157 (39388)*	TRIBAL PAVILLION #32-10B W/AC/PL	PRIVATE LAND	*ESENWNE ENESWNE* 0.0 (FR)	0
3.0N 2.0E 10	*1-1157 (39388)*	TRIBAL PAVILLION #32-10B W/AC/PL	PRIVATE LAND	*SWNESWNE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*1-1191 (39464)*	TRIBAL PAVILLION #11-10W W/AC/PL	PRIVATE LAND	*NWSENWNW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*1-1203 (39473)*	TRIBAL PAVILLION #32-10X W/AC/PL	SPLIT ESTATE	*NESESENW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*2-1007 (43038)*	TRIBAL PAVILLION #33-10B	SPLIT ESTATE	*SNWNESE* 0.0 (FR)	0
3.0N 2.0E 10	*2-1007 (43038)*	TRIBAL PAVILLION #33-10B	SPLIT ESTATE	*CNENWSE C STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*2-1293 (43765)*	TRIBAL PAVILLION 23-10B	PRIVATE LAND	*SENENWNESW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*2-1419 (44952)*	TRIBAL PAVILLION32-10C W/A/PPL	PRIVATE LAND	*WWNWNE WNWSWNE* 0.0 (FR)	0
3.0N 2.0E 10	*2-1419 (44952)*	TRIBAL PAVILLION32-10C W/A/PPL	PRIVATE LAND	*SESWSWNE NNENWSE* 0.0 (FR)	0
3.0N 2.0E 10	*2-1419 (44952)*	TRIBAL PAVILLION32-10C W/A/PPL	PRIVATE LAND	*NENWSWSWNE C STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*2-1421 (43620)*	TRIBAL PAVILLION 23-10c WELL/ACC	PRIVATE LAND	*ESWNESW* 0.0 (FR)	0
3.0N 2.0E 10	*2-1421 (43620)*	TRIBAL PAVILLION 23-10c WELL/ACC	PRIVATE LAND	*CSSENESW C STAKE* 8.0 (FR)	8

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 2.0E 10	*78-816 (2088)*	UNIT 22-10	BLM RAWLINS	*CWSWSENW (C STAKE)* 40.0 (FR)	40
3.0N 2.0E 10	*78-816 (2088)*	UNIT 22-10	BLM RAWLINS	*NSSWSWNW NSWSESWNW* 0.0 (FR)	0
3.0N 2.0E 10	*78-817 (2089)*	UNIT 21-15	BOR	*SSSSESW SSESESWSW* 3.0 (FR)	3
3.0N 2.0E 10	*78-821 (2093)*	UNIT 44-10	BLM RAWLINS	*NWSESE NESWSE* 20.0 (FR)	20
3.0N 2.0E 10	*78-821 (2093)*	UNIT 44-10	BLM RAWLINS	*SENWSE SWNESE* 20.0 (FR)	20
3.0N 2.0E 10	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNENENE* 2.0 (FR)	2
3.0N 2.0E 10	*98-1272 (31058)*	TRIBAL PAVILLION #33-10 WELL, AC	SPLIT ESTATE	*SWNESWNWSE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*98-1272 (31058)*	TRIBAL PAVILLION #33-10 WELL, AC	SPLIT ESTATE	*SENWSE* 0.0 (FR)	0
3.0N 2.0E 10	*99-1086 (32139)*	TRIBAL PAVILLION 32X-10	PRIVATE LAND	*NWNWSENW NENESWNW* 0.0 (FR)	0
3.0N 2.0E 10	*99-1086 (32139)*	TRIBAL PAVILLION 32X-10	PRIVATE LAND	*SESWNESENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 10	*99-1086 (32139)*	TRIBAL PAVILLION 32X-10	PRIVATE LAND	*SSENWNW NESWNWNW* 0.0 (FR)	0
3.0N 2.0E 10	*99-1086-2 (40307*	ROCK ART &WELL PAD CONSTRUCTION:	BLM LANDER	*NSESENW* (FR)	0
3.0N 2.0E 10	*99-1086-2 (40307*	ROCK ART &WELL PAD CONSTRUCTION:	BLM LANDER	*ESENWSENW SWNESENW* (FR)	0
3.0N 2.0E 11	*1-1090 (39240)*	TRIBAL PAVILLION #24-11 W/AC/PPL	PRIVATE LAND	*NESESWSW SENESWSW* 0.0 (FR)	0
3.0N 2.0E 11	*1-1090 (39240)*	TRIBAL PAVILLION #24-11 W/AC/PPL	PRIVATE LAND	*NSWSESW SWNWSESW* 0.0 (FR)	0
3.0N 2.0E 11	*1-1090 (39240)*	TRIBAL PAVILLION #24-11 W/AC/PPL	PRIVATE LAND	*NWSESESW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 11	*2-1033 (43070)*	TRIBAL PAVILLION 21-11B W/A/P	PRIVATE LAND	*NESENWNENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 11	*2-1033 (43070)*	TRIBAL PAVILLION 21-11B W/A/P	PRIVATE LAND	*NWNWNENW ENENW* 0.0 (FR)	0
3.0N 2.0E 11	*78-818 (2090)*	UNIT 21-11	BOR	*CSESWNENW (C STAKE)* 40.0 (FR)	40
3.0N 2.0E 11	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNN SENENE* 20.0 (FR)	20
3.0N 2.0E 12	*0-720 (34719)*	TRIBAL PAVILLION 12-7	BLM LANDER	*EENENE ENESENE* 0.0 (FR)	0
3.0N 2.0E 12	*1-152 (36357)*	TRIBAL PAVILLION #11-12 WELL/ACC	SPLIT ESTATE	*NWNESENWNW C STAKE* 10.0 (FR)	10
3.0N 2.0E 12	*1-152 (36357)*	TRIBAL PAVILLION #11-12 WELL/ACC	SPLIT ESTATE	*NWNESENWNW C STAKE* 10.0 (FR)	10
3.0N 2.0E 12	*1-152 (36357)*	TRIBAL PAVILLION #11-12 WELL/ACC	SPLIT ESTATE	*NWNWNENW* 0.0 (FR)	0
3.0N 2.0E 12	*1-152 (36357)*	TRIBAL PAVILLION #11-12 WELL/ACC	SPLIT ESTATE	*NWNWNENW* 0.0 (FR)	0
3.0N 2.0E 12	*1-163 (37068)*	TRIBAL PAVILLION 12-7 PIPELINE	SPLIT ESTATE	*NNESENE* 0.0 (FR)	0
3.0N 2.0E 12	*1-396 (37886)*	TRIBAL PAVILLION 41-12 W/A/P	PRIVATE LAND	*NSWNENENE C STAKE* 10.0 (CR)	10
3.0N 2.0E 12	*1-396 (37886)*	TRIBAL PAVILLION 41-12 W/A/P	PRIVATE LAND	*0ENESENENE* 0.0 (CR)	0
3.0N 2.0E 12	*1-396 (37886)*	TRIBAL PAVILLION 41-12 W/A/P	PRIVATE LAND	*0ENESENENE* 0.0 (CR)	0
3.0N 2.0E 12	*1-396 (37886)*	TRIBAL PAVILLION 41-12 W/A/P	PRIVATE LAND	*NSWNENENE C STAKE* 10.0 (CR)	10
3.0N 2.0E 12	*1-410 (37903)*	TRIBAL PAV 21-12 WELL/ACC/PPL	PRIVATE LAND	*NSWNWNENW* 0.0 (FR)	0
3.0N 2.0E 12	*1-410 (37903)*	TRIBAL PAV 21-12 WELL/ACC/PPL	PRIVATE LAND	*SSSWNWNENW* 0.0 (FR)	0
3.0N 2.0E 12	*1-410 (37903)*	TRIBAL PAV 21-12 WELL/ACC/PPL	PRIVATE LAND	*SWSWNENENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 12	*1-1471 (40037)*	TRIBAL PAVILLION #32-12 WELL/ACC	BOR	*NWSESWNE C-STAKE* 10.0 (FR)	10
3.0N 2.0E 12	*1-1471 (40037)*	TRIBAL PAVILLION #32-12 WELL/ACC	BOR	*NSWSWNE NSESENW* 0.0 (FR)	0
3.0N 2.0E 12	*1-1475 (40041)*	NORTH-SOUTH PAVILLION LOOP 6" PL	BOR	*WSENWNW* 0.0 (FR)	0
3.0N 2.0E 12	*1-1665 (41135)*	TRIBAL PAVILLION #21	SPLIT ESTATE	*SESENWNENW C-STAKE* 10.0 (FR)	10
3.0N 2.0E 12	*1-1665 (41135)*	TRIBAL PAVILLION #21	SPLIT ESTATE	*SSWNWNENW* 0.0 (FR)	0
3.0N 2.0E 12	*78-820 (2092)*	UNIT 22-12	BLM RAWLINS	*WSENW ESWNW* 40.0 (FR)	40
3.0N 2.0E 12	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*N NENESE* 110.0 (FR)	110

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 2.0E 13	*78-822 (2094)*	UNIT 12-13	BLM LANDER	*NSSWNW* 10.0 (FR)	10
3.0N 2.0E 13	*78-822 (2094)*	UNIT 12-13	BLM LANDER	*SSNWNW NSWNW* 30.0 (FR)	30
3.0N 2.0E 14	*0-991 (36148)*	TRIBAL PAVILLION 44-14 WELL/ACC	PRIVATE LAND	*SENESWSESE C STAKE* 10.0 (FR)	10
3.0N 2.0E 14	*0-991 (36148)*	TRIBAL PAVILLION 44-14 WELL/ACC	PRIVATE LAND	*SNWSESE NSWSE* 0.0 (FR)	0
3.0N 2.0E 14	*0-1186 (37753)*	TRIBAL PAVILLION #23-14 W/A/P	PRIVATE LAND	*ESENESW ENENESESW* 0.0 (FR)	0
3.0N 2.0E 14	*0-1186 (37753)*	TRIBAL PAVILLION #23-14 W/A/P	PRIVATE LAND	*WSENESW WNENESESW* 0.0 (FR)	0
3.0N 2.0E 14	*0-1186 (37753)*	TRIBAL PAVILLION #23-14 W/A/P	PRIVATE LAND	*SSENWNESW C STAKE* 10.0 (FR)	10
3.0N 2.0E 14	*0-1342 (38464)*	TRIBAL PAVILLION #21-14 W/A/P	PRIVATE LAND	*CNESENENW C STAKE* 10.0 (FR)	10
3.0N 2.0E 14	*0-1342 (38464)*	TRIBAL PAVILLION #21-14 W/A/P	PRIVATE LAND	*NNSWNENW* 0.0 (FR)	0
3.0N 2.0E 14	*0-1342 (38464)*	TRIBAL PAVILLION #21-14 W/A/P	PRIVATE LAND	*SESESENENW* 0.0 (FR)	0
3.0N 2.0E 14	*78-819 (2091)*	UNIT 11-14	BOR	*CNESENWNW (C STAKE)* 40.0 (FR)	40
3.0N 2.0E 15	*77-377 (1033)*	PAVILLION 44-15 3N2E15	BLM RAWLINS	*NESWSESW* 0.0 (FR)	0
3.0N 2.0E 15	*77-377 (1033)*	PAVILLION 44-15 3N2E15	BLM RAWLINS	*NWSWSESW* 2.0 (FR)	2
3.0N 2.0E 15	*78-817 (2089)*	UNIT 21-15	BOR	*CNWNENW (C STAKE)* 47.0 (FR)	47
3.0N 2.0E 15	*84-457 (13616)*	RIVERTON PROJ-EXCESS LAND PARCEL	BOR	*EENW* 40.0 (FR)	40
3.0N 2.0E 15	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*EEWNW ENW* 40.0 (FR)	40
3.0N 2.0E 21	*90-1396 (40239)*	NTL GUARD WORK AT OCEAN LAKE	MULT AG	*NE NENW* 0.0 (FR)	0
3.0N 2.0E 21	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NE ENW* 240.0 (FR)	240
3.0N 3.0E 3	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
3.0N 3.0E 4	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
3.0N 3.0E 5	*0-771 (35017)*	TRIBAL PAVILLION 13-5 W/A	MULT AG	*NSWNWSW* 0.0 (FR)	0
3.0N 3.0E 5	*0-771 (35017)*	TRIBAL PAVILLION 13-5 W/A	MULT AG	*CNWSE C STAKE* 10.0 (FR)	10
3.0N 3.0E 5	*0-1247 (38556)*	TRIBAL PAVILLION #12-5 W/A	BOR	*CNWSESWNW C STAKE* 10.0 (FR)	10
3.0N 3.0E 5	*0-1247 (38556)*	TRIBAL PAVILLION #12-5 W/A	BOR	*NNWSWSWNW* 0.0 (FR)	0
3.0N 3.0E 5	*1-156 (37058)*	TRIBAL PAVILLION 12-5 PIPELINE	BOR	*SWNESWNW* 0.0 (FR)	0
3.0N 3.0E 5	*1-156 (37058)*	TRIBAL PAVILLION 12-5 PIPELINE	BOR	*SWSWNW NWNWSW* 0.0 (FR)	0
3.0N 3.0E 5	*1-322 (37650)*	TRIBAL PAVILLION 13-5	BOR	*NWNWSW* 0.0 (FR)	0
3.0N 3.0E 5	*1-569 (38219)*	TRIBAL PAVILLION #24-5 WELL	BOR	*SWNESESW C. STAKE* 10.0 (FR)	10
3.0N 3.0E 5	*1-569 (38219)*	TRIBAL PAVILLION #24-5 WELL	BOR	*SESESW NWNWSESW* 0.0 (FR)	0
3.0N 3.0E 5	*1-569 (38219)*	TRIBAL PAVILLION #24-5 WELL	BOR	*SENWSW* 0.0 (FR)	0
3.0N 3.0E 5	*1-570 (38220)*	TRIBAL PAVILLION #2-5	PRIVATE LAND	*NSESWNW* 0.0 (FR)	0
3.0N 3.0E 5	*1-570 (38220)*	TRIBAL PAVILLION #2-5	PRIVATE LAND	*SENWSWNE C.STAKE* 10.0 (FR)	10
3.0N 3.0E 5	*1-570 (38220)*	TRIBAL PAVILLION #2-5	PRIVATE LAND	*WNWSWNE SNESENW* 0.0 (FR)	0
3.0N 3.0E 5	*1-570 (38220)*	TRIBAL PAVILLION #2-5	PRIVATE LAND	*WNWSWNE SSNSENW* 0.0 (FR)	
3.0N 3.0E 5	*1-1348 (39824)*	TRIBAL PAVILLION 44-5 WELL/ACC	BOR	*SESE C-STAKE* 10.0 (FR)	10
3.0N 3.0E 5	*1-1348 (39824)*	TRIBAL PAVILLION 44-5 WELL/ACC	BOR	*SWSESESE SNSWSE* 0.0 (FR)	0
3.0N 3.0E 5	*1-1348 (39824)*	TRIBAL PAVILLION 44-5 WELL/ACC	BOR	*SWNWSESE SENESESW* 0.0 (FR)	0
3.0N 3.0E 5	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
3.0N 3.0E 5	*79-1814 (4341)*	GRAVEL PIT	BOR	*SESW PORTION* 30.0 (FR)	30

APPENDIX M - 1
CULTURAL RESOURCE SURVEYS IN THE WRPA

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 3.0E 5	*79-1814 (4341)*	GRAVEL PIT	BOR	*ESWSW PORTION* 15.0 (FR)	15
3.0N 3.0E 5	*93-1561 (40772)*	PAVILLION CS H20 MONITORING WELL	BOR	*SWSESE ENESESWSE* 5.0 (FR)	5
3.0N 3.0E 5	*94-1627 (39778)*	PAVILLION WEST "8" LOOP PPLN	BOR	*SSS* 0.0 (FR)	0
3.0N 3.0E 5	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*SWNWSESE NWSWSESE* 0.0 (FR)	0
3.0N 3.0E 5	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*WSWNE ENESENW* 0.0 (FR)	0
3.0N 3.0E 5	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*NENW* 0.0 (FR)	0
3.0N 3.0E 5	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*ENESWSE NWSE* 0.0 (FR)	0
3.0N 3.0E 5	*96-899 (29298)*	PAVILLION COMPRESSOR EXPANSION	BOR	*SWSESE ESESWSE* 6.0 (FR)	6
3.0N 3.0E 5	*96-899-2 (38130)*	PAVILLION COMPRESSOR STATION EXP	BOR	*WSESESE* 3.0 (FR)	3
3.0N 3.0E 6	*0-772 (34389)*	TRIBAL PAVILLION 12-6 W/A	PRIVATE LAND	*SENESWSWNW C STAKE* 10.0 (FR)	10
3.0N 3.0E 6	*0-772 (34389)*	TRIBAL PAVILLION 12-6 W/A	PRIVATE LAND	*SESWSWNW NENWNWSW* 0.0 (FR)	0
3.0N 3.0E 6	*0-772 (34389)*	TRIBAL PAVILLION 12-6 W/A	PRIVATE LAND	*NNENWSW WNWNESW* 0.0 (FR)	0
3.0N 3.0E 6	*0-772 (34389)*	TRIBAL PAVILLION 12-6 W/A	PRIVATE LAND	*NENWSWNESW* 0.0 (FR)	0
3.0N 3.0E 6	*0-854 (35771)*	TRIBAL PAVILLION #44-6	SPLIT ESTATE	*NESWSESE C STAKE* 10.0 (FR)	10
3.0N 3.0E 6	*0-854 (35771)*	TRIBAL PAVILLION #44-6	SPLIT ESTATE	*NESESESE* 0.0 (FR)	0
3.0N 3.0E 6	*1-6 (35664)*	TRIBAL PAVILLION 24-6 W/A	SPLIT ESTATE	*SNESESW SESESW* 10.0 (FR)	10
3.0N 3.0E 6	*1-6 (35664)*	TRIBAL PAVILLION 24-6 W/A	SPLIT ESTATE	*SNESESW SESESW* 10.0 (FR)	10
3.0N 3.0E 6	*1-6 (35664)*	TRIBAL PAVILLION 24-6 W/A	SPLIT ESTATE	*SWSESESW* 0.0 (FR)	0
3.0N 3.0E 6	*1-6 (35664)*	TRIBAL PAVILLION 24-6 W/A	SPLIT ESTATE	*SWSESESW* 0.0 (FR)	0
3.0N 3.0E 6	*1-146 (37020)*	TRIBAL PAVILLION 12-6 WELL/ACC	SPLIT ESTATE	*WSENW* 0.0 (FR)	0
3.0N 3.0E 6	*1-146 (37020)*	TRIBAL PAVILLION 12-6 WELL/ACC	SPLIT ESTATE	*SWNWNW* 0.0 (FR)	0
3.0N 3.0E 6	*1-146 (37020)*	TRIBAL PAVILLION 12-6 WELL/ACC	SPLIT ESTATE	*WSWNW NSWNW* 0.0 (FR)	0
3.0N 3.0E 6	*1-146 (37020)*	TRIBAL PAVILLION 12-6 WELL/ACC	SPLIT ESTATE	*NSWNW* 5.0 (FR)	5
3.0N 3.0E 6	*1-155 (36701)*	TRIBAL PAVILLION 33-6 WELL/ACC	SPLIT ESTATE	*SWNWSE SWSE* 0.0 (FR)	0
3.0N 3.0E 6	*1-155 (36701)*	TRIBAL PAVILLION 33-6 WELL/ACC	SPLIT ESTATE	*SNENWSE NNESE* 0.0 (FR)	0
3.0N 3.0E 6	*1-155 (36701)*	TRIBAL PAVILLION 33-6 WELL/ACC	SPLIT ESTATE	*CNWSE C STAKE* 10.0 (FR)	10
3.0N 3.0E 6	*1-156 (37058)*	TRIBAL PAVILLION 12-5 PIPELINE	BOR	*ENENESE* 0.0 (FR)	0
3.0N 3.0E 6	*1-173 (37100)*	TRIBAL PAVILLION 13-6 WELL/ACC	SPLIT ESTATE	*CNWSW C STAKE* 10.0 (FR)	10
3.0N 3.0E 6	*1-173 (37100)*	TRIBAL PAVILLION 13-6 WELL/ACC	SPLIT ESTATE	*SSNWNWSW* 0.0 (FR)	0
3.0N 3.0E 6	*1-530 (38166)*	TRIBAL PAVILLION #22-6 WELL	PRIVATE LAND	*SENESENW C. STAKE* 10.0 (FR)	10
3.0N 3.0E 6	*1-530 (38166)*	TRIBAL PAVILLION #22-6 WELL	PRIVATE LAND	*SWSWSWNE NNSE* 0.0 (FR)	0
3.0N 3.0E 6	*1-1673 (41211)*	TRIBAL PAVILLION #31-7	SPLIT ESTATE	*WSESWSE* 0.0 (FR)	0
3.0N 3.0E 6	*94-1627 (39778)*	PAVILLION WEST "8" LOOP PPLN	BOR	*NSS* 0.0 (FR)	0
3.0N 3.0E 7	*0-720 (34719)*	TRIBAL PAVILLION 12-7	BLM LANDER	*NWSWSWNW SWNWSWNW* 5.0 (FR)	5
3.0N 3.0E 7	*0-720 (34719)*	TRIBAL PAVILLION 12-7	BLM LANDER	*WWWNWNW WNWNWSWNW* 5.0 (FR)	5
3.0N 3.0E 7	*0-720 (34719)*	TRIBAL PAVILLION 12-7	BLM LANDER	*CSWNW C STAKE* 10.0 (FR)	10
3.0N 3.0E 7	*0-1335 (39942)*	ELECTRICAL DIST. LINE ROW	BOR	*SNSW* 0.0 (FR)	0
3.0N 3.0E 7	*1-163 (37068)*	TRIBAL PAVILLION 12-7 PIPELINE	SPLIT ESTATE	*NWSWNW NENWSWNW* 0.0 (FR)	0
3.0N 3.0E 7	*1-1673 (41211)*	TRIBAL PAVILLION #31-7	SPLIT ESTATE	*WNENENWNE* 0.0 (FR)	0
3.0N 3.0E 7	*1-1673 (41211)*	TRIBAL PAVILLION #31-7	SPLIT ESTATE	*NWNWSENWNE C-STAKE* 10.0 (FR)	10

CULTURAL RESOURCE SURVEYS IN THE WRPA

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
3.0N 3.0E 7	*81-2492 (9979)*	WYOMING TRUSS BRIDGE SURVEY	SHPO	*NESE* 0.0 (FR)	0
3.0N 3.0E 7	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NS NSESE* 55.0 (FR)	55
3.0N 3.0E 8	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NE NNW* 240.0 (FR)	240
3.0N 3.0E 8	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NESE* 40.0 (FR)	40
3.0N 3.0E 8	*79-1814 (4341)*	GRAVEL PIT	BOR	*NENWNW PORTION* 5.0 (FR)	5
3.0N 3.0E 8	*79-1814 (4341)*	GRAVEL PIT	BOR	*NENW PORTION* 25.0 (FR)	25
3.0N 3.0E 8	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SNE S* 220.0 (FR)	220
3.0N 3.0E 8	*97-1314 (30071)*	PAVILLION SUBSTATION	BOR	*NENENWNE* 1.0 (FR)	1
3.0N 3.0E 9	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*N SE* 480.0 (FR)	480
3.0N 3.0E 9	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NSW SESW* 120.0 (FR)	120
3.0N 3.0E 9	*84-1216 (14423)*	RIVERTON ROCK ART STUDY	BOR	0.0 (FR)	0
3.0N 3.0E 9	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*W WWSE* 225.0 (FR)	225
3.0N 3.0E 10	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
3.0N 3.0E 10	*84-866 (14043)*	REROUTED EXXON 1 PPLN	BOR	*WSENWSE SWSE* 0.0 (FR)	0
3.0N 3.0E 10	*84-866-2 (14042)*	EXXON #1 WELL PIPELINE	BOR	*WSE ESESESW* 0.0 (FR)	0
3.0N 3.0E 15	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SENW NESE* 80.0 (FR)	80
3.0N 3.0E 15	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NE NNW* 240.0 (FR)	240
3.0N 3.0E 15	*84-866 (14043)*	REROUTED EXXON 1 PPLN	BOR	*WNWNWNE EENW* 0.0 (FR)	0
3.0N 3.0E 15	*84-866-2 (14042)*	EXXON #1 WELL PIPELINE	BOR	*ENW WWNE* 0.0 (FR)	0
3.0N 3.0E 16	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NENE NENWNE* 50.0 (FR)	50
3.0N 3.0E 16	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NSWNE NENWNW* 20.0 (FR)	20
3.0N 3.0E 16	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NWNE NENW* 50.0 (FR)	50
3.0N 3.0E 22	*92-847 (22611)*	PREB-0707(5) MISSOURI VALLEY RD	PRIVATE LAND	*SESESW* 8.0 (FR)	8
4.0N 2.0E 1	*78-666 (1924)*	PIPELINE TO TOM BROWN 36-43 TRIB	BLM WORLAND	*EEE* 0.0 (FR)	0
4.0N 2.0E 1	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*ESE* 0.0 (FR)	0
4.0N 2.0E 1	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*SWSW* 35.0 (FR)	35
4.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NE SW* 290.0 (FR)	290
4.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSE SNWSE* 50.0 (FR)	50
4.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSSWNW SWSWSENW* 7.0 (FR)	7
4.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*ENW EENWNW* 43.0 (FR)	43
4.0N 2.0E 1	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SWNWNWSE SWSWNESE* 3.0 (FR)	3
4.0N 2.0E 11	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*NSWNE NSENW* 0.0 (FR)	0
4.0N 2.0E 11	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*WNENE NWSENE* 0.0 (FR)	0
4.0N 2.0E 12	*78-666 (1924)*	PIPELINE TO TOM BROWN 36-43 TRIB	BLM WORLAND	*EEENE EEENESE* 0.0 (FR)	0
4.0N 2.0E 12	*79-1582 (4096)*	TOM BROWN 13-24 LATERAL	BIA	*ESESWSE SSSESE* 0.0 (FR)	0
4.0N 2.0E 12	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*NENE* 0.0 (FR)	0
4.0N 2.0E 12	*80-536 (5126)*	TRIBAL 12-23	BOR	*NENWSW NWNESW* 20.0 (FR)	20
4.0N 2.0E 12	*80-536 (5126)*	TRIBAL 12-23	BOR	*SESWNW SWSENW* 20.0 (FR)	20
4.0N 2.0E 12	*80-536 (5126)*	TRIBAL 12-23	BOR	*NNENESW NWNWNWSE* 0.0 (FR)	0

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 2.0E 12	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNW NE* 100.0 (FR)	100
4.0N 2.0E 12	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNESE* 3.0 (FR)	3
4.0N 2.0E 13	*78-871 (2145)*	1-13 TRIBAL	BOR	*NWNENWSESW* 40.0 (FR)	40
4.0N 2.0E 13	*79-1582 (4096)*	TOM BROWN 13-24 LATERAL	BIA	*SESW SSSE* 0.0 (FR)	0
4.0N 2.0E 13	*80-240 (4797)*	AMOCO X-31 PIPELINE	BIA	*SWSW SWNWSW* 0.0 (FR)	0
4.0N 2.0E 13	*80-537 (5127)*	TRIBAL 13-22	BOR	*SWNWNESW EENWSW* 0.0 (FR)	0
4.0N 2.0E 13	*80-537 (5127)*	TRIBAL 13-22	BOR	*SSWNESW SWSENESW* 0.0 (FR)	0
4.0N 2.0E 13	*80-537 (5127)*	TRIBAL 13-22	BOR	*CNSESWSENW* 40.0 (FR)	40
4.0N 2.0E 13	*80-1011 (5658)*	TOM BRN TRBL 24-21 PIPELINE	BOR	*WWSESESW SSWNESESW* 0.0 (FR)	0
4.0N 2.0E 13	*82-147 (10136)*	13-16 GOVT HORNBECK A	BLM LANDER	*NSESE SNESE* 40.0 (FR)	40
4.0N 2.0E 13	*82-1028 (11091)*	13-2 GOV'T HORNBECK A	BIA	*SWNESWNENE* 40.0 (FR)	40
4.0N 2.0E 13	*82-1028 (11091)*	13-2 GOV'T HORNBECK A	BIA	*NENWNENE NNENENE* 0.0 (FR)	0
4.0N 2.0E 13	*94-1625 (39776)*	GOVERNMENT HORNBECK #A13-15 WELL	BOR	*NESWSWSE C-STAKE* 10.0 (FR)	10
4.0N 2.0E 13	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SS SNWSW* 110.0 (FR)	110
4.0N 2.0E 14	*80-240 (4797)*	AMOCO X-31 PIPELINE	BIA	*NESE SWNE* 0.0 (FR)	0
4.0N 2.0E 14	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*E* 110.0 (FR)	110
4.0N 2.0E 20	*0-1253 (30872)*	DISPOSAL WELL POWERLINE	BOR	*SESE* 0.0 (FR)	0
4.0N 2.0E 20	*NO # LISTED*	ANADARKO TRIBAL C-1 WELLPAD/ACC	BIA	*NESE 53.0 (FR)*	53
4.0N 2.0E 20	*NO # LISTED*	ANADARKO TRIBAL C-2 WELL PAD/ACC	BIA	*NW 40.0 (FR)*	40
4.0N 2.0E 21	*0-1253 (30872)*	DISPOSAL WELL POWERLINE	BOR	*W2NWSW* 0.0 (FR)	0
4.0N 2.0E 24	*80-1200 (5871)*	MUDDY RIDGE SECTION SURVEY	BOR	*ENW SWNW* 120.0 (FR)	120
4.0N 2.0E 24	*80-1200 (5871)*	MUDDY RIDGE SECTION SURVEY	BOR	*WSE SESE* 120.0 (FR)	120
4.0N 2.0E 24	*80-1200 (5871)*	MUDDY RIDGE SECTION SURVEY	BOR	*SWNE* 320.0 (FR)	320
4.0N 2.0E 24	*NO # LISTED*	WELL PAD/ACCESS	BIA	*NESW 10.0 (FR)*	10
4.0N 2.0E 25	*0-1121 (37698)*	TRIBAL MUDDY RIDGE #25-43	BOR	*NENESE* 0.0 (FR)	0
4.0N 2.0E 25	*80-154 (4694)*	MUDDY RIDGE 1-36	BOR	*WSESE* 0.0 (FR)	0
4.0N 2.0E 25	*99-867 (31420)*	MUDDY RIDGE TRIBAL #25-44	BOR	*NNSESE* 5.0 (FR)	5
4.0N 2.0E 28	*88-653 (18430)*	FIKE TRIBAL #A-1 PPLN	BOR	*EWSE* 0.0 (FR)	0
4.0N 2.0E 29	*0-1253 (30872)*	DISPOSAL WELL POWERLINE	BOR	*WNWNE* 0.0 (FR)	0
4.0N 2.0E 29	*NO # LISTED*	ANADARKO TRIBAL D-1 WELLPAD/ACC	BIA	*NENE 25 (FR)*	25
4.0N 2.0E 33	*88-653 (18430)*	FIKE TRIBAL #A-1 PPLN	BOR	*E NESE* 0.0 (FR)	0
4.0N 2.0E 35	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSE* 20.0 (FR)	20
4.0N 2.0E 36	*1-260 (37531)*	MUDDY RIDGE TRIBAL 36-42 WELL/AC	SPLIT ESTATE	*EESWNE WSENE* 7.0 (FR)	7
4.0N 2.0E 36	*1-398 (37889)*	MUDDY RIDGE TRIBAL #36-42 W/A/P	PRIVATE LAND	*WNWSENE NSWSENE* 7.0 (FR)	7
4.0N 2.0E 36	*80-154 (4694)*	MUDDY RIDGE 1-36	BOR	*NENE* 40.0 (FR)	40
4.0N 2.0E 36	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SW SSWSE* 130.0 (FR)	130
4.0N 3.0E 6	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NW* 75.0 (FR)	75
4.0N 3.0E 7	*78-666 (1924)*	PIPELINE TO TOM BROWN 36-43 TRIB	BLM WORLAND	*WWWSWNW WWWNWSW* 0.0 (FR)	0
4.0N 3.0E 7	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*WWNWNW WNWSWNW* 0.0 (FR)	0

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 3.0E 7	*79-1841 (4368)*	TRBL1-24,1-TRBL-2,GULFEET7-12	BOR	*NSWNW* 17.0 (FR)	17
4.0N 3.0E 7	*80-2036 (6782)*	TOM BROWN 12-23 PPLN	BOR	*NNWNWNWSW* 0.0 (FR)	0
4.0N 3.0E 7	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SNW NWSW* 85.0 (FR)	85
4.0N 3.0E 7	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SWSWNE NNESW* 5.0 (FR)	5
4.0N 3.0E 17	*80-2432 (7226)*	TRIBAL 17-14	BOR	*SWSW* 40.0 (FR)	40
4.0N 3.0E 18	*0-1086 (37575)*	HORNBECK 18-31M WELL	BOR	*NWSENWSWSW C STAKE* 10.0 (FR)	10
4.0N 3.0E 18	*80-2242 (7016)*	TRIBAL 18-33	BLM LANDER	*ESWSE* 0.0 (FR)	0
4.0N 3.0E 18	*80-2242 (7016)*	TRIBAL 18-33	BLM LANDER	*NWSE* 40.0 (FR)	40
4.0N 3.0E 18	*82-1573 (11671)*	LAND SALES-RIVERTON PROJECTS OFF	BOR	*SSW SWSE* 120.0 (FR)	120
4.0N 3.0E 18	*94-1429 (33701)*	GOVT HORNBECK #18-13 & 18-14 PPL	BOR	*NNSWSW* 0.0 (FR)	0
4.0N 3.0E 18	*94-1627-2 (3977*	PAVILLION NORTH "8" LOOP PPLN	BOR	*WWW* 0.0 (FR)	0
4.0N 3.0E 18	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSWNWSE WSWSE* 20.0 (FR)	20
4.0N 3.0E 18	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*WSESWSE* 2.0 (FR)	2
4.0N 3.0E 18	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*SSNSW SSW* 85.0 (FR)	85
4.0N 3.0E 18	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*SWSWSW* 0.0 (FR)	0
4.0N 3.0E 19	*0-1079 (37561)*	TRIBAL MUDDY RIDGE 19-14M	BOR	*NWSESWSW SESWNESWSW* 0.0 (FR)	0
4.0N 3.0E 19	*0-1099 (37625)*	TRIBAL HORNBECK #1A WELL	SPLIT ESTATE	*NNENESW* 3.0 (FR)	3
4.0N 3.0E 19	*1-1438 (40008)*	TRIBAL MR #19-11M WELL, ACCESS	BOR	*SESWNWNW C-STAKE* 10.0 (FR)	10
4.0N 3.0E 19	*1-1474 (40040)*	TRIBAL MR #19-13M WELL, ACCESS	BOR	*NENWNWSW C-STAKE* 10.0 (FR)	10
4.0N 3.0E 19	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 3.0E 19	*80-1467 (6161)*	TRIBAL 19-23	BOR	*NESW* 40.0 (FR)	40
4.0N 3.0E 19	*80-2243 (7017)*	TRIBAL 20-14	BOR	*SSSE* 0.0 (FR)	0
4.0N 3.0E 19	*81-1365 (8761)*	TRIBAL 19-12	BOR	*SWNW* 40.0 (FR)	40
4.0N 3.0E 19	*81-2351 (9814)*	TOM BROWN NO 20-23 TRIBAL PPLN	BOR	*NNESWSE* 0.0 (FR)	0
4.0N 3.0E 19	*81-2351 (9814)*	TOM BROWN NO 20-23 TRIBAL PPLN	BOR	*SNESW SSWNWSE* 0.0 (FR)	0
4.0N 3.0E 19	*93-1314 (34148)*	TOM BROWN INC #19-11 TRIBAL WELL	BOR	*ENWNW EWNWNW* 25.0 (FR)	25
4.0N 3.0E 19	*94-1299 (25174)*	TRIBAL MR19-13	BOR	*NWSW* 40.0 (FR)	40
4.0N 3.0E 19	*94-1608 (39438)*	TRIBAL MR19-14 WELL	BOR	*CSWSW C. STAKE* 10.0 (FR)	10
4.0N 3.0E 19	*94-1627-2 (3977*	PAVILLION NORTH "8" LOOP PPLN	BOR	*WWW WSESWSW* 0.0 (FR)	0
4.0N 3.0E 19	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNW NNWNE* 65.0 (FR)	65
4.0N 3.0E 19	*94-1709 (40931)*	TOM BROWN INC SEISMIC PROJECT	BOR	*NNWSWNW* 2.0 (FR)	2
4.0N 3.0E 19	*94-1711 (40973)*	TRIBAL MR# 19-14 WELL	BOR	*SWSW* 40.0 (FR)	40
4.0N 3.0E 19	*97-1698 (38109)*	TRIBAL MR #19-21 PIPELINE	BOR	*NWNENW* 0.0 (FR)	0
4.0N 3.0E 19	*97-1743 (39362)*	MR TRIBAL #19-22 WELL, ACCESS	BOR	*NENWSW NNESW* 8.0 (FR)	8
4.0N 3.0E 19	*97-1743 (39362)*	MR TRIBAL #19-22 WELL, ACCESS	BOR	*ESWNW SENW* 30.0 (FR)	30
4.0N 3.0E 19	*97-1744 (39368)*	MR TRIBAL #19-21 WELL, ACCESS	BOR	*NESENWNW* 1.0 (FR)	1
4.0N 3.0E 19	*97-1744 (39368)*	MR TRIBAL #19-21 WELL, ACCESS	BOR	*NENW ENENWNW* 34.0 (FR)	34
4.0N 3.0E 19	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*WNWSENW ESESWNW* 0.0 (FR)	0
4.0N 3.0E 19	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*SENESW SWNWSE* 0.0 (FR)	0
4.0N 3.0E 19	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*ENWNWNW SENWNW* 0.0 (FR)	0

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 3.0E 19	*99-16 (29676)*	BROS-1000(10) VARIOUS BRIDGES	MULT AG	*ENENWSW* 0.0 (FR)	0
4.0N 3.0E 19	*99-868 (31421)*	MUDDY RIDGE #19-12M	BOR	*NESWNW* 0.0 (FR)	0
4.0N 3.0E 19	*99-1123 (32877)*	MUDDY RIDGE #19-14M	BOR	*CNSWNESWSW C STAKE* 10.0 (FR)	10
4.0N 3.0E 19	*99-1701 (38530)*	MUDDY RIDGE #19-21M WELL	BOR	*NNNESENW* 2.0 (FR)	2
4.0N 3.0E 19	*99-1701 (38530)*	MUDDY RIDGE #19-21M WELL	BOR	*EESENENW SSSENENW* 3.0 (FR)	3
4.0N 3.0E 19	*99-1725 (38731)*	MUDDY RIDGE #19-34 W/A/P	BOR	*SWNWNESWSE C STAKE* 10.0 (FR)	10
4.0N 3.0E 20	*80-2243 (7017)*	TRIBAL 20-14	BOR	*SWSW* 40.0 (FR)	40
4.0N 3.0E 20	*80-2244 (7018)*	TRIBAL 20-22	BOR	*SENW* 40.0 (FR)	40
4.0N 3.0E 28	*82-1573 (11671)*	LAND SALES-RIVERTON PROJECTS OFF	BOR	*WNW PORTION* 40.0 (FR)	40
4.0N 3.0E 29	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 3.0E 29	*82-1573 (11671)*	LAND SALES-RIVERTON PROJECTS OFF	BOR	*EENE PORTION* 40.0 (FR)	40
4.0N 3.0E 30	*0-1121 (37698)*	TRIBAL MUDDY RIDGE #25-43	BOR	*NWNWNWSW* 0.0 (FR)	0
4.0N 3.0E 30	*1-477 (38065)*	TRIBAL MR #30-11X WELL LOCATION	BOR	*NWSWNENW C STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*NENWSESWNW NNESESWNW* 2.0 (FR)	2
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*SSNENESWNW SENWNESWNW* 1.0 (FR)	1
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*WSWNWSENW WNWSWSENW* 1.0 (FR)	1
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*NSNESESWNW* 1.0 (FR)	1
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*WSWNWSENW WNWSWSENW* 1.0 (FR)	1
4.0N 3.0E 30	*1-506 (37718)*	MUDDY RIDGE 30-12X WELL/ACC/PPL	BOR	*SENESWNW ESWNESWNW* 3.0 (FR)	3
4.0N 3.0E 30	*1-900 (38833)*	TRIBAL MR#30-12 PIPELINE	BOR	*SNWSWNW* 0.0 (FR)	0
4.0N 3.0E 30	*1-1166 (39437)*	TRIBAL MR 30-24 WELL & ACCESS	SPLIT ESTATE	*WSESW* 0.0 (FR)	0
4.0N 3.0E 30	*1-1166 (39437)*	TRIBAL MR 30-24 WELL & ACCESS	SPLIT ESTATE	*SWNESW C. STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*1-1933 (36439)*	TRIBAL MR #30-12 WELL/ACCESS	BOR	*SWNWSWNW* 0.0 (FR)	0
4.0N 3.0E 30	*1-1933 (36439)*	TRIBAL MR #30-12 WELL/ACCESS	BOR	*CSWNW C STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 3.0E 30	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NENWNW* 0.0 (FR)	0
4.0N 3.0E 30	*79-1582 (4096)*	TOM BROWN 13-24 LATERAL	BIA	*NNWNW* 0.0 (FR)	0
4.0N 3.0E 30	*80-2243 (7017)*	TRIBAL 20-14	BOR	*NNE* 0.0 (FR)	0
4.0N 3.0E 30	*81-1002 (8356)*	TRIBAL 21-30	BOR	*SWNESWNENW C STAKE* 40.0 (FR)	40
4.0N 3.0E 30	*84-1216 (14423)*	RIVERTON ROCK ART STUDY	BOR	0.0 (FR)	0
4.0N 3.0E 30	*94-1627-2 (3977!*	PAVILLION NORTH "8" LOOP PPLN	BOR	*NESESW ENESW* 0.0 (FR)	0
4.0N 3.0E 30	*94-1627-2 (3977!*	PAVILLION NORTH "8" LOOP PPLN	BOR	*SWSWSE SWNWSWSE* 0.0 (FR)	0
4.0N 3.0E 30	*94-1627-2 (3977!*	PAVILLION NORTH "8" LOOP PPLN	BOR	*NENWNW* 0.0 (FR)	0
4.0N 3.0E 30	*94-1627-2 (3977!*	PAVILLION NORTH "8" LOOP PPLN	USFS WASATCH NF	*WESENW NENWSENW* 0.0 (FR)	0
4.0N 3.0E 30	*94-1627-2 (3977!*	PAVILLION NORTH "8" LOOP PPLN	BOR	*SWNENW SWNWNENW* 0.0 (FR)	0
4.0N 3.0E 30	*96-1324 (40549)*	TRIBAL MR NO 30-13 WELL & ACCESS	BOR	*NWNWSENWSW C-STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*96-1324 (40549)*	TRIBAL MR NO 30-13 WELL & ACCESS	BOR	*WWWNW NNWNWSW* 0.0 (FR)	0
4.0N 3.0E 30	*97-916 (27829)*	TRIBAL MR #30-22M	USFS WASATCH NF	*SWSWNWSWNE* 0.0 (FR)	0
4.0N 3.0E 30	*97-916 (27829)*	TRIBAL MR #30-22M	USFS WASATCH NF	*SSNENW SENW* 30.0 (FR)	30
4.0N 3.0E 30	*97-1136 (29347)*	KN TRIBAL 30-13	BOR	*NWNWSW WWNWNW* 0.0 (FR)	0

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 3.0E 30	*97-1729 (39276)*	TRIBAL NP #31-11X WELL/ACCESS	BOR	*NSESWSW SSWSESW* 0.0 (FR)	0
4.0N 3.0E 30	*97-1729 (39276)*	TRIBAL NP #31-11X WELL/ACCESS	BOR	*WWNWSW ENWSWSW* 0.0 (FR)	0
4.0N 3.0E 30	*99-72 (29976)*	MUDDY RIDGE #30-14	BOR	*NNWSWSW* 0.0 (FR)	0
4.0N 3.0E 30	*99-72 (29976)*	MUDDY RIDGE #30-14	BOR	*SWSWSWNW WWNWSW* 0.0 (FR)	0
4.0N 3.0E 30	*99-105 (30068)*	TRIBAL MR #30-23	BOR	*NWNESESW* 0.0 (FR)	0
4.0N 3.0E 30	*99-415 (30490)*	TRIBAL #30-21M	BOR	*SESWNENW NENWNWSENW* 0.0 (FR)	0
4.0N 3.0E 30	*99-1674 (37936)*	TRIBAL MR #30-32 W/A/P	BOR	*SNESENW PIPELINE* 0.0 (FR)	0
4.0N 3.0E 30	*99-1674 (37936)*	TRIBAL MR #30-32 W/A/P	BOR	*NWSWSWSWNE C STAKE* 8.0 (FR)	8
4.0N 3.0E 30	*99-1721 (38698)*	TRIBAL MR#30-14 WELL, ACCESS	SPLIT ESTATE	*SWNWSWSW* 0.0 (FR)	0
4.0N 3.0E 30	*99-1721 (38698)*	TRIBAL MR#30-14 WELL, ACCESS	SPLIT ESTATE	*SWNESWSW C-STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*99-1728 (38738)*	TRIBAL MR#30-23, WELL, ACCESS	BOR	*SESENESW C-STAKE* 10.0 (FR)	10
4.0N 3.0E 30	*99-1728 (38738)*	TRIBAL MR#30-23, WELL, ACCESS	BOR	*EESESW SWSESESW* 0.0 (FR)	0
4.0N 3.0E 30	*99-1802 (40825)*	TRIBAL MR #30-21M WELL/ACCESS	BOR	*NWSENENW C. STAKE* 10.0 (FR)	10
4.0N 3.0E 31	*1-729 (38476)*	MUDDY RIDGE TRIBAL #32-22R	PRIVATE LAND	*NWSENW ENESWNW* 6.0 (FR)	6
4.0N 3.0E 31	*1-729 (38476)*	MUDDY RIDGE TRIBAL #32-22R	PRIVATE LAND	*NESESWNW NSWSENW* 2.0 (FR)	2
4.0N 3.0E 31	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*SSENENE NNSENE* 0.0 (FR)	0
4.0N 3.0E 31	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NSWNE NSENW* 0.0 (FR)	0
4.0N 3.0E 31	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*ESENE NNE* 0.0 (FR)	0
4.0N 3.0E 31	*97-1729 (39276)*	TRIBAL NP #31-11X WELL/ACCESS	BOR	*SWNESENWNW C STAKE* 34.0 (FR)	34
4.0N 3.0E 31	*97-1729 (39276)*	TRIBAL NP #31-11X WELL/ACCESS	BOR	*WNWNE* 0.0 (FR)	0
4.0N 3.0E 31	*98-911 (29407)*	TOM BROWN MUDDY RDG 31-11X PIPE	BOR	*SENWNW NENESWNW* 0.0 (FR)	0
4.0N 3.0E 31	*99-1728 (38738)*	TRIBAL MR#30-23, WELL, ACCESS	BOR	*NENENENW NWNENENW* 0.0 (FR)	0
4.0N 3.0E 32	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 3.0E 32	*84-1216 (14423)*	RIVERTON ROCK ART STUDY	BOR	0.0 (FR)	0
4.0N 3.0E 32	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*WSW WSWSESW* 0.0 (FR)	0
4.0N 3.0E 32	*94-1627-2 (3977§*	PAVILLION NORTH "8" LOOP PPLN	BOR	*SWSWSWNW* 0.0 (FR)	0
4.0N 3.0E 33	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 3.0E 33	*84-1216 (14423)*	RIVERTON ROCK ART STUDY	BOR	0.0 (FR)	0
4.0N 3.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NWNW WSE* 120.0 (FR)	120
4.0N 3.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SESE* 40.0 (FR)	40
4.0N 3.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SW SNW* 240.0 (FR)	240
4.0N 3.0E 34	*82-1573 (11671)*	LAND SALES-RIVERTON PROJECTS OFF	BOR	*NW PORTION* 120.0 (FR)	120
4.0N 3.0E 34	*82-1573 (11671)*	LAND SALES-RIVERTON PROJECTS OFF	BOR	*SE PORTION* 120.0 (FR)	120
4.0N 3.0E 35	*97-1136 (29347)*	KN TRIBAL 30-13	BOR	*EEENE* 0.0 (FR)	0
4.0N 4.0E 13	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SENESE* 0.0 (FR)	0
4.0N 4.0E 13	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SESWSE NWSESE* 0.0 (FR)	0
4.0N 4.0E 13	*3-11 (43313)*	TRIBAL SAND MESA 13-34 W/A/PPL	BOR	*CSWSE C STAKE* 10.0 (FR)	10
4.0N 4.0E 13	*3-11 (43313)*	TRIBAL SAND MESA 13-34 W/A/PPL	BOR	*ENESWSE NSESE* 0.0 (FR)	0
4.0N 4.0E 13	*78-664 (1922)*	420-774 PIPELINE	BLM RAWLINS	*ESESESE* 0.0 (FR)	0

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Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 4.0E 13	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*SSW* 0.0 (FR)	0
4.0N 4.0E 14	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*SSSENE NNWNESE* 0.0 (FR)	0
4.0N 4.0E 14	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*NNENWSE* 0.0 (FR)	0
4.0N 4.0E 15	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*NSESWSE* 0.0 (FR)	0
4.0N 4.0E 15	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*NSESE NWSWSESE* 0.0 (FR)	0
4.0N 4.0E 16	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SS* 160.0 (FR)	160
4.0N 4.0E 19	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*N* 320.0 (FR)	320
4.0N 4.0E 20	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*N* 320.0 (FR)	320
4.0N 4.0E 21	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*N NS* 480.0 (FR)	480
4.0N 4.0E 21	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*ENESE* 0.0 (FR)	0
4.0N 4.0E 21	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*SNW NE* 0.0 (FR)	0
4.0N 4.0E 22	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*NSE NWNWSWSE* 0.0 (FR)	0
4.0N 4.0E 22	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*NSSW SNSW* 0.0 (FR)	0
4.0N 4.0E 22	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*SESENE SESWSENE* 0.0 (FR)	0
4.0N 4.0E 22	*95-1092 (39713)*	SAND MESA PIPELINE PORTIONS	BOR	*SNNWNW NSWNWNW* 0.0 (FR)	0
4.0N 4.0E 23	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SENESESE* 0.0 (FR)	0
4.0N 4.0E 23	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SESWSESE SESESE* 0.0 (FR)	0
4.0N 4.0E 24	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*SSENE SESWNE* 0.0 (FR)	0
4.0N 4.0E 24	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*SSENE SESWNE* 0.0 (FR)	0
4.0N 4.0E 24	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWSENWSW SENENWSW* 0.0 (FR)	0
4.0N 4.0E 24	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWNWSWSW SESWNWSW* 0.0 (FR)	0
4.0N 4.0E 24	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWNWNESW SSENW* 0.0 (FR)	0
4.0N 4.0E 24	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NESENW NWNWSWNE* 0.0 (FR)	0
4.0N 4.0E 24	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SWNWNE NENWNE* 0.0 (FR)	0
4.0N 4.0E 24	*3-10 (43297)*	TRIBAL SAND MESA 26-41 W/A/PPL	PRIVATE LAND	*SWSWSW NESWSW* 0.0 (FR)	0
4.0N 4.0E 24	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 4.0E 24	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NESW ESWSW* 0.0 (FR)	0
4.0N 4.0E 24	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*SWNE NWNWSE* 0.0 (FR)	0
4.0N 4.0E 24	*78-664 (1922)*	420-774 PIPELINE	BLM RAWLINS	*NENE NWSENE* 0.0 (FR)	0
4.0N 4.0E 24	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*NENENW* 0.0 (FR)	0
4.0N 4.0E 24	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*SESESESESE NE* 0.0 (FR)	0
4.0N 4.0E 24	*97-1164 (29416)*	TRIBAL SAND MESA #24-32	BOR	*NSNNW S* 0.0 (FR)	0
4.0N 4.0E 24	*97-1164 (29416)*	TRIBAL SAND MESA #24-32	BOR	*SWNE SWSWNWNE* 40.0 (FR)	40
4.0N 4.0E 24	*97-1731 (39298)*	TRIBAL SAND MESA #24-32 PIPELINE	BOR	*SNWNW SNENW* 0.0 (FR)	0
4.0N 4.0E 24	*97-1731 (39298)*	TRIBAL SAND MESA #24-32 PIPELINE	BOR	*NWNWSWNE* 0.0 (FR)	0
4.0N 4.0E 24	*97-1731 (39298)*	TRIBAL SAND MESA #24-32 PIPELINE	BOR	*SWSWNESWNE C STAKE* 10.0 (FR)	10
4.0N 4.0E 24	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*SSSS S SEC LINE* 0.0 (FR)	0
4.0N 4.0E 24	*99-71 (29975)*	SAND MESA #24-30	BOR	*SESENWSW* 0.0 (FR)	0
4.0N 4.0E 24	*99-71 (29975)*	SAND MESA #24-30	BOR	*NENESW NSWNESW* 0.0 (FR)	0
4.0N 4.0E 24	*99-71 (29975)*	SAND MESA #24-30	BOR	*SSWNE NWNWNWSE* 0.0 (FR)	0

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 4.0E 24	*99-1278 (35545)*	SAND MESA 24-30 WLL/ACC	BOR	*SNWSW* 0.0 (FR)	0
4.0N 4.0E 24	*99-1278 (35545)*	SAND MESA 24-30 WLL/ACC	BOR	*SESENWSW C STAKE* 10.0 (FR)	10
4.0N 4.0E 25	*3-10 (43297)*	TRIBAL SAND MESA 26-41 W/A/PPL	PRIVATE LAND	*NWNWNWNWNW* 0.0 (FR)	0
4.0N 4.0E 25	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*N NSE* 400.0 (FR)	400
4.0N 4.0E 25	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*SW NE* 0.0 (FR)	0
4.0N 4.0E 25	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*NNNN N SEC LINE* 0.0 (FR)	0
4.0N 4.0E 26	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWNESW ESENW* 0.0 (FR)	0
4.0N 4.0E 26	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWSWNE NSENWNE* 0.0 (FR)	0
4.0N 4.0E 26	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SENENWNE NWNWNENE* 0.0 (FR)	0
4.0N 4.0E 26	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWSWSW SENWSW* 0.0 (FR)	0
4.0N 4.0E 26	*3-10 (43297)*	TRIBAL SAND MESA 26-41 W/A/PPL	PRIVATE LAND	*SWSENWNENE C STAKED* 10.0 (FR)	10
4.0N 4.0E 26	*3-10 (43297)*	TRIBAL SAND MESA 26-41 W/A/PPL	PRIVATE LAND	*NENWNENE NNENENE* 0.0 (FR)	0
4.0N 4.0E 26	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SS* 160.0 (FR)	160
4.0N 4.0E 27	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SESESE* 0.0 (FR)	0
4.0N 4.0E 27	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SSE* 80.0 (FR)	80
4.0N 4.0E 31	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S SN* 480.0 (FR)	480
4.0N 4.0E 32	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S SN* 480.0 (FR)	480
4.0N 4.0E 33	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SNW* 80.0 (FR)	80
4.0N 4.0E 33	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S NE* 480.0 (FR)	480
4.0N 4.0E 34	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*WSWNE NWNESWNE* 0.0 (FR)	0
4.0N 4.0E 34	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*WSWSW NNESWSW* 0.0 (FR)	0
4.0N 4.0E 34	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*SENWNE WNENE* 0.0 (FR)	0
4.0N 4.0E 34	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*WNESW NWNESW* 0.0 (FR)	0
4.0N 4.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 4.0E 35	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 4.0E 35	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*SW* 0.0 (FR)	0
4.0N 4.0E 35	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*NE NWNWSE* 0.0 (FR)	0
4.0N 4.0E 36	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 4.0E 36	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*NWNWNW* 0.0 (FR)	0
4.0N 5.0E 10	*47-1 (3)*	BOYSEN RESERVOIR	NPS	*PORTION* 0.0 (FR)	0
4.0N 5.0E 10	*92-1395 (40675)*	COTTONWOOD BAY FENCE	BOR	*NENE* 0.0 (FR)	0
4.0N 5.0E 18	*0-1154 (37839)*	NORTH OWL CREEK 2-D SEISMIC PRSP	BOR	*NWNWSWSW SWNWSW* 0.0 (FR)	0
4.0N 5.0E 18	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*W2SE* 0.0 (CR)	0
4.0N 5.0E 18	*78-664 (1922)*	420-774 PIPELINE	BLM RAWLINS	*SNWSW WSWSW* 0.0 (FR)	0
4.0N 5.0E 19	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*NWNESE* 0.0 (FR)	0
4.0N 5.0E 19	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*NWNESE* 0.0 (FR)	0
4.0N 5.0E 19	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*NNSW NNWSE* 0.0 (FR)	0
4.0N 5.0E 19	*0-1087 (37576)*	TRIBAL SAND MESA 19-43 PPL	BOR	*NNSW NNWSE* 0.0 (FR)	0
4.0N 5.0E 19	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*EE2* 0.0 (CR)	0

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 5.0E 19	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S* 320.0 (FR)	320
4.0N 5.0E 19	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*SSNESW NNWSESW* 0.0 (FR)	0
4.0N 5.0E 19	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NNESE SNWSE* 0.0 (FR)	0
4.0N 5.0E 19	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*SW* 0.0 (FR)	0
4.0N 5.0E 19	*89-673 (19741)*	WEED CONTROL TEST PLOTS	BOR	*SSWSENW PORTION* 1.0 (FR)	1
4.0N 5.0E 19	*89-673 (19741)*	WEED CONTROL TEST PLOTS	BOR	*SESESWNW PORTION* 1.0 (FR)	1
4.0N 5.0E 19	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*SSSW SSWSWSE* 0.0 (FR)	0
4.0N 5.0E 19	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*SSSESWSE SSSSESE* 0.0 (FR)	0
4.0N 5.0E 19	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*NESE C STAKE* 20.0 (FR)	20
4.0N 5.0E 20	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NNWNWSW* 0.0 (FR)	0
4.0N 5.0E 20	*78-663 (1921)*	4 PIPELINES TRIBAL	BOR	*NWNE SNW* 0.0 (FR)	0
4.0N 5.0E 20	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*SSSS S SEC LINE* 0.0 (FR)	0
4.0N 5.0E 21	*91-1235-3 (40695*	PIPELINE RT TO COTT0NWOOD DRAIN	PRIVATE LAND	*NNNESENW* 0.0 (CR)	0
4.0N 5.0E 21	*91-1235-3 (40695*	PIPELINE RT TO COTT0NWOOD DRAIN	PRIVATE LAND	*WWWNWSE WWWSWNE* 0.0 (CR)	0
4.0N 5.0E 27	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*W2SW* 0.0 (CR)	0
4.0N 5.0E 27	*90-41 (20439)*	CAMEAHWAIT WATER STRUCTURES	BOR	*SSESWNE NWSWSWSENE* 5.0 (FR)	5
4.0N 5.0E 27	*96-654 (26703)*	LAKE CAMEAHWAIT REC. AREA	BOR	*NWNW* 40.0 (FR)	40
4.0N 5.0E 27	*96-654 (26703)*	LAKE CAMEAHWAIT REC. AREA	BOR	*S SN* 480.0 (FR)	480
4.0N 5.0E 28	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*ENESENE* 0.0 (CR)	0
4.0N 5.0E 28	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 5.0E 28	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*NNNN* 0.0 (FR)	0
4.0N 5.0E 29	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*WWSWNWNW W2SW* 0.0 (CR)	0
4.0N 5.0E 29	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 5.0E 29	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*NNNN N SEC LINE* 0.0 (FR)	0
4.0N 5.0E 30	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*ENENE* 0.0 (CR)	0
4.0N 5.0E 30	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*ALL* 640.0 (FR)	640
4.0N 5.0E 30	*78-665 (1923)*	PAVILLION FIELD 4 AND 6	BOR	*NWNWNWNWNW* 0.0 (FR)	0
4.0N 5.0E 30	*98-1026 (29699)*	TRIBAL SAND MESA #19-43 WELL/RD	BOR	*NNWNWNW NNNNNE* 0.0 (FR)	0
4.0N 5.0E 31	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*NWNW SWNE* 80.0 (FR)	80
4.0N 5.0E 31	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S SNW* 400.0 (FR)	400
4.0N 5.0E 32	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*W2* 0.0 (CR)	0
4.0N 5.0E 32	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*S* 320.0 (FR)	320
4.0N 5.0E 33	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SS SNSE* 180.0 (FR)	180
4.0N 5.0E 34	*1-844 (37264)*	INDIAN BUTTES PROSPECT 2D	BOR	*W2* 0.0 (CR)	0
4.0N 5.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*WSESE SESESE* 30.0 (FR)	30
4.0N 5.0E 34	*75-60 (138)*	MUDDY CREEK DIVIDE&LOST WELLS BU	BOR	*SW WSE* 240.0 (FR)	240
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NNWNW SNWNENW* 0.0 (FR)	0
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NENE* 0.0 (FR)	0
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NENE* 0.0 (FR)	0
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NSENENW NSNWNE* 0.0 (FR)	0

APPENDIX M - 1
CULTURAL RESOURCE SURVEYS IN THE WRPA

Twp Rge Sect	Acc # (WYCRIS I	Project name	Land manager/unit	Qtrs Acres (County)	Acres
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NSENENW NSNWNE* 0.0 (FR)	0
4.0N 5.0E 34	*89-239 (19282)*	SCP-RC-8127 BOYSEN ST. PARK RDS	MULT AG	*NNWNW SNWNENW* 0.0 (FR)	0
4.0N 5.0E 34	*96-654 (26703)*	LAKE CAMEAHWAIT REC. AREA	BOR	*NW PORTION* 130.0 (FR)	130
4.0N 5.0E 34	*96-654 (26703)*	LAKE CAMEAHWAIT REC. AREA	BOR	*NNWNE* 20.0 (FR)	20
				Total Acres Surveyed, All Block Surveys	23766

APPENDIX M - 2
RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 0058	Unknown		Open Camp, Occupation	None or Other	Smithsonian Institution
FR 0236	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0282	Rec. Not Eligible, No SHPO Rev.	HARRIS Bridge 1	Hearth, Firepit, FCR	None or Other	Unknown
FR 0320	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0321	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Lithic Scatter	None or Other	WY State Archeologist
FR 0323	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0324	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Quarry, Lithic Source	None or Other	WY State Archeologist
FR 0325	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0326	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0327	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Quarry, Lithic Source	None or Other	WY State Archeologist
FR 0351	Unknown	5/2/2001	PreHistoric Lithic Scatter - Lithic Procurement - Secondary	None or Other	North Platte Archaeological Service
FR 0354	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0355	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0356	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0357	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0358	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0359	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Lithic Scatter	None or Other	WY State Archeologist

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 0360	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0361	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0362	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0373	Eligible (SHPO Concurrence)	PETROGLPH 1	PreHistoric Rock Art - Ceremonial	PICTOGRAPHS/PETROGLYPHS	Frontier Archeology
FR 0384	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0385	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0386	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0387	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Open Camp, Occupation	None or Other	WY State Archeologist
FR 0388	Rec. Not Eligible, No SHPO Rev.	WY-14-77	Hearths/Lithic Scatter	None or Other	WY State Archeologist
FR 0389	Not Eligible/SHPO	SITE 4	PreHistoric Artifacts and Features - Milling/Vegetable Processing - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 0390	Eligible (SHPO Concurrence)	RAINY WIND	Rock Art - Unknown Use	PICTOGRAPHS/PETROGLYPHS	WY State Archeologist
FR 0391	Rec. Not Eligible, No SHPO Rev.	DEAD RAVEN	Rockshelter, Cave/Lithic Scatter	None or Other	WY State Archeologist
FR 0392	Rec. Not Eligible, No SHPO Rev.	REVERSE EXPOSMAN	Rock Art - Unknown Use	PICTOGRAPHS/PETROGLYPHS	WY State Archeologist
FR 0393	Rec. Not Eligible, No SHPO Rev.	TUNNEL ART	Rock Art - Unknown Use	PICTOGRAPHS/ PETROGLYPHS	WY State Archeologist
FR 0394	Rec. Not Eligible, No SHPO Rev.		Hearth, Firepit, FCR	None or Other	WY State Archeologist
FR 0395	Rec. Not Eligible, No SHPO Rev.		Hearth, Firepit, FCR	None or Other	WY State Archeologist

APPENDIX M - 2
RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 0490	Rec. Not Eligible, No SHPO Rev.	PAVILLION BUTTE 1	Lithic Scatter	None or Other	Unknown
FR 0527	Unknown	6028R-2,OFF SURVEY	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Greer Services
FR 0527	Unknown	PAVILLION BUTTE 2	Lithic Scatter	None or Other	Unknown
FR 0660	Unknown, Hist. Component Not Eligible	HARRIS Bridge 2	Open Camp/Lithic Scatter, WY Canal Const. Camp	None or Other	Archeological Services, Western Wyoming College
FR 0661	Unknown	HARRIS Bridge 3	Open Camp/Lithic Scatter	None or Other	Archeological Services, Western Wyoming College
FR 0662	Not Eligible/SHPO		PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 0935	Unknown	1410-1	Lithic Scatter	None or Other	Archeological Services
FR 0936	Unknown	1410-3	Hearths/Lithic Scatter	None or Other	Archeological Services
FR 0937	Unknown	1410-6	Lithic Scatter	None or Other	Archeological Services
FR 0938	Unknown	1410-7	Lithic Scatter	None or Other	Archeological Services
FR 0939	Unknown	1410-8	Lithic Scatter	None or Other	Archeological Services
FR 0958	Unknown	1572-2	Hearths/Lithic Scatter	None or Other	Archeological Services
FR 0963	Not Eligible/SHPO		PreHistoric Artifacts and Features - Lithic Procurement - Secondary	None or Other	Archaeological Energy Consulting
FR 1068	Rec. Not Eligible, No SHPO Rev.	8-80-1 (BLDG)	Historic Building (Rural)	None or Other	LTA, Inc.
FR 1138	Unknown	MZ 306	Lithic Scatter	None or Other	Metcalf-Zier Archeological Consultants
FR 1299	Unknown	MEXICAN PASS STGE RD	Historic - Transportation - Trail/Stage Route	None or Other	Wyoming Recreation Commission/Historic Division
FR 1500	Rec. Not Eligible, No SHPO Rev.	6/3/82-1	Hearths/Ground Stone	None or Other	US Bureau of Reclamation Water & Power Resources

APPENDIX M - 2
RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 1501	Rec. Not Eligible, No SHPO Rev.	7/27/82-1	Hearths, FCR/Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1502	Rec. Not Eligible, No SHPO Rev.	7/27/82-2	Open Camp, Occupation	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1503	Rec. Not Eligible, No SHPO Rev.	7/27/82-3	Lithic Scatter/Ground Stone	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1504	Rec. Not Eligible, No SHPO Rev.	7/27/82-4	Lithic Scatter/Quarry	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1505	Rec. Not Eligible, No SHPO Rev.	7/27/82-5	Hearths, FCR/Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1506	Rec. Not Eligible, No SHPO Rev.	7/28/82-1	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1507	Rec. Not Eligible, No SHPO Rev.	7/28/82-2	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1508	Rec. Not Eligible, No SHPO Rev.	7/30/82-1	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1509	Rec. Not Eligible, No SHPO Rev.	7/30/82-2	Lithic Scatter	None or Other	Bureau of Reclamation
FR 1510	Rec. Not Eligible, No SHPO Rev.	7/30/82-3	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1511	Rec. Not Eligible, No SHPO Rev.	7/30/82-4	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1512	Rec. Not Eligible, No SHPO Rev.	7/30/82-5	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1514	Rec. Not Eligible, No SHPO Rev.	6/3/82-2	Lithic Scatter	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1703	Rec. Not Eligible, No SHPO Rev.	8/31/83-1	Historic Dugout	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1704	Rec. Not Eligible, No SHPO Rev.	8/31/83-2	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	US Bureau of Reclamation Water & Power Resources
FR 1739	Rec. Not Eligible, No SHPO Rev.	14	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	US Bureau of Reclamation Water & Power Resources

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RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 1753	Rec. Eligible, No SHPO Review	84-74-1	Ranching - Trash Dump	None or Other	Archeological Consultants
FR 1753	Rec. Eligible, No SHPO Review	84-74-1	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archeological Consultants
FR 1754	Rec. Not Eligible, No SHPO Rev.	84-74-2	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	Archeological Consultants
FR 1795	Eligible (SHPO Concurrence)	84-74A-1	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archeological Consultants
FR 1907	Rec. Not Eligible, No SHPO Rev.		Rock Art - Unknown Use	PICTOGRAPHS/PETROGLYPHS	P III Associates
FR 2371	Rec. Not Eligible, No SHPO Rev.	BRDG EMA FIVE MI CK	Transportation - Bridge	None or Other	Fraser Design
FR 2463	Unknown	PAVILLION/4 EAST	PreHistoric Rock Art - Other	PICTOGRAPHS/PETROGLYPHS	James Stewart
FR 2693	Not Eligible/SHPO	FA90-23-2	Farming - Homestead	None or Other	Frontier Archeology
FR 2694	Not Eligible/SHPO	FA90-23-3	Farming - Homestead	None or Other	Frontier Archeology
FR 2695	Not Eligible/SHPO	FA90-23-4	Historic Trash Dump	None or Other	Frontier Archeology
FR 2696	Not Eligible/SHPO	FA90-23-5	PreHistoric Feature - Habitation - Hearths/FCR	Fire Hearths/FCR	Frontier Archeology
FR 2741	Rec. Not Eligible, No SHPO Rev.	FARM (HOUSE ONLY)	Urban - Building	None or Other	State Historic Preservation Office
FR 3179	Eligible (SHPO Concurrence), SEGMENTS NON-CONTRIBUTING		Irrigation - Canal	None or Other	Archaeological Energy Consulting
FR 3249	Rec. Not Eligible, No SHPO Rev.	92-64-1	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	Bureau of Reclamation, Billings, MT

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Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 3532	Not Eligible/SHPO		PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	John Albanese
FR 3590	Not Eligible/SHPO	SITE A	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3591	Not Eligible/SHPO	SITE B	PreHistoric Lithic Scatter - Lithic Procurement-Primary	None or Other	John Albanese
FR 3592	Not Eligible/SHPO	SITE C	PreHistoric Lithic Scatter - Lithic Procurement-Primary	None or Other	John Albanese
FR 3593	Not Eligible/SHPO	SITE D	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	John Albanese
FR 3594	Not Eligible/SHPO	SITE E	PreHistoric Lithic Scatter - Lithic Procurement-Primary	None or Other	John Albanese
FR 3597	Not Eligible/SHPO	SITE K	PreHistoric Lithic Scatter - Lithic Procurement-Primary	None or Other	John Albanese
FR 3598	Not Eligible/SHPO	SITE L	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	John Albanese
FR 3599	Not Eligible/SHPO	SITE N	PreHistoric Feature - Habitation - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3600	Not Eligible/SHPO	STIE O	PreHistoric Feature - Habitation - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3601	Not Eligible/SHPO	SITE Q	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3602	Not Eligible/SHPO	SITE R	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3603	Not Eligible/SHPO	SITE S	Historic Foundation	WALLS/FoundationS	John Albanese

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RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 3604	Not Eligible/SHPO		PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3605	Not Eligible/SHPO		PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3606	Not Eligible/SHPO	SITE AA	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	John Albanese
FR 3607	Not Eligible/SHPO	SITE BB	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3608	Not Eligible/SHPO	SITE CC	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3609	Not Eligible/SHPO	SITE DD	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3610	Not Eligible/SHPO	SITE EE	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3611	Not Eligible/SHPO	SITE FF	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3612	Not Eligible/SHPO	SITE FF	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3613	Not Eligible/SHPO	SITE GG	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese
FR 3615	Not Eligible/SHPO	SITE KK	PreHistoric Lithic Scatter - FCR - Chipping/knapping Station	Fire Hearths/FCR	John Albanese

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RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 3616	Not Eligible/SHPO	SITE MM	PreHistoric Lithic Scatter - Lithic Procurement-Primary	None or Other	John Albanese
FR 3759	Rec. Not Eligible, No SHPO Rev.	AEC-96-014-05	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	Archaeological Energy Consulting
FR 3760	Rec. Not Eligible, No SHPO Rev.	AEC-96-014-06	Historic Debris	None or Other	Archaeological Energy Consulting
FR 3761	Rec. Not Eligible, No SHPO Rev.	AEC-96-014-07	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	Archaeological Energy Consulting
FR 3762	Rec. Not Eligible, No SHPO Rev.	AEC-96-014-08	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 3763	Rec. Not Eligible, No SHPO Rev.	AEC-96-014-09	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 3778	Not Eligible/SHPO	FA96-18-1	PreHistoric Lithic Scatter - Lithic Procurement - Secondary	None or Other	Frontier Archaeology/Brunette
FR 3905	Not Eligible/SHPO	AEC#97-150-01	PreHistoric Artifacts and Features - Lithic Procurement - Secondary - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 3906	Not Eligible/SHPO	AEC#97-150-02	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 3907	Not Eligible/SHPO	AEC#97-150-03	PreHistoric Artifacts and Features - Lithic Procurement - Secondary - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 3998	Not Eligible/SHPO	AEC-98-058.01,.02&.03	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4108	Not Eligible/SHPO	AEC#99-020-01	PreHistoric Lithic Scatter - Lithic Procurement - Secondary	None or Other	Archaeological Energy Consulting

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Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 4109	Not Eligible/SHPO	AEC#99-020-02	PreHistoric Lithic Scatter - Lithic Procurement - Secondary	None or Other	Archaeological Energy Consulting
FR 4130	Eligible (SHPO Concurrence)	6028-1	PreHistoric Artifacts and Features - Chipping/knapping - Rock Art	PICTOGRAPHS/PETROGLYPHS	Greer Services
FR 4130	Eligible (SHPO Concurrence)	6028-1	PreHistoric Artifacts and Features - Chipping/knapping - Rock Art	PICTOGRAPHS/PETROGLYPHS	Greer Services
FR 4132	Rec. Eligible, No SHPO Review	6028R-3,GARLAND POINT	Not Available	None or Other	Greer Services
FR 4133	Unknown	6028R-4	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Greer Services
FR 4133	Not Eligible/SHPO		PreHistoric Artifacts and Features - Milling/Vegetable Processing - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4135	Unknown	PEC-SH-22-10	PreHistoric Lithic Scatter/Chipping/knapping Station	None or Other	
FR 4162	Rec. Not Eligible, No SHPO Rev.	COPPER MTN-PILOT BUTT	Historic Transmission Line	None or Other	None or Unknown
FR 4317	Rec. Not Eligible, No SHPO Rev.	644 N PAVILLION RD	Historic Building (Rural)	None or Other	State Historic Preservation Office
FR 4319	Rec. Not Eligible, No SHPO Rev.	6054-1	PreHistoric Feature - Habitation - Hearths/FCR	Fire Hearths/FCR	Greer Services
FR 4336	Not Eligible/SHPO	AEC-00-011.01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 4337	Not Eligible/SHPO	AEC-00-039.01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4338	Not Eligible/SHPO	AEC-00-039.02	PreHistoric Lithic Scatter	None or Other	Archaeological Energy Consulting
FR 4512	Not Eligible/SHPO	AEC#00-014-01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4513	Not Eligible/SHPO	AEC#00-014-02	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4531	Unknown	5/1/2001	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	North Platte Archaeological Service
FR 4541	Unknown	AEC-01-016-01	PreHistoric Artifacts and Features - Habitation - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4543	Not Eligible/SHPO	AEC-01-120.01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4544	Not Eligible/SHPO	AEC-01-120.02	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4545	Unknown	AEC-01-121.01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4550	Not Eligible/SHPO	AEC-01-022-01	PreHistoric Lithic Scatter	None or Other	Archaeological Energy Consulting
FR 4566	Not Eligible/SHPO	AEC-01-156-01	PreHistoric Lithic Scatter - FCR - Habitation	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4577	Unknown	5/1/2001	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	North Platte Archaeological Service

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RECORDED CULTURAL RESOURCES IN WRPA

Site #	NRHP Status	Site name	Site type	Features	Field org.
FR 4613	Not Eligible/SHPO	AEC- #01-191-01	PreHistoric Lithic Scatter - Lithic Procurement - Secondary	None or Other	Archaeological Energy Consulting
FR 4614	Rec. Not Eligible, No SHPO Rev.	01-170-01	Historic Debris	None or Other	Archaeological Energy Consulting
FR 4643	Rec. Not Eligible, No SHPO Rev.	AEC-01-247-01	PreHistoric Artifacts and Features - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4644	Rec. Not Eligible, No SHPO Rev.	AEC-01-247-02	PreHistoric Artifacts and Features - Hearths/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4645	Rec. Not Eligible, No SHPO Rev.	AEC-01-247-03	PreHistoric Feature - Other - Hearth/FCR	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4646	Not Eligible/SHPO	AEC-01-225-01	Historic Homestead	None or Other	Archaeological Energy Consulting
FR 4653	Rec. Not Eligible, No SHPO Rev.	WY-54-01	PreHistoric Artifacts and Features - Chipping/knapping - Hearths/FCR	Fire Hearths/FCR	WY State Archeologist
FR 4875	Unknown	AEC-02-090-01	PreHistoric Lithic Scatter - FCR - Habitation	Fire Hearths/FCR	Archaeological Energy Consulting
FR 4880	Not Eligible/SHPO	AEC-02-089-1	PreHistoric Lithic Scatter	None or Other	Archaeological Energy Consulting
NO #	Unknown	NONE	Lithic Scatter	Unknown	University of Wyoming
NO #	Unknown	NONE	Lithic Scatter	Unknown	University of Wyoming

APPENDIX N
SEDIMENT YIELD EVALUATION

1.0 SEDIMENT YIELD EVALUATION

1.1 METHODOLOGY FOR ESTIMATING SOIL LOSSES FOR WRPA

This section provides the assumptions used to estimate potential soil losses from well pads, roads, pipelines, and other activities that would be involved in the development of the Pavillion, Muddy Ridge, Sand Mesa, Sand Mesa South, and Coastal Extension well fields. Sediment yield was calculated by well field as well as by watershed. Areas of disturbance, the timing of operations, and the distribution of wells used in the calculations were based on values presented in Chapter 2. Soil loss rates were based on erosion rates for the site-specific soils presented in Chapter 3.3, Soils, as well as work done by researchers in Wyoming. Factors that control the erodibility of soils are discussed in Appendix F.

For this analysis, the following assumptions were made:

- During periods of well pad construction, road building, and pipeline installation, it is assumed that higher erosion rates apply. During this period of time, temporary berms, topsoil stockpiles, and other steep banks will be present during construction activities. It is, therefore, assumed that steeper slopes will be present (up to 20%). Erosion rates for disturbed, post-disturbance (up to 4 yrs), and natural rates were based on estimated slopes and the physical nature of the soils. For the Pavillion well field, erosion rates were based on a 50-50 split between sandy-clay loam to sandy loam and for the Muddy Ridge field, 50% of soil was considered to be sandy clay loam with the remainder being clay loam.

- Total erosion rates were based on staging of activities over an 11-year period. Rates for the first year are proportioned based on construction disturbance and post-construction disturbance.

- Auxiliary facilities such as compressor stations and underground injection wells would also be constructed. Currently, there would be 9 facilities constructed disturbing a total of 33 acres. It was assumed that three of these facilities would be constructed every other year.

- During the first year, construction, completion, and testing operations will take place during at least part of the year. During the remainder of the year, the site would be reclaimed and erosion rates would be reduced. In Year 3, it is assumed that the number of well sites would be reduced by 10%, based on a 75% success rate for the Proposed Action and 90% success rate for Alternatives A and B.

1.2 ESTIMATED SOIL LOSS RATES FOR THE WRPA

Table N-2 provides the calculation worksheet used to estimate soil losses from the Proposed Action. Tables N-3 and N-4 summarize the estimated soil erosion rates over a 16-year period for the Proposed Action by well field and watershed, respectively, and Table N-5 provides estimates of the sediment loading that would occur in these watersheds based on the calculated soil loss rates and a sediment delivery ratio of 5%. Inspection of Table N-3 reveals that the estimated soil loss rates are highest for the Muddy Ridge well field and lowest for the South Sand Mesa well field. Total annual soil losses are estimated to range from 509 to 1190 tons/acre/year for the Proposed Action. Soil losses would be largest in the Fivemile Creek and Muddy Creek watersheds (Table N-4). Total sediment loading to Fivemile, Cottonwood, and Muddy Creeks would range from 16.07 tons in year 1 to 23.97 tons in year 11 (Table N-5).

Table N-6 provides the calculation worksheet used to estimate soil losses from Alternative A. Tables N-7, N-8, and N-9 provide the estimated soil losses by well field and watershed, and sediment loading to the creeks for Alternative A. The total estimated soil losses for Alternative A are approximately 34% higher than for the Proposed Action, due to the greater number of wells and associated facilities that would be constructed. Sediment loading to Fivemile, Cottonwood, and Muddy Creeks would be greater by a similar amount.

Table N-10 provides the calculation worksheet used to estimate soil losses from Alternative B. Tables N-11, N-12, and N-13 provide the estimated soil losses by well field and watershed, and sediment loading to the creeks for Alternative B. The total estimated soil losses for Alternative B are approximately 0.5% lower than for the Proposed Action, due to the lesser number of wells and associated facilities that would be constructed. Sediment loading to Fivemile, Cottonwood, and Muddy Creeks would be lower by a similar amount.

Table N-14 provides the calculation worksheet used to estimate soil losses from Alternative C. Tables N-15, N-16, and N-17 provide the estimated soil losses by well field and watershed, and sediment loading to the creeks for Alternative C. The total estimated soil losses for Alternative C are approximately 85% lower than for the Proposed Action, due to the limited number of wells and associated facilities that would be constructed. Sediment loading would occur only to Fivemile Creek for this alternative.

Table N-2: Proposed Action – Yearly Soil Loss Calculation Sheet

	Soil Loss (Tons) – Proposed Action											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Year 1												
Pavillion (Irrigated)	6.55	9	2	2	1.38	19.67	3.95	26.89	3.02	0.09	15.98	**53.53**
Pavillion (Dry Land)	7.55	9	3	7	0.00	19.03	13.11	26.24	0.00	54.61	49.28	**58.38**
Muddy Ridge	12.5	32	6	50	0.00	108.14	64.71	50.99	0.00	47.66	53.48	**223.84**
Sand Mesa	16.7	43	8	49	0.00	91.81	17.49	3.09	0.00	0.25	0.33	**112.39**
South Sand Mesa	3	8	1	11	0.00	16.49	3.20	0.55	0.00	0.00	0.00	**20.24**
Coastal Extension	1	3	0	15	0.00	9.24	23.61	8.03	0.00	0.00	2.44	**40.88**
Year 2												
Pavillion (Irrigated)	6.55	9	2	2	1.38	16.15	4.36	2.91	2.48	0.01	4.44	**25.91**
Pavillion (Dry Land)	7.55	9	3	7	0.00	15.63	5.03	12.46	0.00	6.07	13.69	**33.12**
Muddy Ridge	12.5	32	6	50	3.95	49.41	8.91	77.50	7.47	6.15	17.25	**143.29**
Sand Mesa	16.7	43	8	49	0.00	1.41	0.25	1.63	0.00	1.53	5.00	**3.29**
South Sand Mesa	3	8	1	11	0.00	0.25	0.05	0.37	0.00	0.00	0.00	**0.67**
Coastal Extension	1	3	0	15	0.00	5.61	1.01	33.44	0.00	0.00	0.56	**40.06**
Year 3												
Pavillion (Irrigated)	6.55	9	2	2	1.38	16.15	4.36	2.91	2.48	0.01	4.44	**25.91**
Pavillion (Dry Land)	7.55	9	3	7	0.00	15.63	5.03	12.46	0.00	6.07	13.69	**33.12**
Muddy Ridge	12.5	32	6	50	3.95	49.41	8.91	77.50	6.12	6.15	17.25	**141.94**

	Soil Loss (Tons) – Proposed Action											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Sand Mesa	16.7	43	8	49	6.00	1.41	0.25	1.63	2.56	1.53	5.00	**5.85**
South Sand Mesa	3	8	1	11	0.00	0.25	0.05	0.37	0.00	0.00	0.00	**0.67**
Coastal Extension	1	3	0	15	0.00	5.61	1.01	33.44	0.00	0.00	0.56	**40.06**

Table N-2: Proposed Action – Yearly Soil Loss Calculation Sheet (continued)

Year 4												
Pavillion (Irrigated)	4.9	7	2	1	1.38	12.08	3.26	2.18	2.48	0.01	4.44	**20.01**
Pavillion (Dry Land)	5.7	7	2	5	0.00	11.80	3.80	9.41	0.00	6.07	13.69	**25.00**
Muddy Ridge	9.4	24	4	38	3.95	37.15	6.70	58.28	6.12	6.15	17.25	**108.26**
Sand Mesa	12.5	32	6	37	6.00	1.05	0.19	1.22	0.20	1.53	5.00	**2.66**
South Sand Mesa	2.3	6	1	9	2.86	0.19	0.03	0.28	1.22	0.00	0.00	**1.73**
Coastal Extension	0.75	2	0	11	0.00	4.21	0.76	25.08	0.00	0.00	0.56	**30.05**
Year 5												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.93	0.00	0.56	**7.36**
Year 6												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**
Year 7												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**

Table N-2: Proposed Action – Yearly Soil Loss Calculation Sheet (concluded)

Year 8											
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**
Year 9												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**
Year 10												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**
Year 11												
Pavillion (Irrigated)	4.9	7	2	1	1.38	3.95	3.26	0.85	2.48	0.01	4.44	**10.55**
Pavillion (Dry Land)	5.7	7	2	5	0.00	7.16	3.80	3.66	0.00	6.07	13.69	**14.61**
Muddy Ridge	9.4	24	4	38	3.95	11.46	6.70	24.44	6.12	6.15	17.25	**48.72**
Sand Mesa	12.5	32	6	37	6.00	0.30	0.19	0.52	0.20	1.53	5.00	**1.20**
South Sand Mesa	2.3	6	1	9	2.86	0.05	0.03	0.12	0.09	0.00	0.00	**0.30**
Coastal Extension	0.75	2	0	11	2.00	0.72	0.76	0.95	4.40	0.00	0.56	**6.83**

Table N-3: Proposed Action – Soil Loss by Well Field

Field	Soil Loss (TONS)															
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**
Pavillion (Irrigated)	53.53	79.44	105.35	125.36	135.90	146.45	157.00	167.55	178.09	188.64	199.19	156.21	140.85	125.48	116.02	116.02
Pavillion (Dry Land)	58.38	91.50	124.62	149.62	164.23	178.85	193.46	208.08	222.69	237.31	251.92	208.16	189.65	171.15	160.76	160.76
Muddy Ridge	223.84	367.14	509.08	617.34	501.75	466.72	433.03	433.03	433.03	433.03	433.03	433.03	433.03	433.03	433.03	433.03
Sand Mesa	112.39	115.69	121.54	124.20	14.46	13.83	10.64	10.64	10.64	10.64	10.64	10.64	10.64	10.64	10.64	10.64
South Sand Mesa	20.24	20.91	21.58	23.32	23.62	23.93	24.23	24.54	24.84	25.15	25.45	5.51	5.15	4.78	3.35	3.35
Coastal Extension	40.88	80.94	121.00	151.05	158.41	165.23	172.06	178.89	185.72	192.54	199.37	165.32	132.09	98.85	75.63	75.11
Total	**509.27**	**755.61**	**1003.16**	**1190.88**	**998.38**	**995.01**	**990.43**	**1022.72**	**1055.02**	**1087.31**	**1119.61**	**978.87**	**911.41**	**843.94**	**799.44**	**798.91**

Table N-4: Proposed Action – Soil Loss by Watershed

Watershed	Soil Loss BY FIELD (TONS)															
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**
Cottonwood Creek	52.73	91.59	130.75	159.91	153.81	160.28	166.46	173.01	179.57	186.12	192.67	159.98	128.08	96.18	73.89	73.38
Fivemile Creek	192.49	303.10	413.23	497.22	480.77	493.32	506.35	531.52	556.68	581.84	607.00	520.26	486.39	452.52	432.67	432.67
Muddy Creek	264.05	360.92	454.09	533.75	363.81	341.41	317.62	318.20	318.78	319.35	319.93	298.63	296.94	295.24	292.89	292.87
Total	**509.27**	**755.61**	**998.07**	**1190.88**	**998.38**	**995.01**	**990.43**	**1022.72**	**1055.02**	**1087.31**	**1119.61**	**978.87**	**911.41**	**843.94**	**799.44**	**798.91**

Table N-5: Proposed Action – Sediment Loading

Watershed	Sediment Loading (tons)															
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**
Cottonwood Creek	6.01	8.51	11.03	13.38	13.50	14.22	14.92	15.64	16.36	17.08	17.80	13.19	11.42	9.66	8.05	8.00
Fivemile Creek	13.21	20.29	27.34	33.84	33.65	35.60	37.59	39.79	42.00	44.20	46.40	40.72	39.01	37.30	35.94	35.94
Muddy Creek	16.07	22.00	27.66	33.55	24.57	24.19	23.75	23.80	23.86	23.91	23.97	22.34	22.25	22.16	21.99	21.99

Table N-6: Alternative A – Yearly Soil Loss Calculation Sheet

	Alternative A - Soil Loss (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Year 1												
Pavillion (Irrigated)	8.72	12	3	2	6.00	26.18	5.26	35.80	13.14	0.09	15.98	**80.38**
Pavillion (Dry Land)	10	12	4	9	0.00	25.21	17.36	34.75	0.00	54.61	49.28	**77.32**
Muddy Ridge	16.5	42	8	66	0.00	142.75	85.55	67.30	0.00	47.66	53.48	**295.60**
Sand Mesa	16.6	42	8	49	0.00	91.26	17.39	3.07	0.00	0.25	0.33	**111.72**
South Sand Mesa	4.3	11	2	34	0.00	23.64	4.97	0.79	0.00	0.00	0.00	**29.40**
Coastal Extension	2.9	7	1	39	0.00	26.79	61.13	23.29	0.00	0.00	2.44	**111.21**
Year 2												
Pavillion (Irrigated)	8.72	12	3	0	6.00	21.50	5.81	0.31	10.80	0.01	4.44	**38.42**
Pavillion (Dry Land)	10	12	4	7	0.00	20.70	6.66	12.42	0.00	6.07	13.69	**39.78**
Muddy Ridge	16.5	42	8	57	6.00	65.22	11.76	88.16	11.35	6.15	17.25	**176.50**
Sand Mesa	16.6	42	8	44	0.00	1.40	0.25	1.45	0.00	1.53	5.00	**3.10**
South Sand Mesa	4.3	11	2	16	0.00	0.36	0.07	0.53	0.00	0.00	0.00	**0.95**
Coastal Extension	2.9	7	1	15	0.00	16.27	2.93	32.53	0.00	0.00	0.56	**51.74**
Year 3												
Pavillion (Irrigated)	8.72	12	3	0	6.00	21.50	5.81	0.31	10.80	0.01	4.44	**38.42**
Pavillion (Dry Land)	10	12	4	7	0.00	20.70	6.66	12.42	0.00	6.07	13.69	**39.78**
Muddy Ridge	16.5	42	8	57	6.00	65.22	11.76	88.16	9.30	6.15	17.25	**174.4**

	Alternative A - Soil Loss (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
												4
Sand Mesa	16.6	42	8	44	6.00	1.40	0.25	1.45	2.56	1.53	5.00	**5.66**
South Sand Mesa	4.3	11	2	16	0.00	0.36	0.07	0.53	0.00	0.00	0.00	**0.95**
Coastal Extension	2.9	7	1	15	0.00	16.27	2.93	32.53	0.00	0.00	0.56	**51.74**

Table N-6: Alternative A – Yearly Soil Loss Calculation (continued)

Year 4												
Pavillion (Irrigated)	7.8	11	3	0	6.00	19.23	5.19	0.28	10.80	0.01	4.44	**35.51**
Pavillion (Dry Land)	9	10	3	6	0.00	18.63	5.99	11.18	0.00	6.07	13.69	**35.80**
Muddy Ridge	14.9	38	7	54	6.00	58.89	10.62	83.90	9.30	6.15	17.25	**162.71**
Sand Mesa	14.9	38	7	41	6.00	1.25	0.23	1.36	0.20	1.53	5.00	**3.04**
South Sand Mesa	3.9	10	2	15	3.95	0.33	0.06	0.50	1.69	0.00	0.00	**2.58**
Coastal Extension	2.6	7	1	14	0.00	14.59	2.63	31.40	0.00	0.00	0.56	**48.62**
Year 5												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	9.73	0.00	0.56	**16.05**
Year 6												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**
Year 7												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**

Table N-6: Alternative A – Yearly Soil Loss Calculation Sheet (concluded)

Year 8												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**
Year 9												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**
Year 10												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	41	6.00	0.36	0.23	0.58	0.20	1.53	5.00	**1.36**
South Sand Mesa	3.9	10	2	15	3.95	0.09	0.06	0.21	0.13	0.00	0.00	**0.50**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**
Year 11												
Pavillion (Irrigated)	7.8	11	3	0	6.00	6.29	5.19	0.11	10.80	0.01	4.44	**22.40**
Pavillion (Dry Land)	9	10	3	6	0.00	11.30	5.99	4.35	0.00	6.07	13.69	**21.65**
Muddy Ridge	14.9	38	7	54	6.00	18.16	10.62	35.18	9.30	6.15	17.25	**73.27**
Sand Mesa	14.9	38	7	37	6.00	0.36	0.23	0.52	0.20	1.53	5.00	**1.30**
South Sand Mesa	3.9	10	2	22	3.95	0.09	0.06	0.31	0.13	0.00	0.00	**0.59**
Coastal Extension	2.6	7	1	14	3.95	2.50	2.63	1.18	8.69	0.00	0.56	**15.01**

Table N-7: Alternative A – Soil Loss by Field

	Soil Loss (TONS)															
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Pavillion (Irrigated)	80.38	118.80	157.23	192.74	215.13	237.53	259.92	282.32	304.72	327.11	349.51	291.53	275.50	259.47	246.36	246.36
Pavillion (Dry Land)	77.32	117.10	156.88	192.68	214.33	235.97	257.62	279.26	300.91	322.55	344.20	288.52	270.39	252.25	238.10	238.10
Muddy Ridge	295.60	472.10	646.54	809.26	676.37	662.59	650.86	650.86	650.86	650.86	650.86	650.86	650.86	650.86	650.86	650.86
Sand Mesa	111.72	114.82	120.49	123.52	14.84	14.77	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14	12.14
South Sand Mesa	29.40	30.36	31.31	33.89	34.39	34.88	35.38	35.88	36.37	36.87	37.46	8.65	8.29	7.93	5.95	6.04
Coastal Extension	111.21	162.95	214.69	263.30	279.36	294.37	309.38	324.39	339.40	354.41	369.42	273.22	236.49	199.77	166.16	165.12
Total	**705.64**	**1016.13**	**1327.14**	**1615.39**	**1434.41**	**1480.11**	**1525.30**	**1584.85**	**1644.40**	**1703.94**	**1763.59**	**1524.92**	**1453.67**	**1382.42**	**1319.56**	**1318.61**

Table N-8: Alternative A – Soil Loss by Watershed

Watershed	Soil Loss (TONS)															
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Cottonwood Creek	120.17	170.21	220.56	267.59	269.96	284.36	298.46	312.87	327.28	341.69	356.10	263.75	228.49	193.23	160.97	159.97
Muddy Creek	321.35	440.06	553.25	671.05	491.49	483.71	474.99	476.08	477.18	478.28	479.47	446.81	444.98	443.15	439.83	439.88
Fivemile Creek	264.11	405.86	546.86	676.75	672.96	712.03	751.85	795.89	839.94	883.98	928.02	814.36	780.20	746.03	718.76	718.76
Total	**705.64**	**1016.13**	**1320.67**	**1615.39**	**1434.41**	**1480.11**	**1525.30**	**1584.85**	**1644.40**	**1703.94**	**1763.59**	**1524.92**	**1453.67**	**1382.42**	**1319.56**	**1318.61**

Table N-9: Alternative A – Sediment Loading by Watershed

Watershed	Sediment Loading (tons)															
	Year1	Year 2	Year 3	Year 4	Year 5	Year6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Cottonwood Creek	2.64	4.58	6.54	8.00	7.69	8.01	8.32	8.65	8.98	9.31	9.63	8.00	6.40	4.81	3.69	3.67
Fivemile Creek	9.62	15.16	20.66	24.86	24.04	24.67	25.32	26.58	27.83	29.09	30.35	26.01	24.32	22.63	21.63	21.63
Muddy Creek	13.20	18.05	22.70	26.69	18.19	17.07	15.88	15.91	15.94	15.97	16.00	14.93	14.85	14.76	14.64	14.64
Total	**25.46**	**37.78**	**49.90**	**59.54**	**49.92**	**49.75**	**49.52**	**51.14**	**52.75**	**54.37**	**55.98**	**48.94**	**45.57**	**42.20**	**39.97**	**39.95**

Table N-10: Alternative B - Yearly Soil Loss Calculation Sheet

	Soil Loss (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Year 1												
Pavillion (Irrigated)	6.55	9	2	2	1.38	19.67	3.95	26.89	3.02	0.09	15.98	**53.53**
Pavillion (Dry Land)	7.55	9	3	7	0.00	19.03	13.11	26.24	0.00	54.61	49.28	**58.38**
Muddy Ridge	8.5	22	4	63	0.00	73.54	73.90	34.67	0.00	47.66	53.48	**182.11**
Sand Mesa	4	10	2	12	0.00	21.99	4.19	0.74	0.00	0.25	0.33	**26.92**
South Sand Mesa	0.5	1	0	5	0.00	2.75	0.60	0.09	0.00	0.00	0.00	**3.44**
Coastal Extension	0.5	1	0	8	0.00	4.62	11.81	4.02	0.00	0.00	2.44	**20.44**
Year 2												
Pavillion (Irrigated)	6.55	9	2	2	1.38	16.15	4.36	2.91	2.48	0.01	4.44	**25.91**
Pavillion (Dry Land)	7.55	9	3	7	0.00	15.63	5.03	12.46	0.00	6.07	13.69	**33.12**
Muddy Ridge	8.5	22	4	63	3.95	33.60	6.06	96.88	7.47	6.15	17.25	**144.01**
Sand Mesa	4	10	2	12	0.00	0.34	0.06	0.39	0.00	1.53	5.00	**0.79**
South Sand Mesa	0.5	1	0	5	0.00	0.04	0.01	0.16	0.00	0.00	0.00	**0.21**
Coastal Extension	0.5	1	0	8	0.00	2.81	0.51	16.72	0.00	0.00	0.56	**20.03**
Year 3												
Pavillion (Irrigated)	6.55	9	2	2	1.38	16.15	4.36	2.91	2.48	0.01	4.44	**25.91**
Pavillion (Dry Land)	7.55	9	3	7	0.00	15.63	5.03	12.46	0.00	6.07	13.69	**33.12**
Muddy Ridge	8.5	22	4	63	3.95	33.60	6.06	96.88	6.12	6.15	17.25	**142.65**

	Soil Loss (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Sand Mesa	4	10	2	12	3.95	0.34	0.06	0.39	1.69	1.53	5.00	**2.47**
South Sand Mesa	0.5	1	0	5	0.00	0.04	0.01	0.16	0.00	0.00	0.00	**0.21**
Coastal Extension	0.5	1	0	8	0.00	2.81	0.51	16.72	0.00	0.00	0.56	**20.03**

Table N-10: Alternative B – Yearly Soil Loss Calculation Sheet (continued)

Year 4												
Pavillion (Irrigated)	5.9	8	2	1	1.38	14.55	3.93	2.62	2.48	0.01	4.44	**23.59**
Pavillion (Dry Land)	6.8	8	3	6	0.00	14.08	4.53	11.22	0.00	6.07	13.69	**29.83**
Muddy Ridge	7.7	20	4	59	3.95	30.43	5.49	91.92	6.12	6.15	17.25	**133.96**
Sand Mesa	3.6	9	2	11	3.95	0.30	0.05	0.35	0.13	1.53	5.00	**0.84**
South Sand Mesa	0.45	1	0	4	2.00	0.04	0.01	0.14	0.85	0.00	0.00	**1.04**
Coastal Extension	0.45	1	0	7	0.00	2.52	0.46	15.05	0.00	0.00	0.56	**18.03**
Year 5												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.93	0.00	0.56	**6.38**
Year 6												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**
Year 7												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**

Table N-10: Alternative B – Yearly Soil Loss Calculation Sheet (concluded)

Year 8												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**
Year 9												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**
Year 10												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**
Year 11												
Pavillion (Irrigated)	5.9	8	2	1	1.38	4.76	3.93	1.02	2.48	0.01	4.44	**12.19**
Pavillion (Dry Land)	6.8	8	3	6	0.00	8.54	4.53	4.36	0.00	6.07	13.69	**17.43**
Muddy Ridge	7.7	20	4	59	3.95	9.39	5.49	38.55	6.12	6.15	17.25	**59.54**
Sand Mesa	3.6	9	2	11	3.95	0.09	0.05	0.15	0.13	1.53	5.00	**0.42**
South Sand Mesa	0.45	1	0	4	2.00	0.01	0.01	0.06	0.07	0.00	0.00	**0.14**
Coastal Extension	0.45	1	0	7	2.00	0.43	0.46	0.57	4.40	0.00	0.56	**5.86**

Table N-11: Alternative B – Soil Loss by Field

	Soil Loss (TONS)															
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Pavillion (Irrigated)	53.53	79.44	105.35	128.93	141.13	153.32	165.51	177.71	189.90	202.09	214.28	172.95	159.23	145.52	134.12	134.12
Pavillion (Dry Land)	58.38	91.50	124.62	154.44	171.88	189.31	206.75	224.18	241.62	259.05	276.49	235.54	219.86	204.17	191.78	191.78
Muddy Ridge	182.11	326.11	468.77	602.73	554.58	544.54	535.85	535.85	535.85	535.85	535.85	535.85	535.85	535.85	535.85	535.85
Sand Mesa	26.92	27.71	30.18	31.02	4.94	4.99	3.36	3.36	3.36	3.36	3.36	3.36	3.36	3.36	3.36	3.36
South Sand Mesa	3.44	3.65	3.85	4.90	5.04	5.18	5.33	5.47	5.62	5.76	5.90	2.61	2.54	2.48	1.58	1.58
Coastal Extension	20.44	40.47	60.50	78.53	84.91	90.77	96.63	102.48	108.34	114.20	120.05	105.47	91.30	77.12	64.95	64.42
Total	**344.81**	**568.87**	**793.27**	**1000.56**	**962.49**	**988.12**	**1013.42**	**1049.05**	**1084.68**	**1120.31**	**1155.93**	**1055.78**	**1012.14**	**968.50**	**931.64**	**931.11**

Table N-12: Alternative B – Soil Loss by Watershed

Watershed	Soil Loss (TONS)															
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Cottonwood Creek	22.85	42.18	61.70	79.11	82.11	87.74	93.17	98.79	104.41	110.03	115.66	101.66	88.05	74.44	62.76	62.25
Fivemile Creek	177.46	288.34	398.72	500.36	512.66	538.67	565.17	594.79	624.42	654.05	683.68	601.40	572.00	542.59	518.81	518.81
Muddy Creek	144.50	238.36	328.16	421.08	367.72	361.71	355.09	355.47	355.85	356.22	356.60	352.72	352.09	351.46	350.08	350.06
Total	**344.81**	**568.87**	**788.58**	**1000.56**	**962.49**	**988.12**	**1013.42**	**1049.05**	**1084.68**	**1120.31**	**1155.93**	**1055.78**	**1012.14**	**968.50**	**931.64**	**931.11**

Table N-13: Alternative B – Sediment Loading by Watershed

Watershed	Sediment Loading (tons)															
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16
Cottonwood Creek	1.14	2.11	3.09	3.96	4.11	4.39	4.66	4.94	5.22	5.50	5.78	5.08	4.40	3.72	3.14	3.11
Fivemile Creek	8.87	14.42	19.94	25.02	25.63	26.93	28.26	29.74	31.22	32.70	34.18	30.07	28.60	27.13	25.94	25.94
Muddy Creek	7.22	11.92	16.41	21.05	18.39	18.09	17.75	17.77	17.79	17.81	17.83	17.64	17.60	17.57	17.50	17.50

Table N-14: Alternative C – Yearly Soil Loss Calculation Sheet

	Alternative C Soil Loss Yield (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Year 1												
Pavillion (Irrigated)	6.4	9	2	2	1.38	19.22	3.88	26.27	3.02	0.09	15.98	**52.39**
Tribal Protection	3.6	4	1	3	0.00	9.07	6.26	12.51	0.00	0.09	15.98	**27.85**
Year 2												
Pavillion (Irrigated)	6.4	9	2	2	1.38	15.78	4.26	2.87	2.48	0.01	4.44	**25.40**
Tribal Protection	3.6	4	1	3	0.00	7.45	2.40	5.96	0.00	0.01	4.44	**15.80**
Year 3												
Pavillion (Irrigated)	6.4	9	2	2	1.38	15.78	4.26	2.87	2.48	0.01	4.44	**25.40**
Tribal Protection	3.6	4	1	3	0.00	7.45	2.40	5.96	0.00	0.01	4.44	**15.80**
Year 4												
Pavillion (Irrigated)	5.76	8	2	1	1.38	14.20	3.84	2.58	2.48	0.01	4.44	**23.11**
Tribal Protection	3.24	4	1	3	0.00	6.71	2.16	5.36	0.00	0.01	4.44	**14.22**
Year 5												
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**
Year 6												
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**
Year 7												

	Alternative C Soil Loss Yield (Tons)											
	No. of Wells	Well Pad Disturbed Area (acres)	Road Disturbed Area (acres)	Pipeline Disturbed Area (acres)	Auxiliary Facilities (acres)	Well Pads	Roads	Pipelines	Auxiliary Facilities	Existing Pads	Existing Roads	**Total**
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**
Year 8												
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**

Table N-14: Alternative C – Yearly Soil Loss Calculation Sheet (concluded)

Year 9												
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**
Year 10												
Pavillion (Irrigated)	5.76	8	2	1	1.38	4.65	3.84	1.00	2.48	0.01	4.44	**11.97**
Tribal Protection	3.24	4	1	3	0.00	4.07	2.16	2.08	0.00	0.01	4.44	**8.31**

Table N-15: Alternative C – Soil Loss by Well Field

	Soil Loss (TONS)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Pavillion (Irrigated)	52.39	77.79	103.19	126.29	138.26	150.23	162.20	174.17	186.15	198.12
Tribal Protection	27.85	43.65	59.46	73.68	81.99	90.31	98.62	106.93	115.24	123.55
Total	**80.24**	**121.44**	**162.64**	**199.97**	**220.26**	**240.54**	**260.82**	**281.10**	**301.38**	**321.67**

Table N-16: Alternative C – Soil Loss by Watershed

Watershed	Soil Loss (TONS)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Fivemile Creek	80.24	121.44	162.64	199.97	220.26	240.54	260.82	281.10	301.38	321.67
Total	**80.24**	**121.44**	**162.64**	**199.97**	**220.26**	**240.54**	**260.82**	**281.10**	**301.38**	**321.67**

Table N-17: Alternative C – Sediment Loading by Watershed

Watershed	Sediment Loading (TONS)									
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Fivemile Creek	4.01	6.07	8.13	10.00	11.01	12.03	13.04	14.06	15.07	16.08

APPENDIX O
STORM WATER MANAGEMENT PLAN

STORM WATER MANAGEMENT PLAN

This appendix describes the general requirements for storm water managements plans for oil and gas construction activities within the WRPA. The Operators would prepare comprehensive storm water management plans for each construction site in accordance with the Wyoming general storm water permit (WYR10-0000). These facilities may include well pads, pipelines corridors, access roads, and compressor stations. For each plan, the following minimum requirements would apply:

- A description of the project, including the construction sequence, area of disturbance, and surface cover.
- The name, address, and phone numbers of the Operator.
- The name, legal description, and county of the site.
- The anticipated start and end dates of construction activities.
- A listing of all substances that could be spilled at the project site.
- Identification of the receiving water bodies for storm water from the site.
- A map would be prepared showing the surface topography, discharge points, watershed boundaries, reservoirs, infiltration pits, low water crossings, erosional features, water and gas pipelines, springs, wells, roads, storm water drainage patterns, sewers, and other information necessary to describes the water features.
- A description of the Best Management Practices (BMPs) that would be applied.
- A schedule of inspections and reporting.
- A description of the final stabilization measures that would be taken.

Within the WRPA, Tom Brown, Inc has previously submitted several Storm Water Pollution Prevention Plans (SWPPP). An example of a Discharge Permit and SWPPP for Tribal Sand Mesa #26_41, located in Township 4 N, Range 4 E, W.R.M. Fremont County (Permit authorization number WYR101819), is provided below.

APPENDIX P
WILDLIFE MONITORING/PROTECTION PLAN

WILDLIFE MONITORING/PROTECTION PLAN

Prepared for:
Bureau of Indian Affairs
Wind River Agency
Fort Washakie, Wyoming

Prepared by:
Buys and Associates
Littleton, Colorado

December 2003

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WILDLIFE MONITORING/PROTECTION PLAN

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ADDENDA

ABBREVIATIONS AND ACRONYMS

ANS	Artificial Nesting Structure
APD	Application for Permit to Drill
APLIC	Avian Power Line Interaction Committee
BA	Biological Assessment
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BO	Biological Opinion
CSU	Controlled Surface Use
EIS	Environmental Impact Statement
GIS	Geographic Information System
LOP	Life-of-Project
LFO	Lander Field Office
PMZ	Primary Management Zone
ROW	Right-of-Way
T&E	Threatened and Endangered Species
USFWS	U.S. Fish and Wildlife Service
WGFD	Wyoming Game and Fish Department
WRIR	Wind River Indian Reservation
WRPA	Wind River Project Area
WYNDD	Wyoming Natural Diversity Database

1. 0 WILDLIFE MONITORING/PROTECTION PLAN

1.1 INTRODUCTION

This Wildlife Monitoring/Protection Plan was prepared in conjunction with the Environmental Impact Statement (EIS) for the Wind River Natural Gas Development Project, Freemont County, Wyoming. The goal of the plan is to avoid and/or minimize adverse impacts to wildlife by monitoring and protecting wildlife populations and associated habitat in the Wind River Project Area (WRPA). Implementation of the plan will allow managers and project personnel opportunities to achieve and maintain desired levels of wildlife productivity and populations on the WRPA (e.g., at pre-project levels) by minimizing and/or avoiding potential adverse impacts to wildlife species. In addition, the implementation of this plan will facilitate the maintenance of a diverse assemblage of wildlife populations on the WRPA simultaneously with the development of natural gas reserves.

The Proposed Action for the Wind River Natural Gas Development Project involves the development of a maximum of 325 new wells at 325 well locations and associated facilities (roads, pipelines, compressor stations) on the WRPA over the next 20 years. The proposed life-of-project (LOP) is estimated to be from 20 to 40 years. Alternative development strategies also have been proposed (i.e., Alternative A, Alternative B, and Alternative C (No Action)). A complete description of the proposed project and alternatives is provided in Chapter 2.0 of this EIS.

Proposed inventory, monitoring, and protection measures will be implemented under each potential development scenario, unless information revealed in the coordinated review of annual wildlife reports indicates these measures are unnecessary for wildlife protection. The wildlife monitoring/protection plan will not be implemented under the No Action Alternative.

Implementation of the plan will begin after the publication of the Record of Decision, and it is estimated that the implementation will continue for 10 years. However, the plan may be terminated at the end of any year when there is sufficient evidence that wildlife populations and productivity in the WRPA have been successfully protected. The plan will receive a major review for effectiveness every five years, or as determined by the Review Team.

2.1 IMPLEMENTATION PROTOCOL

This section provides a preliminary wildlife inventory, monitoring, and protection protocol for the WRPA. A summary of primary protocol components, including inventory and monitoring requirements are provided in Table P-1. Additional inventory, monitoring, and protection measures are provided in Table P-2 if needed for areas with high levels of development. Standard protocol for Application for Permit to Drill (APD) and right-of-way (ROW) application field reviews are provided in Table P-3. Alternative protocols likely will be developed in the future in response to specific needs identified in annual wildlife reports (see Section 2.1). Methods are provided for each wildlife species. Additional species may be added based on needs identified in annual wildlife reports. The wildlife species and/or categories for which specific inventory, monitoring, and protection procedures will be applied were developed based on management agency (i.e., BIA, USFWS, and WGFD) and individual concerns identified during the preparation of the EIS.

Considerable effort will be required by the agencies and Operators (i.e., Saba Energy of Texas, Samson Resources Company, Tom Brown Inc.) for plan implementation. The proposed data collection methods are consistent with current agency activities. Additionally, during annual planning and throughout project implementation, all efforts will be made to accommodate agency personnel schedules and responsibilities, and cost-sharing approaches will be considered such that public demands and statutory directives are achieved (BLM 2000).

2.1.1 Annual Reports and Meetings

During project development (i.e., 20 years), Operators will provide an updated inventory and description of all existing project plans (i.e., locations, size, and associated work force). This inventory will be submitted to the BIA by the Operators no later than October 15 of each year. This data will be coupled with annual wildlife inventory, monitoring, and protection data obtained from the previous year. When annual wildlife inventory, monitoring, and protection data are collected by contractors or other agencies, they will be requested to provide the data to the BIA by October 15 of each year. Upon receipt of these data, annual reports will be completed in draft form by the BIA and submitted to Operators, USFWS, and other interested parties no later than December 15 of each year. A one-day meeting of the Review Team will be organized by the BIA and held in January/February of the following year to discuss and modify, as necessary, the proposed wildlife inventory, monitoring, and protection protocol for the subsequent field season.

A final annual report will be issued by the BIA to all interested party by February/March of each year. Annual reports will summarize annual wildlife inventory and monitoring results; note any trends across years (if available); identify and assess protection measures implemented during past years; specify monitoring and protection measures proposed for the upcoming year; and recommend modifications to the existing wildlife monitoring/protection plan based on the success and/or failures of past years (e.g., identification of additional species to monitor).

Where possible, the data presented in reports will be used to identify potential correlations between development and wildlife productivity and/or abundance. Addendum P-1 provides examples for the tabular presentation of data within annual reports; however, it should be noted that the final report format will be determined by the BIA. Raw data collected each year also will be provided to other management agencies (e.g., WGFD, USFWS, Wyoming Natural Diversity Database [WYNDD]) at the request of those agencies.

Additional reports may be prepared in any year, as necessary, to comply with other relevant laws and regulations (e.g., black-footed ferret survey reports, raptor reports).

Additional meetings will be held, as necessary, in any given year by the BIA, Operators, and/or USFWS in Rawlins to inform and update Operator personnel on the findings of the annual reports (BLM 2000).

Table P-1: Summary of Wildlife Inventory and Monitoring, Wind River Project Area, Fremont County, Wyoming.

Action	*Dates*	*Responsible Entity*[1,2]
Raptor nest inventories (WRPA plus one mile buffer)	Every 5 years during April-May	USFWS/WGFD
Raptor productivity monitoring (in the WRPA plus a one-mile buffer).	Every 5 years during March to mid-July.	USFWS/WGFD
Aerial greater sage-grouse lek inventories (WRPA plus a two-mile buffer).	Every 5 years during March-April	USFWS/WGFD
Greater sage-grouse lek attendance monitoring on and within two-miles of the WRPA.	Annually during March to mid-May	USFWS/WGFD
Greater sage-grouse winter habitat inventory and monitoring within and adjacent to the WRPA	As required during December-February	USFWS/WGFD
Big game crucial winter range use monitoring (within the WRPA plus a one-mile buffer, or as determined by the Review Team)	No crucial winter ranges present in WRPA	USFWS/WGFD
Gray Wolf productivity monitoring (within the WRPA plus a two-mile buffer, or as determined by the Review Team)	Annually during March – May (only rare incidental observations recorded to-date)	USFWS/WGFD
Gray Wolf winter productivity monitoring (within the WRPA plus a two-mile buffer, or as determined by the Review Team)	Annually during December – February (only rare incidental observations recorded to date)	USFWS/WGFD
Black-footed ferret monitoring (within prairie dog colonies in the WRPA plus a one-mile buffer)	Annually during April-July	USFWS/WGFD.
Mountain plover monitoring (within the WRPA plus a 1/4 mile buffer)	Annually during April-July	USFWS/WGFD.
Grizzly bear population monitoring (within the WRPA plus a two-mile buffer, or as determined by the Review Team)	Annually during April-June (only rare incidental observations recorded to date)	USFWS/WGFD

[1] USFWS Inventories of Wildlife on WRIR.
[2] WGFD Inventories of Wildlife on BOR Land.

Table P-2: Additional Wildlife Inventory and Monitoring Measures in and Adjacent to Areas with High Levels of Development, Wind River Project Area, Fremont County, Wyoming.

Action	*Dates*	*Responsible Entity*[1,2]
Raptor nest inventory/monitoring on areas with a large number of wells per section, plus a one-mile buffer and selected undeveloped reference areas.	Annually during April and May	USFWS/WGFD
Raptor productivity monitoring on areas with a large number of wells per section, plus a one-mile buffer and selected undeveloped reference areas.	Annually during March-July	USFWS/WGFD
Selected sensitive species inventory/monitoring on suitable habitat in areas with a large number of wells per section plus a one-mile buffer and selected undeveloped reference areas.	Annually during spring and summer	USFWS/WGFD
Aerial greater sage-grouse lek inventory on areas with a large number of wells per section plus a two-mile buffer and selected undeveloped comparison areas.	Annually during March-April.	USFWS/WGFD
Greater sage-grouse lek attendance monitoring on areas with a large number of wells per section plus a two-mile buffer and selected undeveloped reference areas.	Annually during March to mid-May.	USFWS/WGFD
Greater sage-grouse winter habitat inventory and monitoring in areas with a large number of wells per section and undeveloped reference areas.	Available years.	USFWS/WGFD
Mountain plover monitoring in areas with a large number of wells per section plus a 1/4-mile buffer and selected undeveloped reference areas.	Annually during March to mid-May	USFWS/WGFD
Other studies on areas with a large number of wells per section and selected undeveloped reference areas.	Year-long and in any year as deemed necessary by BIA, BLM, USFWS, or WGFD.	USFWS/WGFD

[1] USFWS Inventories of Wildlife on WRIR.
[2] WGFD Inventories of Wildlife on BOR Land.

2.1.2 Annual Inventory and Monitoring

The inventory and monitoring protocol will be as identified below for each wildlife species. This protocol will be unchanged across development alternatives, except as authorized by the BIA. Additional wildlife species and associated surveys may be added or omitted in future years, pending the coordinated review of annual wildlife reports. Opportunistic wildlife observations may be made throughout the year by agency and Operator personnel in the WRPA.

The frequency of inventory and monitoring will be dependent upon the level of development in the WRPA (see Tables P-1 and P-2). In general, inventory and monitoring frequency will increase with increased levels of development. Inventory and monitoring results may identify the need for further scientific studies. The Review Team and/or BIA will identify the level of effort required by this wildlife plan, subject to the standards stated in the following paragraphs. Site- and species-specific surveys will continue to be conducted in association with APD and ROW application field reviews (see Table P-3).

Table P-3: Summary of General APD/ROW Application Stage Survey/Protection Measures, Wind River Project Area, Freemont County, Wyoming.

Protection Measure	*Dates*	*Responsible Entity*[1,2]
APD-stage general raptor nest analysis within 0.75 to 1.0 mile of proposed disturbance.	Year-long	USFWS/WGFD
APD-stage seasonal raptor nest avoidance within 0.5 to 1.0 mile of active nests.	February 1-July 31 (depending on species and/or site-specific conditions)	USFWS/WGFD
APD-stage general raptor nest avoidance within 825 feet of active nests (1,200 feet for active ferruginous hawk nest).	Year-long (Controlled Surface Use [CSU]) generally excluding surface disturbance.	USFWS/WGFD
APD-stage sensitive species surveys (within 0.25 - 0.5 miles of proposed disturbance sites).	As necessary	USFWS
APD-stage T&E habitat avoidance.		
APD-stage prairie dog colony mapping and burrow density determination.	As necessary	USFWS
Black-footed ferret habitat (i.e., prairie dog colony) avoidance.	As necessary	USFWS/WGFD
Black-footed ferret surveys where suitable habitat must be disturbed.	Where required, in appropriate season and no more than one-year prior to disturbance.	USFWS
APD-stage mountain plover surveys (within 0.25 mile of proposed project)	As necessary between April and July.	USFWS/WGFD

Protection Measure	***Dates***	***Responsible Entity[1,2]***
Mountain plover nest/brood avoidance.	April 10 - July 10	USFWS/WGFD
APD-stage western burrowing owl surveys (within 0.5 mile of proposed disturbance sites).	As necessary during June-August	USFWS/WGFD
Western burrowing owl nest avoidance.	As necessary	USFWS/WGFD
APD-stage greater sage-grouse lek surveys on suitable habitats within 2.0 miles of proposed disturbance sites.	March 1 - mid-May	USFWS/WGFD
APD-stage greater sage grouse lek avoidance on areas within 2.0 miles of a lek.	March 1 - June 30	USFWS/WGFD
APD-stage greater sage-grouse lek avoidance on areas within 0.25 mile of a lek.	Year-long	USFWS/WGFD
APD-stage greater sage-grouse nest avoidance.	As necessary	USFWS/WGFD
APD-stage greater sage-grouse winter habitat avoidance.	As necessary, in appropriate season December-February with adequate snow cover.	USFWS/WGFD
APD-stage general wildlife avoidance/protection	As necessary	USFWS/WGFD
Big game crucial winter range avoidance.	November 15-April 30	USFWS/WGFD

[1] USFWS Inventories of Wildlife on WRIR.
[2] WGFD Inventories of Wildlife on BOR Land.

2.1.2.1 Raptors

Raptor inventories of potentially affected areas were conducted in early April 2003 and will continue to be conducted every five years for the LOP to determine the location of raptor nests/territories and their activity status by the BIA (Table P-1). At this time, no raptor concentration areas are known to exist. Approximate raptor nest locations on and adjacent to the WRPA have been identified and are presented in the survey report entitled *Preliminary Wildlife Habitat Evaluation of Tom Brown, Inc.'s Wind River Natural Gas Development Project* (B&A 2003a). These surveys may be implemented aerially (e.g. via helicopter) or from the ground. Data collected during surveys will be recorded on Raptor Observation Data Sheets, or similar data forms (Addendum P-1).

Nest productivity monitoring will be conducted by the BIA at all active nests that are located within the project area (WRPA plus one-mile buffer) every five years. Nest productivity monitoring will occur between March 1 and mid-July to determine nesting success (i.e., number of nestlings/fledglings). These surveys will be conducted from the ground, and all active nests and nest failures will be documented.

Additional raptor nest activity and productivity monitoring measures will be applied in areas with high levels of development (Table P-2). Inventory and monitoring efforts in these areas, as well as selected undeveloped comparison areas, will be conducted annually during April and May, followed by nest productivity monitoring. Site- and species -specific raptor nest analyses will be conducted in association with all APD and ROW application field reviews (Table P-3).

All raptor nest/productivity surveys will be conducted using procedures that minimize potential adverse effects to nesting raptors. Specific survey measures for reducing adverse effects are listed in Grier and Fyfe (1987) and Call (1978) and include the following:

- Nest visits will be delayed for as long as possible in the nesting season.
- Nests will be approached cautiously, and their status (i.e., number of nestlings/fledglings) will be determined from a distance with binoculars or a spotting scope.
- Nests will be approached tangentially and in an obvious manner to avoid startling adults.
- Nests will not be visited during adverse weather conditions (e.g., extreme cold, precipitation events, windy periods, hottest part of the day).
- Visits will be kept as brief as possible.
- All inventories will be coordinated by the BIA, WGFD, or USFWS
- The number of nest visits in any year will be kept to a minimum.
- All raptor nest location data will be considered confidential (BLM 2000).

2.1.2.2 Big Game Species

There are no crucial winter ranges of big game species within the WRPA. Yearlong habitat of the pronghorn antelope and mule deer is present within the WRPA, as well as limited use of the northern portion of the WRPA by elk. There are no herd units for the white-tailed deer and moose reported within the WRPA. The ranges of the big game species that have been observed in the WRPA are shown in Figures 3.8-1 to 3.8-5.

2.1.2.3 Threatened and Endangered Species

The level of inventory and monitoring required for threatened and endangered species will be commensurate with established protocols for each potentially affected species. Methodologies and results of these surveys will be included in annual reports or provided in separate supplemental reports. A preliminary list of threatened and endangered species known to occur or to potentially occur in the vicinity of the WRPA is shown in Table P-4. Appropriate modifications will be incorporated to this plan and specified in annual reports if changes in threatened and endangered species occur. Additional species of concern known to occur, or to potentially occur in the vicinity of the WRPA are shown in Tables P-5 and P-6 (BLM Wyoming State Sensitive Species).

Data collected during surveys for threatened and endangered species will be considered confidential and will be provided only as necessary to those agencies requiring the data for management and/or project development needs. Site- and species-specific surveys will continue to be conducted, as necessary, in association with all APD and ROW application field reviews (see Table P-3). Data will be collected on appropriate General Wildlife Observation Data Sheets or similar forms (see Addendum P-1).

Table P-4: Threatened and Endangered Species Documented or Potentially Occurring on or near the Wind River Project Area

Species	***Scientific Name***	***Status***	***Distribution***
Black-footed Ferret	*Mustela nigripes*	Endangered	Possible resident in prairie dog colonies
Bald Eagle	*Haliaeetus leucocephalus*	Threatened (proposed for de-listing)	Nesting, winter resident, migrant, statewide
Canada Lynx	*Lynx canadensis*	Threatened	Resident of forested areas, may travel through
Gray Wolf	*Canis lupus*	Threatened	Greater Yellowstone Area, including all of Wyoming
Mountain Plover	*Charadrius montanus*	Proposed Threatened	Grasslands statewide
Grizzly Bear	*Ursus arctos horribilis*	Threatened	Wyoming portion of the Greater Yellowstone Ecosystem

Black-footed Ferret

The BIA or BLM will determine the presence/absence of prairie dog colonies at each proposed development site during APD and ROW application field revisions (see Table P-3). Prairie dog colonies (i.e., potential black-footed ferret habitat) in and adjacent to the WRPA were mapped in July 2003 and burrow densities were determined. The results of these surveys can be found in the 2003 survey report entitled *White-tailed Prairie Dog (Cynomys leucurus) Survey for Tom Brown, Inc.'s Wind River Natural Gas Development Project (*B&A 2003b) (Appendix J). White-tailed prairie dog colonies located on and adjacent to the WRPA are shown in Figure 3.9-1. Colonies that meet USFWS criteria as potential black-footed ferret habitat (USFWS 1989) will be surveyed for black-footed ferrets by a USFWS certified and BIA-approved biologist prior to any proposed disturbance. Surveys will only be conducted as deemed necessary based on consultation between the BIA and USFWS. Black-footed ferret surveys will be conducted in accordance with the USFWS guidelines (USFWS 1989) on a site-specific basis depending on the areas proposed for disturbance in a given year, as specified in the annual report.

Bald Eagle

The inventory and monitoring protocol for the bald eagle will be as described for raptor species (Section 2.1.2.1).

Grizzly Bear

Although their occurrence is rare, grizzly bears have been observed within the boundaries of the WRPA. According to the Wyoming Grizzly Bear Management Plan (WGFD 2002), effective population management can only be met, if data are collected to determine the status of local and statewide grizzly bear populations. To maintain consistency in data collection and to compare grizzly bear population parameters inside and outside the grizzly bear Primary Management Zone (PMZ), monitoring protocols should be similar. These protocols include four possible monitoring techniques, including: documentation of all grizzly bear observations with emphasis on females and cubs-of-the-year, mark-resight sampling, DNA analysis, and radio tracking. Since records of grizzly bear presence inside the WRPA are rare, populations will only be monitored via documentation of observations.

Monitoring of females with cubs-of-the-year may be used as an index to assess population trends or abundance over time. The number of known individual females with cubs-of-the-year observed are summed and divided by the estimated percentage of females with cubs-of-the-year in the population to achieve a minimum population estimate. This minimum population estimate is used to set mortality thresholds for all human-caused mortalities. The goal of this research is to provide a tool to allow agencies to estimate total population size for individual populations of grizzly bears.

Gray Wolf

According to the WGFD's *Wyoming Gray Wolf Management Plan* (2003), wolf populations in Wyoming will be monitored using any applicable technique, with primary emphasis on monitoring radio-collared individuals and intensive surveys during the winter and denning periods when wolves are most visible. The monitoring program will emphasize existing protocols and techniques that the USFWS and Yellowstone National Park (YNP) Service have employed, to assess whether gray wolf recovery criteria have been met. Survey techniques to track population trends over time could include both aerial and ground surveys to monitor pack numbers, distribution, breeding success, and mortality. Upon delisting, wolves with active radio collars will continue to be monitored (WGFD 2003). In addition to radio telemetry monitoring, emphasis will be placed on non-invasive techniques such as winter track counts, aerial surveys during denning periods, hair sampling, howling surveys, and observations by field personnel for basic survey and inventory data collection. During periods of snow cover, aerial and ground track counts may be used to document wolf presence or absence. Track counts may also be used to estimate pack size, but they must be conducted repeatedly to provide accurate information, as wolves will step in each other's tracks while traveling in groups (WGFD 2003). Since documented gray wolf sightings within the WRPA are rare, records will be kept of all gray wolf observations.

Mountain Plover

The Wind River Project Area was mapped in July 2003 to determine if suitable mountain plover habitat existed (see Figure 3.9-2). Suitable habitat was identified in the WRPA and includes areas with flat topography and vegetation less than four inches high, and disturbed areas. Mountain plover surveys will be completed each field season to identify occupied habitat within the WRPA. Well pads, access roads, ancillary facilities and reserve pits located in occupied plover habitat may require additional stipulations (see Addendum P-2). The Mountain Plover Survey Guidelines (USFWS 2002) will be followed (see Addendum P-2). The guidelines describe surveys required to determine the presence and absence of mountain plover as well as density of nesting plovers.

Canada Lynx

Since there is no habitat or prey species present in the WRPA, surveys will not be conducted for the Canada lynx. However, any observations of lynx will be recorded.

2.1.2.4 Wyoming Sensitive Species

Population declines have occurred in many wildlife species in Wyoming in recent years. As a result of this decline, the State of Wyoming Game and Fish Department has developed seven categories of sensitive mammals and birds. Category 1 (NSS1), which includes species with the highest level of concern in Wyoming, is for species with significant habitat loss or substantial decline in population and a possible extirpation from the state. Category 2 (NSS2) refers to species with restricted or vulnerable habitat, but with no recent or ongoing significant loss occurring. However, the species is sensitive to human disturbance. In addition, populations are restricted or declining in numbers and/or distribution. Tables P-5 and P-6 identify mammals and birds that are state species of concern in categories NSS1, NSS2, and NSS3.

Surveys for Wyoming sensitive species will be conducted by the BLM on BOR land, by USFWS on tribal land, and by WGFD on land managed by the state. Surveys for these species may be implemented in conjunction with surveys for other species or as components of the APD/ROW application.

In sections where a large number or wells are drilled, the entire section plus a one mile buffer will be surveyed. Surveys will also be conducted in undeveloped areas, so that comparisons can be made. Surveys will be conducted annually during spring and summer by the BIA and/or BLM biologists for selected sensitive species (see Table P-2). The Review Team may revise the distance of the survey area based on biological requirements and the number of surveys required for each species. If any sensitive species are observed, the observations will be noted on the appropriate data forms (see Addendum P-1). In addition, when and if sensitive species are observed, efforts will be made to determine their activities (e.g., breeding, nesting, foraging, hunting, etc.). If any management agency (e.g., BIA, USFWS) identifies a potential concern regarding any of these species, additional inventory and monitoring may be implemented as specified in annual reports (BLM 2000).

Greater Sage-grouse

Baseline data for greater sage-grouse lek locations were collected throughout the WRPA and 2-mile buffer in April of 2003 (see Figure 3.9-3). Leks within 2 miles of existing and proposed disturbance areas will be monitored annually by the BIA in coordination with the WGFD between March 1 and May 15, to determine lek attendance (see Table P-1). Surveys will be conducted aerially, or on the ground, between March and April as deemed appropriate by the BIA or BLM. Aerial surveys will be used only to determine lek locations. In areas with large numbers of well locations per section, aerial inventories will be conducted annually on affected sections, a 2-mile buffer of disturbance areas, and selected undeveloped comparison areas (see Table P-2). Data collected during these surveys will be provided on Greater Sage-Grouse Lek Records or other suitable forms (see Addendum P-1) (BLM 2000). Figure 3.9-3 in Chapter 3 shows the greater sage-grouse leks that have been identified within and near the WRPA; these leks include both known active and inactive leks.

Greater sage-grouse winter habitat surveys within the WRPA will be conducted when weather conditions permit to determine the use of these areas and/or any changes that may have occurred to this habitat within the project area (see Table P-1). Winter habitat surveys can only be completed during specific weather conditions, where there is adequate snow cover to determine actual winter use areas. In years when this snow cover is not available, then surveys should not be completed.

Table P-5: Native Species Status (NSS) of Mammalian Species of Most Concern in Wyoming

	A. On-going significant loss of habitat.	B. Habitat is restricted or vulnerable but no recent or on-going significant loss; species is sensitive to human disturbance.	C. Habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance.	D. Habitat is stable and not restricted.
1. Populations are greatly restricted or declining; extirpation within Wyoming appears possible.	**NSS1**	**NSS2** Black-footed Ferret Pygmy Shrew	**NSS3** Preble's Shrew	**NSS4**
2. Populations restricted or declining in numbers and/or distribution; extirpation in Wyoming is not imminent.	**NSS2** Spotted Bat Long-eared Myotis Northern Myotis Long-legged Myotis Townsend's Big-eared Bat Pallid Bat Fringed Myotis Lynx	**NSS3** Black-tailed Prairie Dog White-tailed Prairie Dog Dwarf Shrew Pygmy Rabbit Water Vole Cliff Chipmunk Pinyon Mouse Canyon Mouse Swift Fox Vagrant Shrew Idaho Pocket Gopher Great Basin Pocket Mouse Plains Pocket Mouse Silky Pocket Mouse Olive-backed Pocket Mouse Hispid Pocket Mouse Spotted Ground Squirrel Western Heather Vole Prairie Vole Least Weasel	**NSS4**	**NSS5**
3. Species is widely distributed; population status and trends within Wyoming are assumed stable.	**NSS3** Little Brown Myotis Big Brown Bat Western Small-footed Myotis Wolverine	**NSS4**	**NSS5**	**NSS6**
4. Populations are stable or increasing and not restricted in numbers and/or distribution.		**NSS5**	**NSS6**	**NSS7**

Source: Wyoming Game and Fish Department - Habitat Protection - 26 February 2002
Note: Only the 35 mammalian species in categories NSS1 - NSS3 are shown. There are 84 nongame and a total of 120 mammalian species in Wyoming.

Table P-6: Native Species Status (NSS) of Bird Species of Most Concern in Wyoming

	A. On-going significant loss of habitat	B. Habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance.	C. Habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance.	D. Habitat is stable and not restricted.
1. Populations are greatly restricted or declining-extirpation appears possible.	**NSS1** Common Loon	**NSS2**	**NSS3**	**NSS4**
2. Populations are declining or restricted in numbers and/or distribution-extirpation is not imminent.	**NSS2** Trumpeter Swan Bald Eagle Yellow-Billed Cuckoo	**NSS3** American White Pelican American Bittern Snowy Egret Black-crowned Night-Heron White-faced Ibis Caspian Tern Forster's Tern Black Tern Harlequin Duck Merlin Peregrine Falcon Long-billed Curlew Lewis' Woodpecker Ash-throated Flycatcher Western Scrub-Jay Juniper Titmouse Bushtit Scott's Oriole	**NSS4** Grasshopper Sparrow Baird's Sparrow McCown's Longspur Chestnut-collared Longspur Boblink	**NSS5**
3. Species is widely distributed; population status and trends are unknown but are suspected to be stable.	**NSS3** Ferruginous Hawk	**NSS4** Clark's Grebe Western Grebe Great Blue Heron Mountain Plover Upland Sandpiper Northern Goshawk Northern Pygmy-Owl Great Gray Owl Boreal Owl Burrowing Owl Black-backed Woodpecker Common Yellowthroat Veery American Redstart Orange-crowned Warbler Indigo Bunting Pygmy Nuthatch	**NSS5**	**NSS6**

	A. On-going significant loss of habitat	B. Habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance.	C. Habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance.	D. Habitat is stable and not restricted.
4. Populations are stable or increasing and not restricted in numbers and/or distribution	**NSS4**	**NSS5**	**NSS6**	**NSS7**

Ferruginous Hawk and Burrowing Owl

The inventory and monitoring protocol for these species is described in the raptor section (see Section 2.1.2.1).

Fish

Muddy, Fivemile, and Cottonwood Creeks will be sampled in the summer for identification of resident fish species. Fish samples will also be collected from two upstream reference sites for comparison with the affected areas. Sampling methods used will depend of the amount of water in the stream.

2.1.2.5 Other Inventory and Monitoring Measures

Additional inventory and monitoring measures may be applied, as specified, in annual reports.

The BIA or BLM will be responsible for keeping records of selected wildlife species observed during the course of their activities on the WRPA. The information collected will include observations of wildlife species, their numbers, location, activity, and other pertinent data as applicable.

2.2 PROTECTION MEASURES

The wildlife protection measures proposed are based on standard measures developed for oil and gas development in Wyoming (BLM 2000). Additional measures may be included and/or BIA or BLM may modify existing measures in any given year as deemed appropriate. These measures will be specified in annual reports. It is assumed that as the wildlife issues within the WRPA are further described and impacts identified, some protection measures may be removed, and others may be added. Operators will implement protection measures with assistance from and/or in consultation with the BIA. In addition, the BIA may modify these measures on a site-specific basis as deemed appropriate after completion of APD and ROW application field reviews. The principle protection measures for most wildlife species will be avoidance of sensitive/crucial habitats (e.g. big game crucial winter range, raptor nests, greater sage-grouse leks, etc.). However, numerous species- and project-specific measures may be implemented.

Additionally, general wildlife protection measures (see Table P-3) will likely benefit the majority of wildlife species found on and adjacent to the WRPA.

2.2.1 Raptors

The primary protection measure for raptor species on the WRPA will be avoidance of active/inactive nest locations during the breeding season. Active nests are defined as any raptor nest that has been used within the last three years. Depending on the timing of proposed construction and drilling activities, all surface-disturbing activities will be restricted from February 1 through July 31 within a 0.5 to 1.0 mile radius (depending upon species and site-specific conditions) of active, or occupied, as well as inactive, raptor nests and/or nesting territories (i.e., seasonal nest avoidance).

Exceptions to the timing stipulation may be made, based on field investigations of the nest at the time the exception was requested. In addition, well locations, roads, ancillary facilities, and other surface structures requiring repeated human presence will not be constructed within 825 feet of active raptor nests, except ferruginous hawk, where the restriction will be 1,200 feet. The seasonal buffer distance and exclusion dates may vary, depending on nest activity status, species, prey availability, natural topographic barriers, and line-of-sight distances. Actual nest buffers for each raptor nest will be established in annual reports.

Operators will notify the BIA and USFWS on WRIR, and WGFD on BOR surface, immediately if raptors are found nesting on or within 1,200 feet of project facilities. In addition, the Operators will assist the BIA in erecting artificial nesting structures (ANS's), as appropriate. The use of ANS's will be considered as a last resort for raptor protection. If nest manipulation or a situation requiring a "taking" of a raptor nest becomes necessary, a special permit will be obtained from the Denver USFWS Office, Permit Section. Permit acquisition will be coordinated with the USFWS Office in Cheyenne, Wyoming and will be initiated with sufficient lead time to allow for development of mitigation measures. Required corresponding permits will be obtained from the state (i.e., WGFD) office in Cheyenne. Consultation and coordination with the USFWS and the WGFD will be conducted for all protection activities relating to raptors.

If the Review Team determines that project activities could potentially affect raptor nesting on or adjacent to the WRPA, ANS's may be constructed at a rate of one to two ANS's per one impacted nest. Existing degraded raptor nests may also be upgraded/reinforced to minimize potential impacts. The BIA, USFWS, or WGFD will determine the number of degraded nests, up to two per project, based on site-specific conditions and requirements. This focuses on the overall decline of raptor nesting success and will occur if the Review Team determines that projects may be the cause for this decline. The location, design, and other pertinent data regarding ANS's or nests proposed for upgrading will be identified in annual reports. ANS's will be located within the nesting territory of potentially affected raptor pairs and outside of the line-of-sight or nest buffer of actively nesting pairs, where possible. Annual ANS maintenance activities will be completed after August 1 and prior to October 15 each year, as necessary. ANS's will be placed within the nesting territories of potentially affected raptor pairs at sites sufficiently removed from development activities to minimize or avoid potential adverse effects.

In cases where existing project features (e.g., well pads) are located within the nest buffers of active raptor nests, no maintenance activities requiring a work-over rig will be allowed during critical periods (i.e., early March through mid-June) unless an exception has been approved. The exact dates of exclusion will be determined by the USFWS or WGFD and will likely vary from year to year, depending on the species present and variations in weather, nesting chronology, and other factors.

No aboveground power line construction is expected with the proposed project, however, if any power lines are built, construction will follow recommendations of the Avian Power Line Interaction Committee (APLIC 1994, 1996) and Olendorff et al. (1981) to avoid collision and/or electrocution of raptors.

In the event that winter roost sites are identified, then construction, drilling, and other activities disruptive to wintering raptors are prohibited during the period of November 15 to April 30.

2.2.2 Big Game Species

There is no crucial winter range of big game species in the WRPA. Yearlong range is present within the WRPA for pronghorn antelope and mule deer. There is also limited habitat for elk within the WRPA. Only incidental observations have been reported for white-tailed deer and moose.

No road or pipeline ROW fencing is proposed for the project; however, if ROW fencing is required, it will be kept to a minimum, and the fences will meet BLM/WGFD standards for facilitating wildlife movement. Wildlife-proof fencing will be used only to enclose reclaimed areas where it is determined that wildlife species are impeding successful vegetation establishment. Snow-fences, if used, will be limited to segments of 0.25 mile or less. Project personnel will also be advised to minimize stopping and exiting their vehicles in big game winter habitat while there is snow on the ground. In addition, escape openings will be provided along roads in big game winter ranges as designated by the BIA or BLM to facilitate exit of big game animals from snow-plowed roads. Additional habitat protection/improvement measures may also be applied in any given year as directed by the BIA or BLM, in consultation with the Operators and other agencies, and specified in annual wildlife reports.

Increased human access within the WRPA may lead to increased poaching of big game animals. Potential increases in poaching may be reduced through employee and contractor awareness/education programs regarding wildlife laws. If violations are discovered on the WRPA, Operators will immediately notify the BIA.

2.2.3 Threatened and Endangered Species

USFWS consultation and coordination will be conducted for all protection activities relating to threatened and endangered species and their habitats, as needed. Where possible, these actions will be specified in advance in the annual reports. The terms and conditions of the Biological Opinion (BO) prepared by the USFWS will be followed.

Black-footed Ferret

All prairie dog colonies on the WRPA will be avoided, where practical. If prairie dog colonies of sufficient size and burrow density for black-footed ferrets are scheduled to be disturbed, then black-footed ferret surveys of those colonies will be conducted pursuant to USFWS determinations made during informal consultations. Survey protocol will adhere to USFWS guidelines as established by the USFWS (1989) and will be conducted by the USFWS, or USFWS-qualified biologist, within one year of the proposed disturbance. Reports identifying survey methods and results will be prepared and submitted to USFWS in accordance with Section 7 of the Endangered Species Act of 1973, as amended, and the Interagency Cooperation Regulations.

If black-footed ferrets are found on the WRPA, the USFWS and BIA will be notified immediately and consultation with the USFWS will be initiated to develop strategies that ensure no adverse effects to the species occur. All activities will be stopped, and authorization to proceed must be received from the BIA, in consultation with the USFWS, before ground-disturbing activities are reinitiated in black-footed ferret habitat, (BLM 2000).

Bald Eagle

No surface disturbing activities are permitted between February 1 and July 31 within one mile of bald eagle nests (see raptor protection measures in Section 2.2.1). Although no bald eagle nests have been identified within the WRPA and one-mile buffer, the timing restrictions apply to all raptor nests.

Grizzly Bear

Grizzly bear sightings in the vicinity of the WRPA are rare. The Wyoming Grizzly Bear Management Plan (2002) recommends monitoring of major grizzly bear food sources and continued consultation with land management agencies and private land owners on issues related to grizzly bear habitat protection, disturbance, and mitigation.

Radio telemetry studies have identified roads as a major factor in habitat deterioration and increased mortality of grizzly bears (WGFD 2002). The USFWS seeks to influence agencies to maintain average road densities of one mile or less per square mile of habitat. This goal has been demonstrated to meet the needs of a variety of wildlife, while maintaining reasonable public access. If a change in road management is warranted based on knowledge gained as grizzly bears reoccupy areas, it should be developed and implemented by land management agencies.

Gray Wolf

In the final rule on nonessential, experimental populations of the gray wolf (Federal Register 1994:60260), the USFWS encouraged states and Tribes to define unacceptable wolf impacts to ungulate populations. Upon approval of the draft Wyoming Wolf Management Plan by the USFWS, the state will have the option to translocate or kill wolves in areas where ungulates are negatively impacted. It is not anticipated that wolves will cause excessive predation on ungulates, in most circumstances. However, some wintering elk, deer, moose and bighorn sheep sub-populations in winter ranges or winter feed grounds or near cattle feed lines could be susceptible to wolf predation. Management action may then be necessary, under specific conditions.

Mountain Plover

Mountain plover habitats (e.g., cushion plant communities, playa lakes, flat areas with vegetation <4 inches in height) will be avoided where practical, and where these habitats will be disturbed, reclamation will utilize procedures designed to reestablish suitable plover habitat. No surface disturbing activities will be conducted within suitable mountain plover habitat on the WRPA during the breeding and nesting periods between April 10 and July 10. Additional protection measures listed in Addendum P-2 will be attached to individual APD's and ROW's, for those projects that include well pads, access roads, and reserve pits that occur in occupied habitat areas.

Exceptions to construct during the timing stipulation period may be granted provided that the *Mountain Plover Survey Guidelines* (USFWS March 2002) are followed. If an active mountain plover nest is observed within survey areas, planned development activities will be delayed at least 37 days or one week post-hatching. If a brood of flightless chicks is discovered, planned activities will be delayed at least seven days.

Canada Lynx

Since there is no habitat or prey species of the Canada lynx in the WRPA, it is unlikely that protective measures would be necessary.

2.2.4 Wyoming Sensitive Species

The sensitive mammal and bird species that have been identified in the State of Wyoming are listed in Tables P-5 and P-6. In order to protect these species, construction an drilling activities may be restricted during certain times during the breeding season, and for a specific distance from nesting areas of these species, as appropriate

Avoidance of sensitive habitats will be accomplished in consultation and coordination with the USFWS on the WRIR and the WGFD on BOR and state lands. Activities will be delayed until such time that no adverse effects will occur (e.g., after fledging). It is assumed that the protocol specified for general wildlife will likely benefit sensitive species as well. If any agency (i.e., BLM, WGFD, USFWS) identifies a potential for impacts to any sensitive species, additional measures may be implemented, as specified in annual reports.

Greater Sage-grouse

A NSO (no surface occupancy) restriction will apply within 0.25 miles of greater sage-grouse leks. In addition, powerlines will not be constructed within 0.6 miles of any lek, as necessary to protect leks from raptor predation. To protect nesting greater sage-grouse, Operators will restrict construction activities between March 1 and June 30 within a two mile radius of an identified greater sage-grouse lek and associated nesting habitat. In addition, construction, drilling, and other activities potentially disruptive to wintering greater sage-grouse are prohibited during the period of November 15 to April 30 for the protection of winter concentration areas (BLM 2000).

Ferruginous Hawk, Peregrine Falcon, and Burrowing Owl

The protection protocol for the ferruginous hawk, peregrine falcon, and burrowing owl would be the same as described for other raptors (see Section 2.2.1). Additional measures will be applied on a species- or site-specific basis, as deemed appropriate by the USFWS and/or WGFD and specified in conditions of approval for individual APD's/ROW's. To protect nesting and brood-rearing burrowing owls, construction, drilling, and other activities will be restricted between February 1 and July 31, or until young are fully fledged.

2.2.5 General Wildlife

Unless otherwise indicated, the following protection measures will be applied for all wildlife species not specified above. Additional measures primarily designed to minimize impacts to other WRPA resources (e.g., vegetation and surface water resources, including wetlands, steep slopes, etc.) are identified in the EIS and these measures may provide additional protection for wildlife. These actions will be specified in annual reports. All roads on and adjacent to the WRPA that are required for the proposed project will be appropriately constructed, improved, maintained, and posted to minimize potential wildlife/vehicle collisions and facilitate wildlife (most notably big game) movement through the WRPA. Appropriate speed limits will be adhered to on all WRPA roads, and Operators will advise employees and contractors regarding these speed limits.

To protect important habitat in areas with sagebrush greater than three feet tall, wells and facilities will avoid this habitat, where possible. Additional non-species specific wildlife mitigation includes the following:

- Reserve, work-over, and flare pits and other locations potentially hazardous to wildlife will be adequately protected by netting and/or fencing to prohibit wildlife access.

- No surface water or shallow ground water in connection with surface water will be utilized for the proposed project.

- If dead or injured raptors, big game, migratory birds, or unusual wildlife are observed on the WRPA, Operator personnel will contact the appropriate BIA and WGFD offices.

- Operators will implement policies designed to control poaching and littering and will notify all employees (contract and company) that conviction of a major violation could result in disciplinary action. Contractors will be informed that any intentional game law violation or littering within the WRPA could result in dismissal.

2.3 COMBINATIONS OF WILDLIFE CONCERNS

Based on existing data sources, the primary wildlife resources known to be present within the WRPA were mapped (Figures 3.8-1 to 3.8-6 and 3-9.1 to 3.9-3). These resources include: big game habitat, raptor nests, upland game bird habitat, neotropical migratory bird habitat, mountain plover habitat, potential sage grouse habitat, and white-tailed prairie dog colonies. Figure 4.8-1 identifies the locations in the WRPA where important species' habitats overlap. Additional mitigation may be required in areas where those resource concerns overlap. The maximum number of potential wildlife concerns located within a single section is five and occurred in only seven sections (T4N:R2E, Sections 3, 4, 8, 9, 10, 16, and 17). Sections with the most wildlife concerns were generally located in the northwest portion of the WRPA. The southern and eastern portions of the WRPA tended to have fewer sensitive wildlife resources present. The more wildlife resources that are present within a section the greater the potential for impacts from disturbance. Therefore, when 4-5 wildlife resource concerns are present with a section, the BIA may consider a reduction in the number of well locations allowed within that section if well placement does not adequately avoid the resource concerns within the section. If this approach is followed, significant impacts are not expected. This approach provides the Operators with beneficial information that can be utilized when developing gas well placement plans. Planned placement of disturbances may be used to avoid individual wildlife resource concerns, or overlapping concerns present within a section. All appropriate mitigation measures for the corresponding wildlife resources that are disturbed within a section would be implemented.

REFERENCES

Avian Power Line Interaction Committee (APLIC). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D.C. 78 pp. + append.

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Bureau of Land Management. May 2000b. Record of Decision Environmental Impact Statement Continental Divide/Wamsutter II Natural Gas Project, Sweetwater and Carbon Counties, Wyoming. Rawlins and Rock Springs Field Offices. Rawlins and Rock Springs, Wyoming. BLM/WY/PL-00/018+1310.

Bureau of Land Management. April 9, 2001b. Issuance of BLM (Wyoming) Sensitive Species Policy and List. Instruction Memorandum No. WY-2001-040. Expires 9/30/2002.

Buys & Associates, Inc. (B&A). 2003a. Preliminary Wildlife Habitat Evaluation of Tom Brown, Inc.'s Wind River Natural Gas Development Project. Littleton, Colorado.

Buys & Associates (B&A). 2003b. White-tailed Prairie Dog *(Cynomys leucurus)* Survey for Tom Brown, Inc.'s Wind River Natural Gas Development Project. Littleton, Colorado.

Call, M.W. 1978. Nesting Habitats and Surveying Techniques for Common Western Raptors. U.S. Department of the Interior, Bureau of Land Management, technical Note No. 316. 115 pp.

Grier, J.W., and R. W. Fyfe. 1987. Preventing Research and Management Disturbance. Pages 173-182 In B.A.G. Pendleton, B.A. Milsap, K.W. Cline, and D.M. Bird, editors. Raptor Management Techniques. Institute of Wildlife Research, National Wildlife Federation, Scientific and Technical Series No. 10 420 pp.

Olendorff, R.R., A.D. Miller, and R.M. Lehman. 1981. Suggested Practices for Raptor Protection On Power Lines: The State of the Art in 1981. Raptor Research Report No. 4, Raptor Research Foundation, Inc. University of Minnesota, St. Paul. 111 pp.

U. S. Fish and Wildlife Service. 1989. Black-footed Ferret Survey Guidelines for Compliance with the Endangered Species Act. U.S. Department of the Interior, Fish and Wildlife Service, Denver, CO and Albuquerque, NM. 15pp.

U. S. Fish and Wildlife Service. 2002. Mountain Plover Survey Guidelines. U.S. Fish and Wildlife Service, Cheyenne, Wyoming. 7 pp.

Wyoming Game and Fish Department. 2003. Wyoming Gray Wolf Management Plan. November 2002.

Wyoming Game and Fish Department. 2002. Wyoming Grizzly Bear Management Program. Prepared by D. Moody, D. Hammer, M. Bruscino, D. Biornlie, R. Grogan, and B. DeBolt. 2002.

ADDENDUM P-1:
EXAMPLE DATA SUMMARY TABLES AND FORMS

ADDENDUM P-2: MOUNTAIN PLOVER SURVEY GUIDELINES AND ADDITIONAL STIPULATIONS

ADDENDUM P-3:
BLM WYOMING SENSITIVE SPECIES
POLICY AND LIST

APPENDIX Q
VISUAL RESOURCES

THE STATE OF WYOMING

Dave Freudenthal
GOVERNOR

Department of Environmental Quality

Herschler Building ● 122 West 25th Street ● Cheyenne, Wyoming 82002

ADMINISTRATION	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZARDOUS WASTE	WATER QUALITY
(307) 777-7758	(307) 777-6145	(307) 777-7391	(307) 777-7368	(307) 777-7756	(307) 777-7752	(307) 777-7781
FAX 777-7682	FAX 634-0799	FAX 777-5616	FAX 777-6937	FAX 634-0799	FAX 777-5973	FAX 777-5973

Authorization to Discharge Storm Water Associated
Large Construction Activities
Under the National Pollutant Discharge Elimination System

In compliance with the provisions of the Federal Water Pollution Control Act and the Wyoming Environmental Quality Act,

Tom Brown, Inc.

Tribal Sand Mesa #26-41

Various sections, Township 4 North, Range 4 East, W.R.M., Fremont County

and located within the State of Wyoming which has or may discharge storm water associated with Construction Activities, is hereby authorized to discharge to the surface waters of the State of Wyoming in accordance with the requirements of this permit which was issued June 1, 2002.

Coverage under the general permit expires August 31, 2006.

This facility has been assigned **permit authorization number WYR101819**

Authorization under this general permit is effective beginning 4/22/2003.

Attached is a signed copy of the general permit.

If you have questions concerning the conditions of the permit, contact Barb Sahl at (307) 777-7570 or Leah Krafft at (307) 777-7093.

Marlies L Nelson

Authorized Signature
Department of Environmental Quality/Water Quality Division

Mailing Address:
Tom Brown, Inc.
Brant Gimmeson
555 17th Street, Suite 1850
Denver, CO 80202-3918

NOTICE OF INTENT
TO REQUEST DISCHARGE AUTHORIZATION FOR STORM WATER
FROM LARGE CONSTRUCTION ACTIVITIES
(Under General Construction Storm Water Permit WYR10-0000)

1. Name, address, and telephone number of the construction site operator. This is the company, individual, or organization that has day to day supervision and control of activities occurring at the construction site and which will be the permittee:

Name: Tom Brown, Inc.

Address: 555 17th Street, Suite 1850

Denver, Colorado 80202

Telephone: 303-260-5000 Fax: 720-946-5430

2. Name, legal description, and county of the project for which this notice is being filed (for linear projects give location at each end of the construction area):
Note that a project location using section, township, and range OR a street address is required.
Project Name: Tribal Sand Mesa #26-41

Quarter: NE Section: 26 Township: 4N Range: 4E W.R.M. County: Fremont

If this is a linear project add ending location. If more space is needed attach additional sheet(s):

Quarter: SW *Section:* 24 *Township:* 4N *Range:* 4E W.R.M. *County:* Fremont

Street Address (If applicable): ______

Latitude and longitude to the nearest 15 seconds (optional): N43d 18'02.8 W108d21'54.0"

3. If this is a WYDOT project, list project number(s): ______

4. Briefly describe the project. The project consists of a drilling location (3.4 acres max. disturbance), 321 feet of new access road, 2717 feet of gas pipeline.

5. Date construction is planned to start: 5-31-03 Date construction is planned to end: 7-20-03

6. The surface area that will be disturbed during the construction project is approximately 4.0 acres.

7. Name of the nearest defined drainage(s) which could receive runoff from the construction project, whether it contains water or not. Include bodies of water such as lakes and wetlands where applicable.

Muddy Creek

8. Will storm water discharge from the project enter a municipal storm sewer? no What municipality? ______

To what water body does the storm sewer discharge?

______

______

9. Has a "Storm Water Pollution Prevention Plan," following the guidelines presented in the general construction storm water permit (WYR10-0000), been prepared for the construction project?

☒ Yes ☐ No

Please note that the SWPPP is a permit requirement and you will not be issued coverage under the general permit unless you answer yes to this question.

10. Attach a site map that shows the boundaries of expected land clearing. Indicate storm water drainage patterns on the map *or* include a topographic map that includes the locations of nearby drainages, water bodies, and/or municipal storm sewers.

11. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Brant Gimmeson	Environmental/Safety Manager
Printed Name of Person Signing	Title

[signature]	4-10-03	303-260-5000
Signature of Applicant	Date	Telephone

Section 35-11-901 of Wyoming Statutes provides that:

"Any person who knowingly makes any false statement, representation, or certification in any application . . . shall, upon conviction, be fined not more than ten thousand dollars ($10,000) per day for each violation or imprisoned for not more than one (1) year, or both."

Mail this application to:
NPDES Permits Section
DEQ/WQD
Herschler Bldg. - 4 W
122 West 25th Street
Cheyenne, WY 82002

DEQ use only:

Outfall: SW

River Basin: ______

Stream Class: ______

City Code: ______

Basin Code: ______

HUC: ______

/pjb 2-0927-doc

Storm Water Pollution Prevention Plan
Tom Brown, Inc.
Tribal Sand Mesa #26-41
NENE Section 26 T4N R4E W.R.M.

Project Description

Tom Brown, Inc. is constructing the Tribal Sand Mesa #26-41 Facility located in Fremont County, Wyoming which is associated with oil & natural gas well drilling, completion and production facilities.

The general construction sequence of the facility will consist of:

- Clear topsoil, grade and fill the project areas level, and clear and grade right-of-way
- Reserve pit construction
- Move in drilling equipment and drill oil & gas well
- Remove all drilling equipment and move in completion equipment to complete well
- Remove all completion equipment and install semi-permanent production equipment
- Re-seed/reclaim the remaining disturbed area to restore area to previous or better condition.

Total project area for the Facility is approximately 4.0 acres maximum disturbance. The area of the construction disturbance will be approximately 3.3 acres.

A low sage brush/bunch grass community, with abundant prickly pear cactus, characterizes vegetation. Surface vegetation covers an estimate 10-15% of the surface.

The most common substances that could be spilled within the project area are: 1) diesel fuel and gasoline used to fuel construction equipment and vehicles 2) lubricating oils used by construction equipment 3) Drilling mud, a bentonite mud used to drill and condition the hole 4) Produced Water and 5) Condensate

No non-storm water components of storm water discharge are anticipated.

The receiving water bodies for surface water drainage from the Facility will be the Muddy Creek in the area of Section 26, T37N-R89W.

SITE MAPS

A topographic map of the area surrounding the Facility is presented as Figure 1 and shows the Facility in relation to surrounding topographic features.

Best Management Practices for Storm Water Management

Erosion and Sediment Controls

Erosion control will be accomplished through a combination of construction techniques, vegetation, and structural features.

Non-Stuctural Practices

Run off will be directed into areas of low gradient with vegetative cover. Where possible vegetation will be cut flat without disturbance to the root bed. Permanent seeding will be the major stabilization practice for minimizing erosion and sediment transport. Mulch will be utilized in reclaimed areas. Along pipeline right of ways vegetation will be cut flat without disturbance to the root bed.

Structural Practices

Structural practices will be implemented as the need arises. Due to the topographic nature of the project the need for structural practices is not apparent at this time.

Implementation of Structural Practice

Additional structural practices will be developed as the need arises. These may include silt fences, straw bale dikes or equivalent sediment controls installed so as to protect down slope surface waters, wetlands and roads from sediment flow due to runoff from a storm event.

All grade surfaces, walls, and structures, vegetation, erosion and sediment control measures and other protective devices identified in the site plan will be maintained, repaired and restored as necessary.

INSPECTION

Active Construction sites. During construction, qualified personnel (provided by the permittee) shall inspect disturbed areas, control measures, and locations at least once every 14 calendar days and within 24 hours of any precipitation and/or snow melt event which exceeds 0.5 inches.

Inactive Construction sites. During seasonal shutdowns and during the period following completion of construction, but prior to return of the site to "finally stabilized" conditions and termination of coverage under this permit, qualified personnel (provided by the permittee) shall inspect the site at least once every month. After reclamation has been initiated inspections will be conducted at least every 30 calendar days and within 24-hours of any precipitation event exceeding 1.0 inches prior to completing reclamation (70% of pre-construction vegetation).

The operator shall keep a record of inspections. Uncontrolled releases of mud or muddy water or measurable quantities of sediment found off site shall be recorded with a brief explanation as to the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site.

BMPs shall be assessed to determine if they are functioning properly or if they are in need of repair or maintenance. If the report describes deficiencies in pollution control structures or procedure, such deficiencies shall be corrected immediately. A brief description of measures taken to correct deficiencies shall be recorded.

When an inspection does not identify any incidents of non-compliance, the report shall contain a certification that the site is in compliance, with the SWPPP and this permit.

The date, time, and inspector identity should also be recorded. This record shall be signed in accordance with Part VII.G of the permit and made available to the Administrator upon request.

Maintenance

Maintenance will be the responsibility of the Company. Maintenance will be performed on an as-needed basis based upon the results of inspections conducted at the site.

FINAL STABILIZATION AND LONG-TERM STORM WATER MANAGEMENT

Unless otherwise directed by the landowner reclamation will be conducted as specified by the operator and the BLM under the terms and conditions of the Application for Permit to Drill Surface Use Plan and BLM conditions of approval for the subject Permit to Drill.

TOM BROWN, INC.

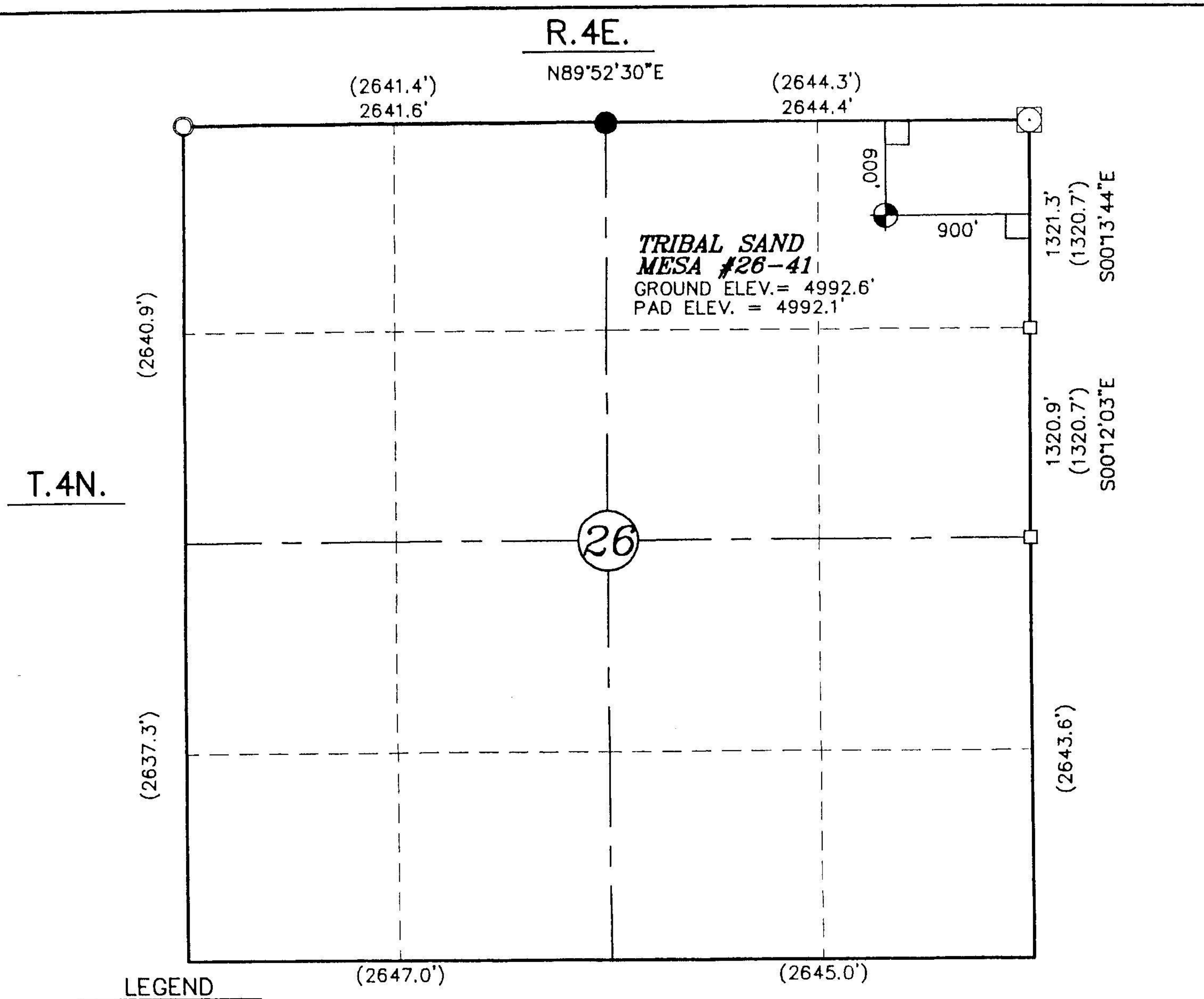
WELL LOCATION

TRIBAL SAND MESA #26-41

LOCATED IN NE1/4NE1/4, SECTION 26, T.4N., R.4E., W.R.M. FREMONT COUNTY, WYOMING

BASIS OF ELEVATION

ELEVATION BASED UPON USGS BENCHMARK "VS 75" LOCATED IN SE1/4SE1/4, SECTION 13, T.3N., R.3E., W.R.M., RECORD ELEVATION 5299.9'



LEGEND

- WELL LOCATION
- EXISTING 2" DIA. IRON PIPE SET IN CONCRETE
- EXISTING 2-1/2" DIA. ALUMINUM CAP SET ON USBR MONUMENT
- EXISTING 3/4" SQUARE TOPPED USBR REBAR
- 2-1/2" ALUMINUM CAP SET, PLS 8972
- ( ) - DENOTES RECORD DATA

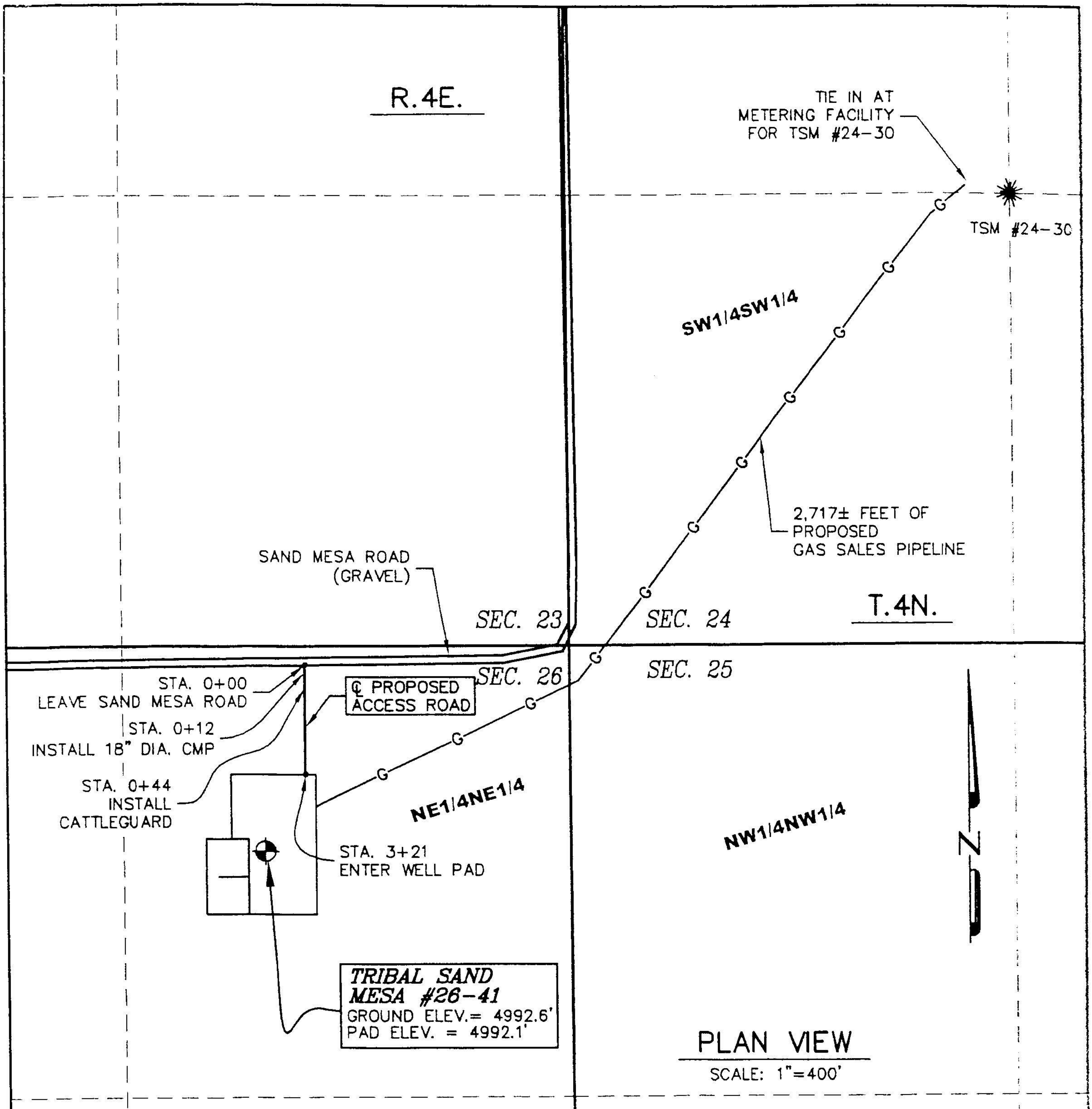
STATE OF WYOMING } S.S.
COUNTY OF FREMONT }

I, THOMAS A. JOHNSON, DO HEREBY CERTIFY THAT THIS MAP WAS PREPARED FROM NOTES TAKEN DURING AN ACTUAL SURVEY MADE BY MYSELF AND THAT IT CORRECTLY SHOWS THE LOCATION OF THE DRILLING SITE AS STAKED ON DECEMBER 5, 2002.

Professional Land Surveyor — Thomas A. Johnson 8972 — WYOMING — Date: 12/7/02

SHEET 1 OF 7

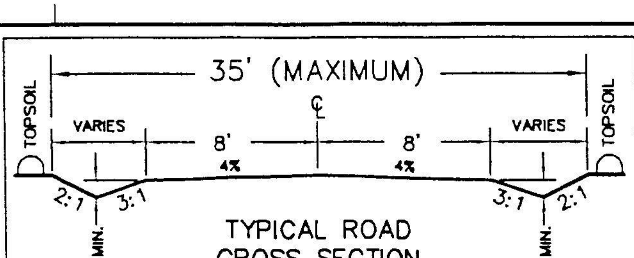
APEX SURVEYING, INC. *ENGINEERING AND LAND SURVEYING*	407 West Adams Avenue, Box 1751 Riverton, Wyoming 82501 (307)856-1647	Job: 02349 Bk: 173 & GPS Pg: 4	LAT: N43°18'02.8" LONG: W108°21'54.0" SOURCE: STATE PLANE	FIELD: 12/3/02, 12/5/02 OFC: 12/7/02 REVISED:



PLAN VIEW

SCALE: 1"=400'

SHEET 7 OF 7



TYPICAL ROAD
CROSS SECTION
NOT TO SCALE

TOM BROWN, INC.

ACCESS ROAD AND GAS PIPELINE

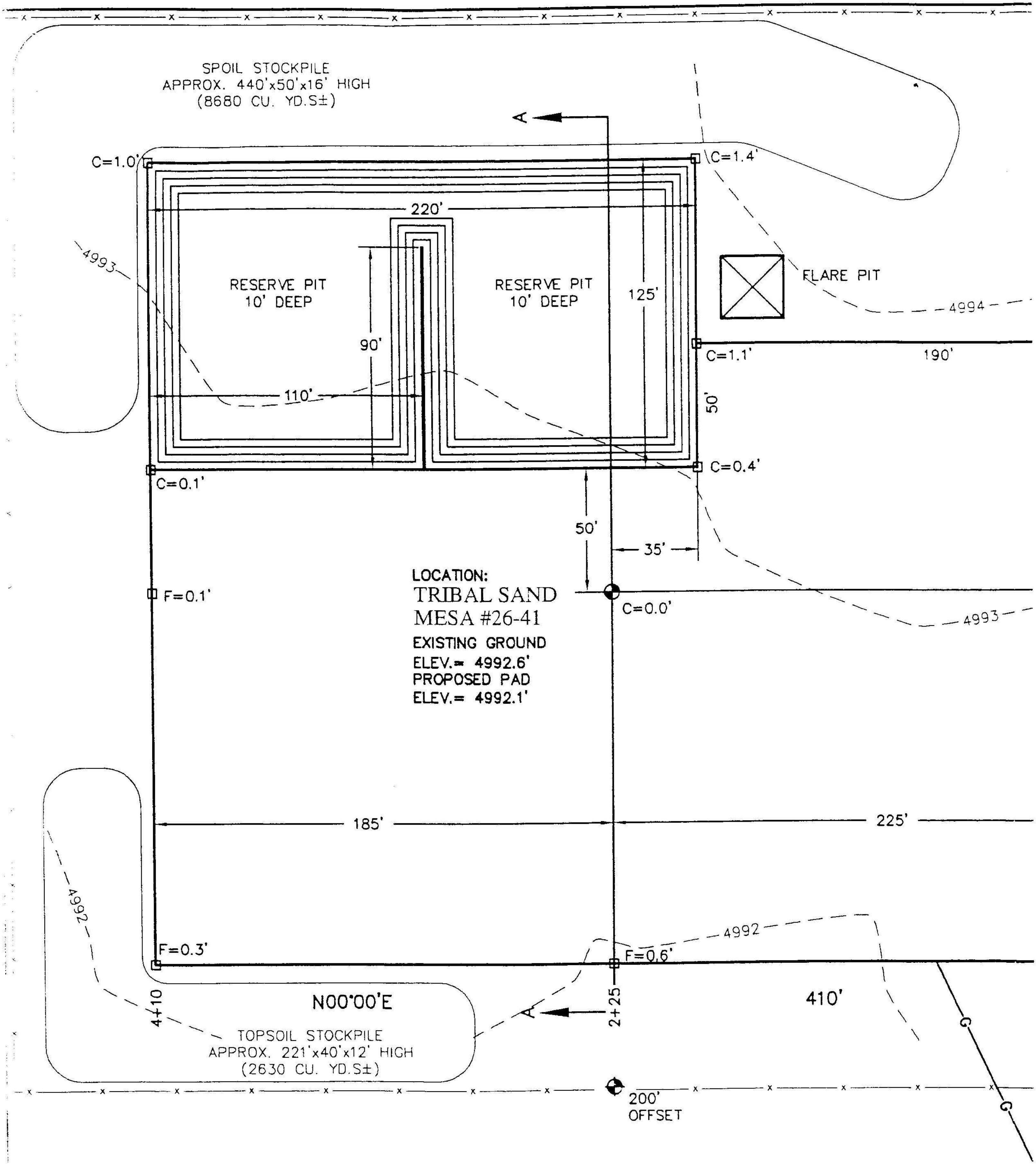
TRIBAL SAND MESA #26-41

NE1/4NE1/4, SECTION 26,
T.4N., R.4E., W.R.M.,
FREMONT COUNTY, WYOMING
600' FNL, 900' FEL

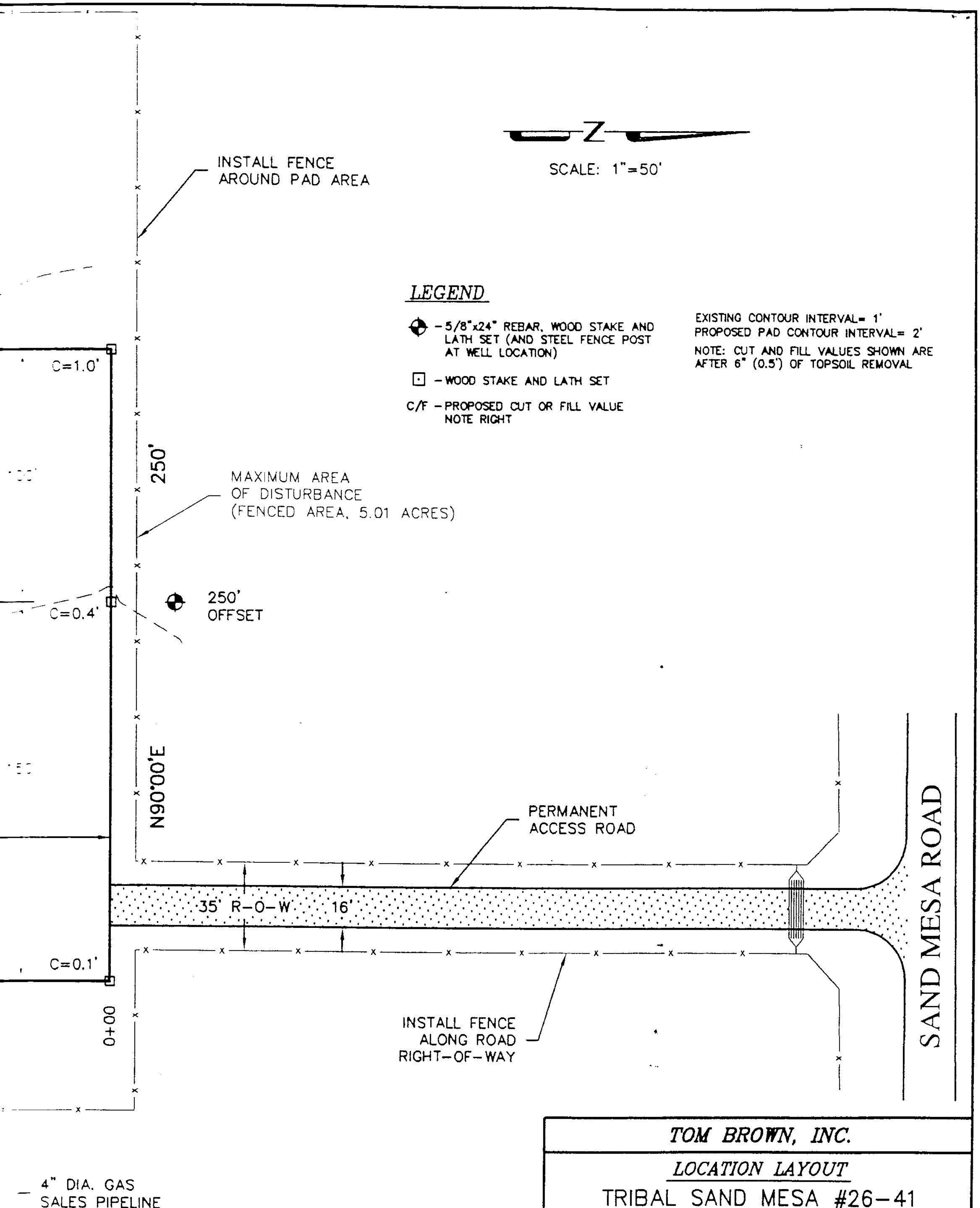
APEX SURVEYING, INC.
ENGINEERING AND LAND SURVEYING

407 West Adams Avenue, Box 1751
Riverton, Wyoming 82501
(307)856-1647

Job: 02349
Bk: 173 & GPS
Pg: 4



APEX SU
ENGINEERING A



SHEET 3 OF 7

EYING, INC.
LAND SURVEYING

407 West Adams Avenue, Box 1751
Riverton, Wyoming 82501
(307)856-1647

Job: 02349
Bk: 173 & GPS
Pg: 4

TOM BROWN, INC.

LOCATION LAYOUT

TRIBAL SAND MESA #26-41

NE1/4NE1/4, SECTION 26,
T.4N., R.4E., W.R.M.
FREMONT COUNTY, WYOMING
600' FNL, 900' FEL