CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

MONTANA

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Introduction

This chapter presents the environmental impacts from management actions described in Chapter 2. The descriptions of predicted effects that would result from the exploration, construction, operation and maintenance, and abandonment activities associated with coal bed methane (CBM) for each alternative is compared to the pre-project environment. The method of recognizing impacts and accomplishing a systematic impact analysis are in accordance with the Council of Environmental Quality (CEQ) guidelines, which address procedures on applying the National Environmental Policy Act (NEPA). The duration of the impacts are analyzed and described as either short-term (up to 5 years) or long-term (greater than 5 years).

Chapter 4 contains an *Introduction, Analysis Assumptions, and Guidelines* section, individual Resource Topic discussions and a *Comparison Table for Alternative Impacts*. The *Introduction* outlines the chapter and provides an explanation of the organization and creation of assumptions. The *Analysis Assumptions and Guidelines* section presents the Reasonable Foreseeable Development scenario (RFD) used to predict the level of CBM development and addresses the analysis assumptions common to all alternatives. The Resource Topic discussions are organized alphabetically. Under each resource topic, the following are addressed: assumptions, impacts from management common to all alternatives, and impacts from management specific to each alternative.

Impacts from management of conventional oil and gas are found in the *Impacts From Management Common to All Alternatives* sections. Impacts from management of CBM are found in the *Impacts From Management Specific to Each Alternative* sections.

The narrative describing the impacts from management specific to each alternative includes subsections summarizing the impacts to the Crow and Northern Cheyenne Tribes, mitigation measures and a conclusions summary. The conclusion summarizes the cumulative impacts from other regional ongoing and foreseen projects.

Cumulative impacts consider the alternative in combination with other substantial existing and future developments in and near the CBM emphasis area, including oil and gas development projects, existing and future coal mines, the Tongue River Railroad project, new power plants, and effects from Wyoming's CBM development. Project descriptions for activities considered in the cumulative impacts analysis are presented in the *Minerals Appendix* under Oil and Gas. Mitigation measures that are not already included as part of the alternative or alternatives are described and evaluated, and the residual impacts are determined.

The resource discussions also address the differences between U.S. Bureau of Land Management (BLM) and State of Montana (state) impacts where divisions are meaningful. Physical impacts on landscapes from development disturbances can easily be quantified for BLM and state regulated wells; however, effects on watersheds or wildlife from both BLM and state development cannot easily be distinguished and therefore are discussed in conjunction.

Analysis Assumptions and Guidelines

Analysis assumptions and guidelines provide common data to EIS team members to use when conducting the environmental assessments for each resource. The assumptions and guidelines are based on previous events, experience of personnel, and their knowledge of the resources in the planning area. The assumptions include the demand for various resources, the ability of the resources to meet the demand, and how the actions will be carried out. An RFD was developed for this purpose and is discussed in the following sections.

Potential for Development—Reasonable Foreseeable Development Scenario

The RFD addresses potential development of all owners, including the Crow and Northern Cheyenne Indian reservations and the Ashland Ranger District of the U.S. Forest Service (USFS). The RFD is in no way stating that the BLM or the State of Montana are making decisions for Indian lands or the USFS administered lands. For example, the decision to develop CBM on Indian lands will be made by the Indian allottees, and the tribes with concurrence of the Bureau of Indian Affairs (BIA), not by BLM or the state.

The presumption of possible impacts to the environment is based on BLM guidance (BLM H-1624-1) provided for estimating the potential for oil and gas resources and for extrapolating the degree of development that is reasonably foreseeable over a

given period of time. In the case of Montana's Powder River Basin and additional areas of emphasis, it is the level of CBM development most likely to occur over the next 20-year period. The RFD is located in the *Minerals Appendix*, under "Oil and Gas." The following sections contain explanations of 1) the potential for CBM resources within the emphasis area boundaries, and 2) RFD for the different detailed development scenarios that are addressed by the various alternatives in this EIS.

Potential for CBM Resources

An estimate of CBM and conventional oil and gas resources was accomplished using many sources of information, including established files and databases, the BLM resource management plans (RMPs) for the areas, coal information from the U.S. Geological Survey (USGS), professional and academic literature, available oil and gas maps, previous mineral assessments and expressions of interest, and projections from the oil and gas industry. To project CBM exploration and development, the areal extent of certain coals and the rank of coals in the CBM emphasis area were considered. Areas of subbituminous to bituminous coals were considered as the most likely to be explored and developed in Montana, although exploration and development has occurred mainly in subbituminous coal in the Wyoming portion of the Powder River Basin. The USGS produced a Open File Report (OF 96-92) showing the areas of coal, by rank, for the United States. This information indicates subbituminous and bituminous coals in many parts of the emphasis area. See Map MIN-1 in the *Minerals Appendix* for an illustration of this data and Map 4-1 for a geographical presentation of potential CBM development within Montana. Powder River, Rosebud, Custer, and Big Horn counties contain the northern part of the basin, which extends from Wyoming. Blaine and Musselshell counties have mostly subbituminous coal. Carbon County has an extension of the Big Horn Basin coal, which is ranked as bituminous coal. Gallatin and Park counties have scattered areas of bituminous to subbituminous coals. The amount of methane gas that could be produced from the coal beds in Montana has been projected to range from a low of 1 trillion cubic feet (TCF) (Crockett and Meyer 2001) to a high of 17.7 TCF (Nelson 2000). This and other information for Montana is used to predict where CBM exploration is most likely to occur in the emphasis area. The RFD predicts the number of CBM wells that would be drilled and completed during the next 20 years per alternative. By making these predictions, cumulative impacts can be assessed.

Reasonable Foreseeable Development Scenario

Projections of future CBM development and production are difficult to make. Several variables complicate such forecasts, including new exploration, development or production techniques; increases or decreases in demand for natural gas; and price increases or decreases that may prompt larger or smaller development and production programs. For this EIS, a combination of historical trends, present activity, government and industry estimates, and professional judgments were used in establishing the estimate of RFD. The RFD is discussed under two scenarios: restricted development and expanded development.

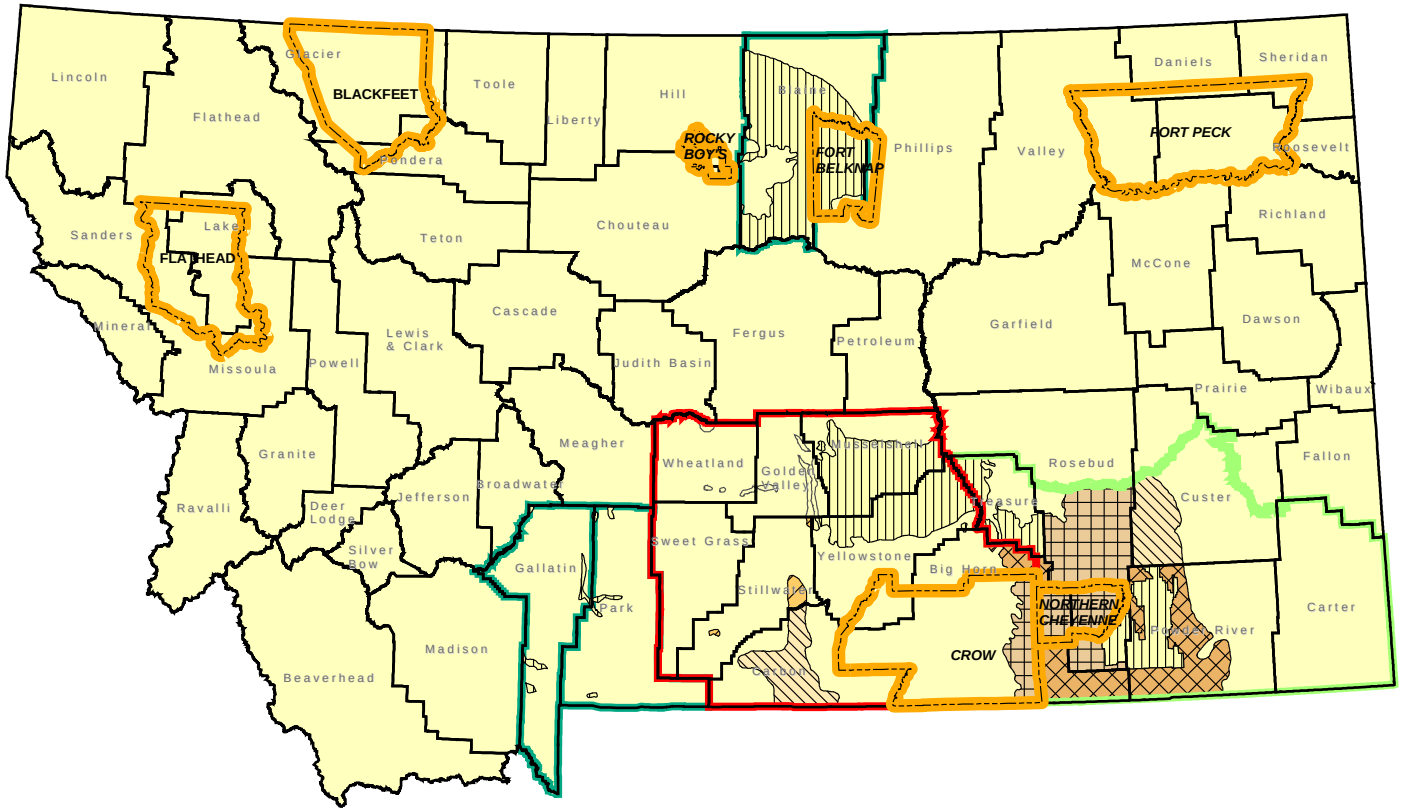
Restricted Development

Restricted development is applied to Alternative A. Under this scenario, the BLM would only approve exploration well permits and the state would only proceed with the development identified in the Stipulation and Settlement Agreement as presented in Chapter 2. With regards to the BLM exploration wells, an RFD of 200 wells per RMP area was assigned to provide a level of quantification for analysis; however, the BLM has no actual upper cap on issuing exploration well permits. The RFD number in no way represents a regulatory number for exploration wells that could be issued by the BLM. The 400 BLM exploration wells, combined with the state's limited development, results in a total of 675 exploration wells and 250 production wells assumed under Alternative A.

Expanded Development

Expanded development is considered for Alternatives B, C, D, and E. Expanded refers to the number of potential wells based on known coal volumes that would be drilled in the CBM emphasis area during the next 20 years, regardless of mineral ownership. Given the current oil and gas stipulations, the restricted development areas, and the unknown geographical distribution of coal bed methane, it is unlikely that the maximum well density of 1 well per producing coal seam per 80 acres would be achieved. Map 4-1 indicates the predicted number of wells per county overlying known coal occurrences. The estimate for expanded development ranges from 10,000 to 26,000 wells drilled, which includes a potential 4,000 wells for each of the Crow and Northern Cheyenne reservations. The Powder River RMP area could host as many as 7,500 to 14,000 producing CBM

Map 4-1: CBM Development Based on Reasonable Foreseeable Development Scenario



Legend

POTENTIAL CBM WELLS

- Minimal
- 1 - 150
- 151 - 400
- 401 - 700
- 701 - 4000
- 4001 - 7000

- Powder River RMP Area
- Billings RMP Area
- Special Consideration Counties
- Native American Reservations

1:5,000,000

64,000 0 64,000 128,000 192,000 Meters

30 15 0 30 60 90 Miles

N W E S

This map shows the maximum number of CBM wells as described in the Reasonable Foreseeable Development Scenario. NOTE: Development on this map has been confined to the regions with known sub-bituminous coal occurences.

DATA SOURCES:

Counties: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana.
Reservations: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana.
Development Data: BLM Reasonable Foreseeable Development Scenario.

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wells during the next 20 years. The RFD also estimated that between 200 to 800 new conventional oil and gas wells could be drilled in the Powder River RMP area during the same time period. In the Billings RMP area, an estimated 1,000 to 2,400 producing CBM wells could be installed. Conventional oil and gas wells are estimated to increase by 250 to 975 during this same time. The expanded estimate for the three counties outside the RMP areas suggested that from 18 to 50 CBM wells could be drilled (Blaine 3 to 10, Gallatin 5 to 15, and Park 10 to 25), along with 150 to 500 conventional oil and gas wells.

The expanded development estimate also predicted the number of potential field and sales compressors needed to export the gas. This level of development would require from 400 to 1,000 field compressors and from 50 to 100 sales compressors. Estimates for the gathering and sales lines are also included in the RFD.

Assumptions Common to All Alternatives

Assumptions common to all alternatives address issues such as level of disturbance associated with various development scenarios, implementation of best management practices (BMPs), general assumptions for percentages of alternative themes and numbers for various field equipment utilized, well spacing for production of CBM, and water discharge and drawdown rates for expanded development.

Assumptions represent the best professional judgment of the specialists based on past experience, similar studies reviewed, and on the known circumstances for the given situation. These assumptions are used to ground the analysis so that similar comparisons can be conducted across the various resource topics and throughout the alternatives.

Levels of Disturbance

In evaluating environmental impacts, criteria for determining quantitative impacts are required. Further, to facilitate some uniformity with respect to impact analyses, the following synopsis was prepared to give a general understanding of the resources necessary for the installation and production of a single CBM well.

These values were determined from a variety of sources, including previous CBM Environmental Assessments, discussions with BLM and state personnel, discussions with CBM operators, and information derived from the review of numerous applicable documents. However, actual references are not provided as these numbers were ultimately derived through internal analysis based on understanding of current and proposed CBM activities in Montana and other areas (including Wyoming, Colorado, New Mexico, Arkansas, Alabama, and Oklahoma).

The values presented in Table 4-1 can be scaled to accommodate the various scenarios being proposed for exploration, construction and operation phases.

The following descriptions outline the assumptions used to develop Table 4-1:

Well Sites

Construction = 0.25 acres based on a 105-foot by 105-foot pad for exploration, construction and drilling operations

Operations = 0.058 acres based on a 50-foot by 50-foot pad for operations, well pad size may increase if multiple wells are drilled on the same pad, but total acres of disturbance would be less than separate well pads for single wells

Access Roads

Two-track = 0.30 acres based on 12-foot-wide roads by 0.21 miles/well (this applies to both construction and operation)

Graveled Roads = 0.11 acres based on 12-foot-wide roads by 0.075 miles/well (this applies to both construction and operation)

Bladed Roads = 0.075 acres based on 12-foot-wide roads by 0.05 miles/well (this is for construction phase only)

Bladed Roads = 0.090 acres based on 12-foot-wide roads by 0.06 miles/well (this is for operation phase only)

Bladed Roads = 0.75 acres based on 12-foot-wide roads by 0.5 miles/well (this is for exploration only)

Utility Lines

Water = 0.35 acres based on 15-foot by 0.20 miles/well (construction only)

Elec. Utility Overhead = 0.20 acres based on 10-foot by 0.15 miles/well (construction and operation)

Elec. Utility Underground = 0.35 acres based on 15-foot by 0.20 miles/well (construction only)

Transportation Lines

Low Pressure Gas = 0.90 acres based on 15-foot by 0.5 miles/well (construction only)

Intermediate Pressure Gas = 0.25 acres based on 25-foot by 0.08 miles/well (construction only)

Battery Site

Construction and Operation = 0.5 acre per battery site. Assume one battery site per field compressor. Disturbance per well = (0.5/24) = 0.020

Access Roads = 0.15 acres based on 25-foot by 0.050 miles/well during construction and operations

Field Compressors = 1 compressor/24 producing wells

Sales Compressors = 1 compressor/240 producing wells or 10 field compressors

Plastic line = 0.5 miles/well pad. Assume 3 wells per pad, 25-foot width

Gathering line = 2.0 miles/field compressor at 25-foot width or (5280*2*25/24/43,560) = 0.25 acres/well

Sales line = 6.0 miles/sales compressor at 25-foot wide. (6*5280*25/240/43,560) = 0.075 acres/well

Produced Water Management

Assume 1 discharge point for every 20 wells

Discharge points construction = 0.01 acres/point based on 20-foot by 20-foot area during construction

Discharge points operations = 0.002 acres/ point based on 10-foot by 10-foot area during operations

Storage impoundments = 6 acres/impoundment during construction per well pod of 20 wells, assume one acre reclaimed from construction so 5 acres/impoundment during operation per pod of 20 wells

Total Area of Disturbance

Exploration = 1.0 acres/well

Construction = 3.25 acres/well

Operation = 2.0 acres/well

Field Rules and Leasing Stipulations

The discussion of impacts assumes that the leasing stipulations described for each resource would be successfully implemented in each of the alternatives regardless of land ownership or management classes to which they apply. Existing Lease Stipulations and mitigation measures (see *Minerals Appendix*) are considered to be standard operating procedures by BLM. The MBOGC implements restrictions analogous to stipulations through the issuance of field rules. Field rules are applied on a case-by-case basis to protect resources on state land and private land. The Montana Board of Oil and Gas Conservation (MBOGC) reviews each operator's development plan and then issues field rules. The MBOGC will provide guidance to private landowners if requested on how and what to include in their leases to protect resources, but it is up to the individual lessor as to what they request from the operator in terms of reclamation, mitigation, and other measures. The Montana Trust Land Management Division (TLMD) of the Montana Department of Natural Resources and Conservation (DNRC) also has lease stipulations for their minerals as listed in the *Minerals Appendix*. The TLMD utilizes a set of standard stipulations on all oil and gas leases that is different from those used by BLM. Additional stipulations are placed on the leases on a case-by-case basis prior to their being leased. In addition, the TLMD undertakes a site-specific review process for exploration and operating plan proposals. This review process generates site-specific stipulations for issues such as steep topography, wildlife, streams, wooded areas, rivers/lakes. It was assumed that only requirements contained in existing federal and state law that apply to private land ownership will be enforced on private land.

Stipulations and field rules are intended to avoid potential effects on resource values and land uses from oil and gas activities and include actions such as site clearances and occupancy and timing restrictions. Lease stipulations would be implemented before conducting exploration, production, and abandonment activities. The following discussion of project impacts assumes that applicable stipulations and field rules would be fully implemented and followed. The success of these stipulations or field rules in avoiding covered impacts, in some instances, will require collection of site specific information regarding the resources to be protected relative to exploration, production, and abandonment plans followed by strict adherence to the terms of the stipulations and field rules. Planned monitoring activities for all resources have been outlined in a table attached in the *Monitoring Appendix*. Impacts described include those that would occur in spite of the successful implementation of stipulations or field rules, or where stipulations or field rules are not expected to avoid all impacts.

TABLE 4-1
LEVEL OF DISTURBANCE

Facilities		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/Production Disturbance (acres/well)
Well Sites		0.25	0.25	0.05
Access Roads/ Routes to Well Sites	Two-track	N/A	0.30	0.30
	Graveled	N/A	0.10	0.10
	Bladed	0.75	0.075	0.10
Utility Lines	Water	N/A	0.35	----[1]
	Overhead Elec.	N/A	0.20	0.20
	Underground Elec.	N/A	0.35	----
Transportation Lines	Low Pres. Gas	N/A	0.90	----
	Intermediate Pres. Gas	N/A	0.25	----
Processing Area	Battery Site	N/A	0.020	0.020
	Access Roads	N/A	0.15	0.15
	Field Compressor	N/A	----	(0.5/24) = 0.02
	1/24 producing wells			
	Sales Compressor	N/A	----	(1.0/240) = 0.005
	1/10 Field Compressors			
	[2]Plastic Line	N/A	----	0.5
	Gathering Line	N/A	----	0.25
	Sales Line	N/A	----	0.075
Produced Water Management	Discharge Point	N/A	0.01	0.002
	Storage Impoundment	N/A	0.3	0.25
Total Disturbance		1.0	3.25	2.0

Note: This table shows levels of disturbance associated with exploration and development of CBM wells and field transfer equipment. All values represent acres per well unless otherwise noted.

[1]All utilities are completed underground and the land above is reclaimed so the acres of disturbance are removed from the operation column. **Note:** The intent of reclamation is to stabilize the area of disturbance and establish a vegetative cover similar to the native plant community that existed prior to disturbance. Reclamation success will vary as described in the Vegetation section.

[2]Lines within processing area are assumed to disturb an average width of 25 feet.

Proposed mitigation measures are intended to minimize the impacts that cannot be avoided. Mitigation measures also apply to all alternatives on BLM and state lands. Residual impacts are those expected to remain after the implementation of mitigation measures.

General Assumptions

General assumptions address the various alternative themes and apply numerical interpretations to the theme explanations. The following assumptions apply to each alternative:

- The spacing for CBM wells would be similar to CBM well spacing in Wyoming with one well per 80 acres per coal seam. Up to three coal seams have been identified for possible methane extraction in the Powder River Basin. This would result in three wells drilled per 80 acre spacing unit.
- The life of a typical CBM production well is assumed to be 20 years.
- It is assumed that a single CBM well will drain the methane from a single coal seam over an 80-acre unit. Research by the BLM in the Wyoming portion of the Powder River Basin suggests that drainage may be across a broader radius (Crockett and Meyer 2001). Drainage issues will need to be assessed on a case-by-case basis to determine the drainage radius, which will depend upon local reservoir parameters.
- The level of disturbance associated with a production well is the same regardless of the method of completion, whether a single well bore per coal seam or multiple seam completions in a well bore.
- Typical drilling operations for each CBM well, regardless of whether it was a CBM exploration or production well, would require 3 to 5 days with an additional 2 to 3 days for completion work. A maximum of 7 to 8 people would be present on a well at any one time during this construction phase.
- Approximately 8,000 gallons of water would be needed to drill each well. The water will be obtained from the local river, streams, wells, or reservoirs trucked into remote sites as needed.
- Equipment present at each well site during construction would consist of the following: one or two truck-mounted drill rig(s), with three men per rig; one backhoe; one blade; three crew pick-up trucks; one well logging truck; one pipe truck; two to four water trucks; one cement truck; one electrical generator trailer; one frac tank for waste water; and two large flat bed trailers. Not all vehicles would be at the well site at the same time or for the entire duration of drilling and completion operations.
- Portable toilets would be available at the drill sites. Garbage would be stored in closed containers. Sewage and solid waste would be hauled offsite to permitted disposal facilities.
- Each CBM well would be equipped with a submersible pump ranging from 3 to 20 horsepower, depending on well depth and other site conditions.
- Exploration wells would be visited once a day during testing and pumping operations. Pump tests could last as long as 6 months depending on the time required for measuring cumulative methane production estimates. Methane would be flared (burned off) continuously during the testing phase.
- Fuel for generators during exploration testing would be either gas (propane) or diesel and require at least one trip to the well site weekly. Small generators used during testing would be mobile, enclosed, and between 15 to 20 kW.
- A larger generator used during production would serve several wells (three to four) and be in the range of 75 to 125 kW.
- Under Alternatives B, C, and D, the number of exploration/dry holes would be approximately 10 percent of the total estimated wells drilled. Furthermore, all exploration/dry holes would be drilled in the first 5 years of development.
- Under Alternatives A and C, the number of wells connected to each compressor would be per operators plans; it is assumed that this is consistent with the RFD of 24 wells per compressor. This estimate is based on an average well production rate of 250,000 cubic feet per day methane being sent to a 6 million cubic feet per day, four-stage reciprocal compressor operating at 380 horsepower and using natural gas.
- Under Alternatives B and D, the number of wells connected to each compressor would be maximized; this is assumed to be approximately 35 wells at average production going to a 9 million cubic feet per day, four-stage reciprocal compressor. The maximization of well

connections would reduce the number of field compressor sites and air emissions.

- No hydraulic fracturing or cavitation would be required to stimulate wells; however, low-pressure, low-volume water enhancement may be used. This would involve flushing the well with a few hundred gallons of water to clean the face of coal surface in the exposed seam. This process does not fracture the coal; it simply cleans out the existing fractures.
- Under Alternatives B and D in the theme of CBM, multiple completions in a single borehole would be required. It is assumed that a small reduction in surface disturbance would be experienced, but that the levels of disturbance previously described are acceptable for these alternatives without alteration.
- Under *Lands and Realty*, when no transportation corridors are required, it is assumed that the utility lines (power, water, and gas) would be placed along separate routes, or in existing disturbances to and from the well site locations or compressor batteries, whichever is more suitable to the operator. When transportation corridors are required, it is assumed that they would be placed adjacent to access roads and along existing disturbances, resulting in a 35 percent reduction of disturbed surface areas.
- Concerning *Socioeconomics* it is assumed that the state would not enforce buffer zones on their minerals or on private minerals since they do not have a trust responsibility.
- The potential development on the reservations would be considered under the cumulative effects analysis based on the development outline in the RFD for the reservations.
- Under the *Hydrology* theme for Alternative B, untreated CBM water from exploration wells would be placed in tanks and disposed of at a permitted injection well. It is assumed that the use of pits, impoundments, and other holding facilities as permitted under Alternative A would be allowed. In addition, it is assumed produced water would be injected into a deeper aquifer of lesser quality with no communication to aquifers used as sources of drinking water or into coal seam aquifers.
- Under the *Hydrology* theme for Alternatives C and D, produced water would be available for beneficial use. It is assumed that industries and landowners would use approximately 20 percent of the produced water. The estimate of 20 percent is based on the observed beneficial uses at the CX Ranch, and in Wyoming and on the perceived potential for similar uses throughout the emphasis area.

Resource Topics

Air Quality and Climate

Assumptions

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (i.e., well operations, injection well and pipeline compressor engines, etc.), are potential causes of air quality impacts. These issues are more likely to generate public concern where natural gas development activities occur near residential areas. The Federal Land Managers (FLM), including the U.S. Department of Agriculture (USDA)—Forest Service (FS), the U.S. Department of the Interior (USDI)—National Park Service (NPS), and the USDI—U.S. Fish & Wildlife Service (FWS), have also expressed concerns regarding potential visibility and atmospheric deposition (acid rain) impacts within distant downwind Prevention of Significant Deterioration (PSD) Class I and PSD Class II areas under their administration, located throughout Montana, Wyoming, southwestern North Dakota, western South Dakota, northwestern Nebraska, and northeastern Utah.

Air pollution impacts are limited by state, tribal and Federal regulations, standards, and implementation plans established under the Clean Air Act and administered by the applicable air quality regulatory agency (including the Montana Department of Environmental Quality—Air and Waste Management Bureau (MTDEQ-AWM) and the U.S. Environmental Protection Agency [EPA]). Although not applicable to the development alternatives, the Wyoming Department of Environmental Quality—Air Quality Division (WYDEQ-AQD) has similar jurisdiction over potential air pollutant emission sources in Wyoming, which may have a cumulative impact with MTDEQ-AWM approved sources. Air quality regulations require proposed new, or modified existing air pollutant emission sources (including gas compression facilities) to undergo a permitting review prior to construction. Therefore, the applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees and control devices, prior to construction and/or operation.

In addition, the U.S. Congress (through the Clean Air Act Section 116) authorized local, state, and tribal air quality regulatory agencies to establish air pollution control requirements more (but not less) stringent than Federal requirements. Additional site-specific air quality analysis would be performed, and additional emission control measures (including a BACT analysis and determination) may be required by the applicable air quality regulatory agencies to ensure protection of air quality.

In addition, under the Federal Land Policy and Management Act (FLPMA) and the Clean Air Act, BLM cannot authorize any activity which does not conform to all applicable local, state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Therefore, land use authorizations will specify that operating conditions (i.e., air pollutant emissions limits, control measures, effective stack heights, etc.) are consistent with the applicable air regulatory agency's requirements.

The significance criteria for potential air quality impacts include state, tribal, and federally enforced legal requirements to ensure air pollutant concentrations will remain within specific allowable levels. These requirements include the National and Montana Ambient Air Quality Standards which set maximum limits for several air pollutants, and PSD increments which limit the incremental increase of certain air pollutants (including $N0_2$, PM-10 and $S0_2$) above baseline concentration levels. These ambient air quality limits were presented in Chapter 3—Affected Environment.

Impacts from Management Common to All Alternatives

Impacts to air quality would be localized and short-term in duration, lasting from hours to days. A more detailed discussion of potential air quality impacts from conventional oil and gas development is presented in the *Final Oil and Gas Amendment, Billings—Powder River—South Dakota RMPIEIS, Miles City District Appendix D—Air Quality* (BLM 1992).

There would be no measurable impacts to climate under any of the proposed Alternatives.

Impacts from Management Specific to Each Alternative

Alternative A

Given the lower level of anticipated CBM development, potential air quality impacts are anticipated to be within applicable air quality standards, and would be less than those described for Alternative C below.

Crow Reservation

The Crow reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Northern Cheyenne Reservation

The Northern Cheyenne reservation would experience air quality changes less then those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, nonsaline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local, and resource roads which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits on all project-required roads in and adjacent to the Project Area.

Conclusion

Future development activities must comply with applicable state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Some increase in air pollutant emissions would occur as a result of this development alternative. However, based on the "reasonable, but conservative" assumptions, direct and cumulative impacts are assumed to be within applicable air quality standards.

Alternative B

Employing directional drilling techniques and requiring natural gas-fired compressors, potential air quality impacts are anticipated to be within applicable air quality standards, and would be less than those described for Alternative C below.

Crow Reservation

The Crow reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Northern Cheyenne Reservation

The Northern Cheyenne reservation would experience air quality changes less then those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, nonsaline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local, and resource roads which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits (15 mph) on all project-required roads in and adjacent to the Project Area.

Conclusion

Future development activities must comply with applicable state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Some increase in air pollutant emissions would occur as a result of this development alternative. However, based on the "reasonable, but conservative" assumptions, direct and cumulative impacts are assumed to be within applicable air quality standards.

Alternative C

Air quality impacts would occur during construction (due to surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, and drilling rig and vehicle engine exhaust) and production (including well production equipment, nitrogen injection, and pipeline compression engine exhausts). Applying water or chemical surfactants to disturbed soils would control the amount of air pollutant emissions during construction. Air pollutant emission limitations imposed by applicable air quality regulatory agencies would influence the amount and frequency of water or chemical surfactant applied. Actual air quality impacts depend on the amount, duration, location and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.).

Construction emissions would occur during limited road building, well drilling, and completion testing. During well completion testing, natural gas could be burned (flared) for a limited time. Hydrogen sulfide

(H_2S) is not anticipated to be a concern since the gas fields are typically "sweet" (containing negligible concentration of sulfur compounds). However, should H_2S be encountered during drilling, operators must comply with Oil and Gas Order Number 6, which requires special precautions to protect worker and public safety. Maximum air pollutant emissions from each well would be temporary (i.e., occurring during a limited construction period) and would occur in isolation, without appreciably interacting with adjacent well locations. Where needed, particulate matter emissions from well pad and resource road construction would be minimized by application of water and/or chemical dust suppressants. The control efficiency of these dust suppressants would be 50 percent during construction. In addition, particulate matter concentrations would decrease rapidly from the emission source. The maximum short-term (3- and 24-hour) $S0_2$ emissions would be generated by drilling rigs and other diesel engines used during the drilling and completion operations (sulfur is a trace element in diesel fuel). Since these PM-10 and $S0_2$ construction emissions would be temporary, PSD increments are not applicable.

Operation emissions (primarily CO and NO_x) would occur due to increased compression requirements. Since produced coal bed natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no substantial direct volatile organic compound (VOC) emissions would occur due to well operations. The maximum direct annual $N0_2$ impact would be below the applicable annual PSD Class II increment. All NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis.

Potential formaldehyde (a listed Hazardous Air Pollutant, or HAP) impacts could occur very close to pipeline compressor engines. However, neither the MTDEQ-AWM nor EPA has established HAP standards. It is assumed potential 8-hour HAP concentrations would be below a range of maximum Acceptable Ambient Concentration Levels identified in other states. Maximum formaldehyde concentrations would occur adjacent to a compressor station; as the distance from the emission source increases, the potential concentrations would decrease rapidly.

Although well development would cause short-term (less than five years) impacts to air quality during construction, drilling and completing oil or gas wells, long-term (over five years) operational impacts would occur throughout the life of a typical oil or gas well, until plugging and abandonment.

It is important to note that before actual development could occur, the applicable air quality regulatory agencies (including the state, tribe, or EPA) would review specific air pollutant emissions preconstruction permit applications, which examine potential project-wide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional detailed air quality impacts analyses or mitigation measures. Thus, before development occurs, additional site-specific air quality analyses would be performed to ensure protection of air quality.

Since the direct Alternative C and cumulative air pollutant emission sources constitute many minor sources spread out over a very large area, it is unlikely the maximum potential air quality impacts at downwind PSD Class I areas (including Northern Cheyenne Tribal Lands), or other "sensitive receptors," would: 1) exceed the PSD Class I $N0_2$ increment; 2) cause noticeable nitrate and sulfate atmospheric deposition (and their related impacts) in sensitive lakes; or 3) cause perceptible visibility impacts (regional haze).

Crow Reservation

The Crow reservation would experience air quality changes similar to those discussed above. As noted, no major changes in air quality or violation of applicable Federal, state, or tribal air quality standards would occur.

Northern Cheyenne Reservation

The Northern Cheyenne reservation would experience air quality changes similar to those discussed above. As noted, no major changes in air quality or violation of applicable federal, state, or tribal air quality standards would occur.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, nonsaline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local and resource roads which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits (15 mph) on all project-required roads in and adjacent to the Project Area.

Conclusion

Future development activities must comply with applicable state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Some increase in air pollutant emissions would occur as a result of this development alternative. However, based on the "reasonable, but conservative" assumptions, direct and cumulative impacts are assumed to be within applicable air quality standards.

Alternative D

Requiring a combination of natural gas-fired and electric compressors, potential air quality impacts are anticipated to be within applicable air quality standards, and would be less than those described for Alternative C above.

Crow Reservation

The Crow reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Northern Cheyenne Reservation

The Northern Cheyenne reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, nonsaline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local, and resource roads which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits (15 mph) on all project-required roads in and adjacent to the Project Area.

Conclusion

Future development activities must comply with applicable state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Some increase in air pollutant emissions would occur as a result of this development alternative. However, based on the "reasonable, but conservative" assumptions, direct and cumulative impacts are assumed to be within applicable air quality standards.

Alternative E (Preferred Alternative)

By encouraging multiple-well directional drilling at a site and optimizing the number of wells connected to a compressor, potential air quality impacts are anticipated to be within applicable air quality standards, and would be less than those described for Alternative C above.

Crow Reservation

The Crow reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Northern Cheyenne Reservation

The Northern Cheyenne reservation would experience air quality changes less than those discussed under Alternative C. Potential air quality impacts to Tribal Lands are anticipated to be within applicable air quality standards.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, nonsaline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local, and resource roads which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits (15 mph) on all project-required roads in and adjacent to the Project Area.

Conclusion

Future development activities must comply with applicable state, tribal, and Federal air quality laws, statutes, regulations, standards, and implementation plans. Some increase in air pollutant emissions would occur as a result of this development alternative. However, based on the "reasonable, but conservative" assumptions, direct and cumulative impacts are assumed to be within applicable air quality standards.

Cultural Resources

Assumptions

Cultural resources would be treated similarly and equally in terms of type, composition, and significance; their distributions and densities are detailed in Table 3-2 in Chapter 3. Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. There would be 1 site for every 100 acres surveyed for cultural resources. This assumption was made by averaging the number of sites vs. acres surveyed in the planning area.

Impacts From Management Common To All Alternatives

Cultural resources would be impacted by surface and subsurface disturbing activities. Activities that involve the use of heavy equipment (road construction, well drilling, pad construction, pipeline and utility placement, etc.) that result in changes to the natural landscape cause the most disturbance and have the greatest effect on cultural resources. Other activities, such as increased travel and vandalism resulting from access improvements, and increased erosion resulting from surface disturbances, would also impact cultural resources. These activities can also produce indirect impacts to cultural resources from fires; and to rock art sites from gas emissions, abrasive dust, and vibrations from drilling equipment. Noise, activity, traffic and smells can affect the quality and continued use of traditional cultural sites.

Impacts would occur at an estimated 318 cultural resource sites. Thirty-two to forty-six of these sites are projected to be National Register of Historic Places eligible. The estimated number of sites include 176 cultural resource sites from disturbance by conventional oil and gas development, and 142 sites as a result of impacts caused by the proposed Tongue River Railroad and surface coal mining activities.

Mitigation

The laws and regulations established for cultural resources were established to minimize and mitigate impacts to cultural resources. Cultural resource inventories prior to development attempt to discover properties before they can be impacted, so that appropriate plan changes are implemented. These inventories may not find all sites prone to impact during surface and subsurface activities. Unavoidable impacts may occur to cultural resources that are not identified by surveys. To minimize impact to cultural resources surface and subsurface disturbance may need to be monitored. Cultural resources may also be damaged or destroyed by unauthorized disturbances (pot hunting) and vandalism particularly once access to previously inaccessible areas is opened as a result of CBM development. The cultural resources survey should extend outside the area of direct CBM development in order to evaluate, and mitigate if necessary, the potential impact to cultural resources by unauthorized disturbance, vandalism, and secondary and indirect impacts. A lease notice tells the lessee that cultural resources may be present, also that the surface management agency would have to examine the site and may specify mitigation measures. Lease Stipulations (BLM 1994), which require inventory and mitigation measures, can benefit cultural resources by delineating and minimizing impacts to these resources. Noteworthy cultural sites that could not be avoided through project relocation would be mitigated through data recovery or excavation. Although mitigation by excavation recovers valuable data, the process of archeological excavation using the most current methods and technology still results in the destruction of sites and loss of some data. Sites that have religious or sacred values cannot be mitigated through standard mechanical or archival means, and some sites exist that cannot be mitigated at all. Despite these efforts some cultural resources will be lost but the recording of these resources will enrich local and state knowledge of past cultures.

Impacts from Management Specific to Each Alternative

Alternative A

Alternative A has the least impact to cultural resources of all alternatives since this alternative has the least amount of surface and subsurface disturbance. Approximately 17 cultural resource sites would be disturbed by all projected CBM activities in state and BLM planning areas. An estimated four sites would be impacted from exploration activities in state planning areas; six sites would be impacted from production activities at CX Ranch; and seven would be impacted from exploration activities in BLM planning areas. One or two of these disturbed sites could be found eligible for the National Register of Historic Places. There would be no production activities in BLM planning areas under this alternative and therefore no impacts from production.

Crow Reservation

Impacts to the Crow Reservation are not expected because no exploration wells are planned for installation on the Reservation at this time. However if exploration wells were to be drilled on the Reservation the likelihood of site impacts would occur at a similar frequency as described for Cultural Resources in general.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation also are not expected at this time because the Northern Cheyenne have not indicated that exploration wells would be drilled. As with the Crow Reservation, it is anticipated that when and if the Northern Cheyenne explore their Reservation for CBM resources cultural sites would be encountered on the same regularity as described for Cultural Resources in general. It is conceivable though that the density of cultural sites would be increased on the Reservation resulting in an increase in cultural site disturbance during exploration activities.

Conclusion

Over the next 20 years, disturbances from CBM development, conventional oil and gas development, and other cumulative effect analysis project activities could identify 4,285 cultural resource sites of which 430 to 612 would be eligible for the National Register requiring mitigation. Impacts from surface disturbance would be minimized by using existing disturbances where possible, and by allowing aboveground utility lines. The impacts from erosion as a result of surface discharge of produced water at CX Ranch would be negligible because of the conveyance systems used to transport the relatively small amount of discharged water. The mitigation measures would be the same as those discussed in the *Impacts From Management Common to All Alternatives* section above. However, given the number of acres likely to be disturbed by all anticipated CBM development, it is unlikely that it would be necessary to mitigate sites or cultural properties through data recovery. In almost all situations, direct impacts to cultural properties would be avoided by relocating well sites or pipelines. Monitoring may indicate sites adjacent to the development fields are being indirectly affected by vandalism in which case data recovery would be the preferred mitigation.

These are the best estimates of cultural resources that can be derived at this level of study. It is understood that sites occur in clusters based on a host of various criteria (location to water, slope, view, predominate wind, etc) and that some sites are more important than others. A cultural resource location and significance model would be an important and useful tool to help identify areas of critical concern.

Alternative B

Under this alternative, an estimated 629 cultural resource sites would be disturbed by all projected CBM activities in state and BLM planning areas. Of these sites, 119 to 170 could be found eligible for the National Register of Historic Places. An estimated 16 sites would be impacted by exploration activities in state planning areas, 335 sites from production activities in state planning areas, 10 sites from exploration activities in BLM planning areas, and 269 sites from production activities on BLM planning areas.

Crow Reservation

Impacts to the Crow Reservation would be the same as described for Cultural Resources in general. Disturbance totals include sacred Native American sites that would be identified and impacted from the above mentioned activities.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be the same as described for Cultural Resources in general. Disturbance totals include sacred Native American sites that would be identified and impacted from the above mentioned activities.

Conclusion

Over the next 20 years, disturbances from CBM development in state, BLM, Native American, and U.S. Forest Service planning areas; conventional oil and gas development; the proposed TRR; and surface coal mining activities would impact approximately 5,135 cultural resource sites. Of those sites 515 to 735 would be eligible for the National Register, and may require mitigation. These totals include sacred Native American sites that would be identified and impacted from the above mentioned activities. The requirement of transportation corridors, one-way in-and-out roads, and the prevention of surface discharge of produced water would help to minimize the number of cultural resource sites impacted. The mitigation measures would be the same as those discussed in the *Impacts From Management Common to All Alternatives* section above.

Alternative C

Under this alternative, impacts to cultural resources would be similar to Alternative B with the following exceptions: transportation corridors are not required, thereby increasing the number of disturbed acres and hence disturbed sites; discharge of produced water directly to the ground surface would increase erosion and site disturbance; power lines may be aboveground or buried, which would decrease the number of disturbed acres. The estimated number of cultural resources disturbed under Alternative C would total 629 with 119 to 170 of these sites being found eligible for the National Register of Historic Places.

Crow Reservation

Impacts to the Crow Reservation would be the same as described for Cultural Resources in general.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be the same as described for Cultural Resources in general.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance from roads and utilities would be greater because one-way in-and-out roads and transportation corridors would not be required. Cultural resource inventories would be conducted along the surface watercourses. Surface discharge of produced water would result in increased erosion. The discharge of produced water to the surface would increase erosion and cause increased surface disturbance. The increased surface disturbance would be in the area near the production area, and in the downstream segments of perennial streams and valleys leading to the major surface waters. Further discussion of erosion and the disturbances to soils can be found in the *Soils* section of this chapter. Mitigation measures would be similar to Alternative B with some exceptions. Mitigation measures would include the use of piping instead of discharging waters into drainage ditches in order to minimize erosion.

Alternative D

Under this alternative, impacts to cultural resources would be similar to Alternative B.

Crow Reservation

Impacts to the Crow Reservation would be the same as described for Cultural Resources in general.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be the same as described for Cultural Resources in general.

Conclusion

Cumulative impacts would be similar to Alternative B. Mitigation measures would be the same as for Alternative B.

Alternative E (Preferred Alternative)

Under this alternative the impact to cultural resources would be similar to Alternative B with the following exceptions: the removal of an inactive buffer zone around active coal mines and reservations would increase the potential acreage for CBM development and hence increase the number of impacted cultural resources; there might be a decrease in the number of well pads since operators might be able to use vertical wells for deep coal seams decreasing the impact to cultural resources; transportation corridors are not required, thereby increasing the number of disturbed acres and hence disturbed sites; power lines may be aboveground or buried, which would decrease the number of disturbed acres. The operator's project plan would help develop a survey identification strategy and increase the likelihood of site identification and implementation of mitigation measures. The estimated number of cultural resources disturbed under Alternative E would total 629 with 119 to 170 of these sites being found eligible for the National Register of Historic Places.

Conclusion

Cumulative impacts would be similar to Alternative B. Mitigation measures would be the same as for Alternative B.

Environmental Justice

Assumptions

The purpose of this analysis is to report whether high and adverse human health or environmental effects of the proposed alternatives are likely to fall disproportionately on minority or low-income populations. This analysis focuses on the populations that are located within the areas potentially affected by the alternatives. It examines where expected high and adverse impacts, if any, fall relative to minority and low-income populations. In order to make a finding that a proposed project is inconsistent with the Environmental Justice policy established in Executive Order (EO) 12898 and described in Section 4.10.1.7, two situations must occur at the same time: 1) there must be a minority or low-income population; and 2) that population must receive a disproportionately high and adverse environmental or human health impact.

Two options are considered depending on what the impacts are:

- If adverse impacts are identified in the resource analyses, the individual occurrence potential, where relevant, is analyzed for disproportionate effects on minority and/or low-income populations.
- If no adverse impacts are reported in the resource analyses, then no NEPA environmental justice issues would be expected as a result of any of the alternatives. Therefore, it is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations. Consequently, none of the impacts of the proposed action can be described as having a high and adverse impact in the context of EO 12898. The proposed alternatives are therefore consistent with the policy established in EO 12898.

Impacts from Management Common to All Alternatives

Current management of conventional oil and gas resources does not appear to disproportionately impact minority populations.

Mitigation

Under management common to all alternatives, the EO and guidance are expected to bolster minority participation in future BLM management decisions. This participation will assist in these under-represented groups achieving greater political efficacy.

Impacts From Management Specific to Each Alternative

Alternative A

A review of the resources analyses prepared for the management objectives described under the existing management alternative revealed that no adverse impacts of concern warrant further analysis for disproportionate effects to minorities or low-income populations, with the exception of CBM-produced waters being discharged into the Little Bighorn River and the Tongue River Reservoir from Wyoming CBM activities. See reservation discussions below.

Crow Reservation

The Little Bighorn River, which originates in Wyoming and flows onto the Crow Reservation, would experience impacts to its water quality. The changes in water quality would be dependent upon the Final Water Quality Agreement signed between Montana and Wyoming. Impacts could range from a negligible effect to a modest increase in Sodium Adsorption Ratio (SAR), Total Dissolved Solids (TDS), electrical conductivity (EC), and bicarbonate. If the agreement allows for some CBM-produced water to be discharged into the Little Bighorn River, the resulting downstream water would increase SAR, EC, TDS, and bicarbonate, thus the tribe's beneficial use of that water may be diminished. No health effects are foreseen from the change in water quality or the consumption of downstream fish present in the Little Bighorn River. No other impacts are anticipated from the other resource topics analyzed.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne's Water Right in the Tongue River Reservoir would be the result of Wyoming allowing CBM-produced waters to be discharged into the Tongue River, altering the water quality of the reservoir. The range of water quality changes would be dependent upon the Final Water Quality Agreement between Montana and Wyoming. The scenarios for possible impact ranges are described in detail in the *Hydrology* section of this chapter. Worth mentioning though, is that even a slight change in water quality to the reservoir would impact the Northern Cheyenne's ability to market their water as a commodity and reduce their own beneficial uses. Other resource topics do not indicate any other impacts would be felt on the reservation from this alternative.

Mitigation

Mitigation for the potential impacts to the surface water concerns of both tribes could be somewhat alleviated by their participation in the state-to-state discussions regarding the Water Quality Agreement. Furthermore, if either tribe were to obtain self-governance over their water quality, they could act as a state and set their own water quality or non-degradation standards and negotiate with Wyoming for an altered agreement more in line with their specific needs and concerns.

Conclusion

No adverse impacts, with the exception of the undetermined Wyoming discharge influence, are reported in the resource analyses. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.

Alternative B

A review of the resource analyses conducted for Alternative B indicates that the following impacts would have effects, which warrant further review for occurrence potential, and relevance to disproportionate effects on minority or low-income populations. The impacts included in this evaluation are the drawdown of groundwater; air quality changes; and changes to vegetation and soils.

Groundwater Drawdown

CBM production in Montana would result in the depletion of an estimated 21 percent (ALL 2001b) of the groundwater resources in Montana's Powder River Basin watersheds. This drawdown would be basinwide and correspond to the geographical distribution of production wells. The occurrence potential is not localized and would not impact segregated portions of the population, the impact would be felt evenly across the region. Furthermore, the drawdown has the potential to reduce surface water flows in some drainages depending on specific site conditions. The availability of groundwater is important, as many rural families depend on the supply of groundwater for their household and ranch/agricultural (irrigation) applications.

Air Quality Changes

CBM development in the Powder River Basin would necessitate the construction of many minor emission sources spread out over a very large area. It is unlikely the maximum potential air quality impacts at downwind mandatory Federal PSD Class I areas, or at other "sensitive receptors" would exceed the PSD Class I NO_2 increment; cause substantial nitrate and sulfate atmospheric deposition (and their related impacts) in sensitive lakes; or cause perceptible visibility impacts (regional haze).

The negligible changes in air quality from development would be widespread and distributed across the region. The impacts associated with the dispersion of air pollutants across the region would not be disproportionately distributed upon any minority or low-income groups.

Crow Reservation

Under this alternative, a 2-mile buffer zone would be enforced on federal minerals around the reservation to restrict development of minerals adjacent to these boundaries. This buffer zone would delay some of the groundwater drawdown impact associated with federal pumping but would not prevent state and private mineral estates from being developed adjacent to the reservation. Therefore, drawdown will affect Indian populations within the Crow Reservation adjacent to off-reservation development.

The Crow tribal government derives some of its income from operator lease fees: ranchers and irrigators operating both on private and reservation lands. If these operators were to experience a reduction in available groundwater that impacted their operations and the Crow Tribe subsequently changed the fees the tribe would be able to collect. Trust agencies might be needed to resolve conflicts. Ideally, the form of resolution most desirable would be the replacement of water resources and the according adjustment in fees. However, if the replacement of water resources could not be achieved because of site-specific conditions or other variables, the loss in potential income generation from reduced fees and limited new fee opportunities could be viewed as environmental justice impairment.

Northern Cheyenne Reservation

The Northern Cheyenne Tribe would experience similar groundwater drawdown and potential operator lease fee issues as discussed under the Crow Reservation section above.

As described under the above Air Quality Changes section, no adverse impacts are anticipated from CBM infrastructure development to PSD Class I areas, including the Northern Cheyenne's PSD Class I area.

Mitigation

Mitigation measures for groundwater drawdown and air emission sources would be consistent with the previously mentioned measures discussed under these two resource topics.

Conclusions

If the Northern Cheyenne and Crow tribes elected to develop their CBM resources the federal buffer zone would be eliminated and drawdown impacts from adjacent federal mineral developments would increase the effect on the reservation. An additional 11 percent of drawdown would be experienced across the basin watersheds from the Northern Cheyenne and Crow tribal developments (see *Hydrology* section for details). If the tribe's CBM resources were drilled to the levels estimated in the RFD (4,000 wells for each reservation), the depletion of the groundwater resource would increase to 32 percent across the region and cause a hardship on numerous low-income and minority populations, which are prevalent throughout the area. However, water well and spring mitigation agreements are required by the MBOGC, BLM, and TLMD and would facilitate the replacement of groundwater lost to the drawdown of resources within the coal seam aquifers. Drawdown in deeper aquifers is not anticipated. Replacement may not be possible in some areas with concentrated CBM production, this represents a possible environmental justice issue if the non-replacement areas are adjacent to reservation boundaries and no suitable water is available for mitigation.

No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana rivers would constitute a potential environmental justice issue if unresolved. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.

Alternative C

The resource analyses performed for Alternative C indicate that groundwater drawdown, and changes to the surface water quality and the subsequent impacts on vegetation, wildlife, and aquatic resources would have effects that warrant further review for occurrence potential, and relevance to disproportionate effects on minority or low-income populations.

Groundwater Drawdown

The drawdown of groundwater within the Powder River Basin watersheds would have the same effects as described under Alternative B; however, with the elimination of the federal development buffer zone around Indian reservations, these effects could be amplified and appear sooner on reservation properties.

Surface Water Quality

Under Alternative C, the quality and quantity of surface waters in the Powder River Basin watersheds will be altered depending on the outcome of the statewide water quality standards. The MDEQ is in the process of setting statewide water quality standards that would likely include the framework for managing surface discharge of CBM-produced water throughout the state. The watersheds would most likely experience increases in SAR values, sedimentation, TDS, and a marginal increase in base flow as described in the *Hydrological Resources* section of this chapter. Based on SAR values, the addition of untreated CBM-produced waters with high SAR values under the least restrictive extreme criteria would not exceed an SAR value of 12. High-quality watersheds in the CBM emphasis area would have adequate assimilative capacity to accept expected discharges from full-scale development of CBM. All other watersheds should only experience a slight increase in SAR, which would remain below the suggested not to exceed a value of 3 for some soils and possibly as high as 12 for others.

It is assumed that the sodium content of produced CBM water is the target contaminant that determines the usefulness of the water for crop irrigation. Irrigation uses the majority of water resources in those watersheds thought to have the greatest potential for CBM development. Sodium causes osmotic stress to plants and destroys the texture of clayey soils; these combined effects make sodium content, and especially SAR, a point of emphasis when gauging impacts to water resources from CBM water. Other parameters such as TDS, nitrogen, and barium concentration may be locally important in determining restrictions to beneficial use. It is assumed that discharge to high-quality watersheds would be limited during the irrigation season and managed on a flow-based discharge scenario. Under these circumstances, high-quality watersheds in the CBM emphasis area would have sufficient capacity to meet the current irrigation needs. Flow-based discharge would however, require additional storage of produced water during the irrigation season for later discharge when stream flows are less sensitive to being impacted by produced water discharges.

The trickle-down effects of increased SAR and base flow would result in the erosion of riparian areas along rivers, the reduction of both vegetation and wildlife habitat, and the impairment of fish populations. These trickle-down effects are mentioned because of the large number of Native Americans who have a traditional reliance on the natural agriculture for sacred plants used in medicines and for their hunting and fishing way of life. If these combined water quality impacts are realized, there could be a disproportionate effect felt by the Native Americans as it reduces their ability to gather sacred plants and limit their hunting and fishing opportunities. A large percentage of the population in Big Horn (61 percent) and Rosebud (33 percent) counties are Native Americans and constitutes a sizeable minority population within the CBM emphasis area.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts projected for the CBM emphasis area. The reservation can expect impacts to surface water such as increased flow volume, changes to quality of various water parameters, including SAR, EC, and bicarbonate. The Crow Tribe would experience drawdown of groundwater from coal seam aquifers from Wyoming and Montana CBM production. The traditional pattern of natural resource consumption would be altered and therefore impacts to sacred plants and hunting and fishing are expected.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts projected for the CBM emphasis area. The Northern Cheyenne Reservation will experience impacts to surface water in the form of increased flow volume and changes to water quality for various water parameters, including SAR, EC, and bicarbonate. The reservation will also experience drawdown of coal seam aquifers from CBM production in the area surrounding the reservation. The traditional pattern of natural resource consumption would be altered and therefore impacts to sacred plants and hunting and fishing are expected.

Mitigation

Mitigation measures for groundwater drawdown and air emission sources would be consistent with the previous measures discussed under these two resource topics.

Conclusions

These surface water quality and quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, will further increase the SAR value, base flow, and other potential constituents of concern in the Tongue, Powder, and Little Powder rivers. The combined decrease in water quality will necessitate the use of flow-based discharge to avoid limiting the resource for use as a source of irrigation. The resulting impacts may still impair tribal government leasing activities, rendering an environmental justice impact to tribes as described under Alternative B with regards to drawdown of groundwater and subsequent availability.

If the Northern Cheyenne and Crow tribes elected to develop their CBM resources, impacts as described under Alternative B above would be experienced.

No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana rivers would constitute a potential environmental justice issue if unresolved. It is concluded that adverse environmental effects would be expected from downstream water quality changes, resulting in limitations to subsistence living styles. These limitations would fall disproportionately on minority or low-income populations from this alternative.

Alternative D

A review of the resource analyses for Alternative D revealed that similar potential effects would be felt as described under Alternative B for groundwater drawdown and air quality changes and under Alternative C for surface water quality but at a reduced impact because of water treatment and discharge conveyance. The same trickle-down effects would be experienced under Alternative D as described in Alternative C but, again, at a reduced level because of water treatment.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts described above under this Alternative.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts described above under this Alternative.

Mitigation

Mitigation measures for groundwater drawdown and air emission sources would be consistent with the previous measures discussed under these two resource topics.

Conclusions

These surface water quality and quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, would be less than those described in Alternative C because of the treatment of discharge water. Water would be available for irrigators and tribal government leasing activities would not be impaired. The drawdown of groundwater and subsequent availability would be as described in Alternative B. If the Northern Cheyenne and Crow tribes elected to develop their CBM resources, impacts as described under Alternative B above would be experienced. No adverse human health impacts or environmental effects are foreseen from these management objectives.

Alternative E (Preferred Alternative)

A review of the resource analyses for Alternative E indicates that impacts to hydrology would be similar to those described in Alternative C and dependent upon the water quality criteria being developed. Alternative E stresses the beneficial uses of produced water from CBM wells and requires a Water Management Plan be developed explaining how an operator can discharge without degrading the surface water quality before any discharge can occur. Similar potential effects would be felt as described under Alternative B for groundwater drawdown and air quality changes. The trickle-down effects of surface water quality changes would be reduced considerably.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts projected for the region under Alternative E.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts projected under Alternative E.

Mitigation

Mitigation measures for groundwater drawdown and air emission sources would be consistent with the previous measures discussed under these two resource topics.

Conclusions

These surface water quality and quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, would be less then those described in Alternative C. Water would be available for irrigators and tribal government leasing activities would not be impaired. The drawdown of groundwater and subsequent availability would be as described in Alternative B. If the Northern Cheyenne and Crow tribes elected to develop their CBM resources, impacts as described under Alternative B above would be experienced. No adverse human health or environmental effects are anticipated from this alternative.

Geology and Minerals

Assumptions

- Federal oil and gas leases would continue to be issued with standard lease terms and stipulations as identified by BLM. No Surface Occupancy (NSO), Controlled Surface Use (CSU) and Timing Restriction (Timing) stipulations provide protection to other resources from oil and gas lease activities. A detailed listing and description of stipulations are found in the Final Oil & Gas EIS/Amendment (BLM 1992).
- Federal APDs and Sundry Notices would continue to be issued with Conditions of Approval (COAs) as identified by BLM. COAs provide mitigation to minimize or eliminate impacts to other resources or land uses from oil and gas lease activities. COAs must conform to lease rights and land use decisions.
- BLM would continue to consult with private surface owners before approving oil and gas lease activities on private surface. Surface owner requirements can be incorporated as COAs.
- BLM would continue to require a copy of a signed agreement between the private surface owner and the CBM operator before approving drilling operations on private surface.
- Other related Assumptions regarding typical CBM operations are found at the beginning of this Chapter.

Impacts From Management Common to All Alternatives

The production or drainage of oil and gas results in the irreversible and irretrievable loss of these resources. Oil and gas resources within a lease area can be directly removed by wells located on the lease area or drained by wells located adjacent to the lease when geologic conditions allow. Gas resources can be irreversibly and irretrievably lost during venting or flaring operations. The cumulative impact to oil and gas resources would be a reduction in the known amount of these resources.

The cumulative impacts to lease development from stipulations, field rules, permit requirements, and regulations would be a reduction in the number of wells drilled on leases with more or more restrictive stipulations, an increase in the number of wells drilled on less restrictive leases, relocation of proposed well sites, interference with orderly field development, possible loss of revenues, and loss of oil or gas resources from drainage by off-lease wells.

CBM development in Wyoming would result in drainage to Montana lands by wells just across the state boundary. The 80-mile-wide belt of the Powder River Basin that is prospective for CBM would represent approximately 320 1/4-by-1/2-mile (80-acre) spacing units draining resources (gas) from the adjacent state.

Another drainage issue results from produced water associated with oil and gas production that may or may not be an irreversible or irretrievable loss of resources depending on the water quality and aquifer from which it is drawn. A more detailed discussion about impacts to water resources is included later in this chapter in the *Hydrology* section.

Oil and gas development would impact strippable coal resources in areas adjacent to existing coal mines or in new areas of coal mine interest. Oil and gas well bores and the production infrastructure would prevent the mining of coal in areas of oil and gas production.

Conventional oil and gas lease operations would not impact CBM resources because of the geology and well bore requirements. Migration of conventional oil and gas from source reservoirs to coal seams usually does not occur because the geology includes an impermeable layer(s) between the hydrocarbon bearing formations and the coal seams. The BLM and State require well bores to be completed with steel casing and cement in key locations of the well annulus to prevent the migration of fluids and drastically reduce the migration of gas from one formation to another formation.

Conventional oil and gas wells and the associated infrastructure could be located on a lease area with CBM wells and associated infrastructure.

Sand, gravel, or scoria needed for lease operations can be removed from BLM land by the operator from areas disturbed by lease operations under authority of the lease. Removal of sand, gravel, or scoria from BLM surface by the operator outside of the area of disturbance for lease operations or removal by a third party would require a separate permit approved by BLM.

Mitigation

Existing BLM and State regulations allow for the production of oil and gas in a manner that conserves those resources so they are not wasted. Oil and gas production is guided by well spacing rules, field rules,

lease development requirements, and protective agreements such as Communitization and Unit Agreements. Flaring and venting operations must be conducted in accordance with agency approval which also seeks to limit the wasting of gas resources as well as minimizing air quality and safety impacts.

The policy of both the BLM and State is to use the least restrictive method to provide protection for other resources and land uses from oil and gas activities while allowing for lease development and production. Regulations, lease stipulations, and permit requirements allow for lease exploration and development while sustaining other resource values and land uses.

Water produced with oil and gas operations is required to be put to beneficial use unless the quality of the water would prevent beneficial use. Produced water of poor quality may be treated so the water can be put to beneficial use or with agency approval can be disposed of into a subsurface formation designated by the State with the same or poorer quality water.

BLM issued oil and gas leases are issued with an NSO stipulation in an area with an approved mine plan. The NSO stipulation prohibits surface occupancy and use for oil and gas lease operations. In areas outside of approved mine plans, BLM may issue both coal and oil and gas leases on the same parcel of land. BLM regulations support approval of applications from the first lessee, but also require lessees to resolve conflicts. Resolution of conflicts is further guided by BLM Instruction Memorandum WO-IM-2000-081 (BLM 2000c).

Well spacing and field rules would be established to help maintain the integrity of subsurface formations and help reduce the migration of hydrocarbons. The BLM and State would continue to require certain well drilling and completion practices, such as steel casing and cementing, to stabilize the well bore and dramatically reduce the opportunity for hydrocarbon migration.

Operators would be required to minimize surface disturbance by sharing access roads, flowline routes, and utility line routes. When feasible, multiple wells would be drilled on the same well pad. Reclamation would be required on areas of surface disturbance during the production and abandonment phases of development. operators, along with surface owners, would be invited to discuss development plans to reach a common agreement.

Impacts From Management Specific To Each Alternative

Alternative A

Under this alternative, CBM production would be limited by the number of wells that can be permitted for CBM production by BLM and the State. The total number of producing CBM wells is limited to 250 by the terms of the Settlement Agreement affecting the State. The constraint is in place until the State has completed an EIS addressing the impacts from CBM field development throughout the state. BLM is not approving the production of CBM from federal wells until completion of the EIS which addresses the impacts from CBM field development in the Powder River and Billings RMP areas.

The production and venting of CBM during the testing phase represent an irretrievable loss of that resource. Under the existing situation, CBM may be drained from federal lands by producing CBM wells on private and state leases. This drainage of federal CBM represents an irretrievable loss of that resource and loss of royalties to the federal and state governments. The vending of CBM during coal mining represents the irretrievable loss of the resource. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on federal lands.

Expansion of the Decker coal mine to the west and south, and expansion of the Spring Creek coal mine to the south would be constrained by CBM wells and the associated infrastructure of the CX Field. Mine expansion could occur after abandonment of the CX Field and removal of facilities and equipment.

Removal of groundwater by CBM wells in coal seams that are being mined by Decker and Spring Creek could reduce the amount of groundwater flowing into the mine areas. Reduction in the amount of groundwater or degradation of groundwater quality by CBM production would reduce the amount of groundwater available for domestic water wells from a particular coal seam. CBM could migrate to domestic wells or escape at the surface from the removal of groundwater for CBM production.

The presence of CBM wells and the associated infrastructure could prevent certain types of seismic operations from being conducted in the area of CBM production. The use of explosives could damage well bores or surface equipment, and could damage the upper coal seam used for CBM production.

Crow Reservation

Producing CBM wells located within 1 mile of the Crow Reservation boundary could drain CBM resources from the Reservation. This drainage of Indian owned or privately owned CBM would represent an irretrievable loss of the resource and a loss of royalties to the mineral owner. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on lands within the Crow Reservation.

Producing CBM wells located within 1 mile of the Crow Reservation boundary could drain groundwater from the Reservation. This drainage of groundwater could represent an irretrievable loss of the resource unless the aquifer is recharged to pre-production level. Reduction in the amount of groundwater or degradation of groundwater quality by CBM production would reduce the amount of groundwater available for domestic water wells from a particular coal seam. CBM could migrate to domestic wells or escape at the surface from the removal of groundwater for CBM production.

A detailed description of potential drainage impacts to Crow resources is found in the Environmental Justice section, and a detailed description of potential impacts to groundwater from drawdown by CBM wells is found in the hydrology section.

Northern Cheyenne Reservation

Producing CBM wells located within 1 mile of the Northern Cheyenne Reservation boundary could drain CBM resources from the Reservation. This drainage of Indian owned or privately owned CBM would represent an irretrievable loss of the resource and a loss of royalties to the mineral owner. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on lands within the Reservation.

Producing CBM wells located within 1 mile of the Northern Cheyenne Reservation boundary could drain groundwater from the Reservation. This drainage of groundwater could represent an irretrievable loss of the resource unless the aquifer is recharged to pre-production level. Reduction in the amount of groundwater or degradation of groundwater quality by CBM production would reduce the amount of groundwater available for domestic water wells from a particular coal seam. CBM could migrate to domestic wells or escape at the surface from the removal of groundwater for CBM production.

A detailed description of potential drainage impacts to Northern Cheyenne resources is found in the Environmental Justice section, and a detailed description of potential impacts to groundwater from drawdown by CBM wells is found in the hydrology section.

Conclusion

The production of CBM by state and private wells, and the venting of CBM represents the irreversible and irretrievable loss of the resource. Drainage by off-lease CBM wells represents the irreversible and irretrievable loss of the resource and royalties to the lessee of the lease being drained. The restrictions on the total number of CBM wells approved for production reduces and delays associated revenues to lessees and government. The venting of CBM during coal mining represents the irreversible and irretrievable loss of the resource.

Production of CBM should not impact the geology of the production area or any conventional oil and gas in the area of CBM production. CBM wells and the associated infrastructure would hinder the expansion of the Decker and Spring Creek coal mines toward the CX Field. The production of CBM would not prohibit the production of conventional oil and gas resources from the area of CBM production. The production of conventional oil and gas in or around the CX Field would increase and intensify the impacts to other resources and on land uses.

The mitigation measures for this alternative would be similar to those described in the Impacts From Management Common to All Alternatives section.

Alternative B

Under this alternative, impacts would be similar to Alternative A, but increased because of expanded CBM production on state, fee, and BLM oil and gas lease areas. The increased development as part of this alternative would result in more CBM production and the irretrievable commitment of more resources. Increased CBM production would amplify the opportunity for methane drainage from adjacent leases. Under this alternative, multiple coal seams would be developed from a single well bore. All coal seams would be developed at the same time and directional drilling for deeper coal seams would be required.

This alternative also includes a 1-mile buffer zone around active coal mines that would minimize the water drawdown impact from nearby CBM production. Production of CBM would not be authorized on federal leases within a 2-mile buffer zone in Montana along

the Reservation boundary. The state may allow production of CBM from state leases within the buffer zone. The prohibition on the production of CBM within the buffer zone would not apply to fee leases within the buffer zone. The drawdown of groundwater from coal seams would not damage the coal resource present through compaction, nor would the likelihood of coal seam fires be greater than before. The circumstances for self-ignition of coal would not be present in the direct vicinity of CBM wells in the emphasis area. During the production stage of CBM activity, conditions essential to cultivate spontaneous combustion of coal such as oxidation, heat of wetting, airflow rate, coal particle size, pyrite content and temperature are not present. In fact, the design and construction of CBM wells efficiently vents heat out of the coal so that temperatures needed for coal ignition are neither present nor anticipated. After the coal seam is exhausted of inexpensive methane resources, wells must be plugged and sealed. Unlike abandoned mines, CBM wells leave no underground voids vulnerable to further subsidence and associated spontaneous coal ignition. The probability of completely dewatering a coal bed and revealing large areas of fine coal particles to oxygen seem exceedingly remote (Lyman and Volkmer 2001). Further discussion regarding groundwater issues is contained in the *Hydrology* section of this chapter.

The presence of CBM wells and the associated infrastructure could prevent certain types of seismic operations from being conducted in the area of CBM production. The use of explosives could damage well bores or surface equipment and could damage the upper coal seam used for CBM production.

The drawdown of groundwater from CBM activities has been identified as the cause of surface subsidence in Wyoming (Case et al. 2000). The subsidence was recorded as 1/2 inch and therefore, does not represent an immediate impact to surface lands. In Montana where coal seams are thinner, subsidence would be less than what has been observed in Wyoming where coal seams are thicker.

Crow Reservation

Impacts to mineral resources on the Crow Reservation would be the same as described above in this alternative. Expanded CBM development activities may increase the impacts and extraction of CBM resources described in Alternative A if there is development and production near tribal lands or on fee lands within the external boundaries of the Reservation.

Northern Cheyenne Reservation

Impacts to mineral resources on the Northern Cheyenne reservation would be the same as described above in this alternative. Expanded CBM development activities may increase the impacts and extraction of CBM resources described in Alternative A if CBM production occurs near the external boundaries of the reservation.

Conclusion

One of the cumulative impacts from this alternative would be increased production of CBM from an increased number of producing wells and from multiple coal seam development simultaneously. Multiple coal seam development simultaneously would result in the production of CBM occurring more quickly than single seam development. Along with venting of CBM during well testing, this would represent an irreversible and irretrievable loss of the resource.

A second cumulative impact from this alternative would be the potential for a greater amount and extend of groundwater because of the increased number of producing CBM wells. Groundwater drawdown would be increased where CBM production wells are located in an area affected by drawdown occurring from coal mining. The volume of groundwater produced would increase with the increased number of producing CBM wells, especially during the first two production years of the well's life cycle.

The increased number of producing CBM wells and the associated infrastructure could inhibit the expansion of existing coal mines, even with the 1-mile buffer zone. This would delay or possibly preclude the mining of coal in certain areas. Areas of new coal mine interest would be excluded from opening new coal mines by the existence of producing CBM wells and infrastructure.

The mitigation measures for this alternative would be similar to those described in the Impacts From Management Common to All Alternatives section. Additional mitigation measures include buffer zones around existing coal mines and the Crow and Northern Cheyenne Reservations, requiring simultaneous production of multiple coal seams through single well bores, subsurface injection of untreated water produced with CBM, and maximizing the number of producing CBM wells connected to field compressors.

Alternative C

Under this alternative, CBM production could occur on state, fee, and BLM lease areas. Operators would not be required to produce CBM simultaneously from multiple coal seams through a single well bore. CBM production from multiple coal seams could occur simultaneously through single well bores or simultaneously through separate well bores or different coal seams could be developed separately (staggered over time) or a combination of production methods. Allowing CBM production from state, fee, and BLM leases would increase the amount of CBM produced. Producing CBM from multiple coal seams simultaneously would have impacts similar to those described in Alternative B. Producing CBM from single coal seams would have similar impacts, but would extend the length of time for production. The potential for drainage of CBM resources by producing CBM wells would increase with the increase in the number of producing wells. Directional drilling would not be required. Without directionally drilled wells, the impacts from vertical wells would be the same as Alternative A.

CBM production will impact adjacent coal mines by increasing coal bed aquifer drawdown. The added dewatering from CBM operations would affect the coal mines by hindering the aquifer restoration efforts the mine must perform once mining activities cease. In addition, the removal of coal seam water may create a situation where some coal mines would need to purchase water for dust control.

The drawdown of groundwater does not represent an immediate impact to surface lands resulting from subsidence. The thinness of the coal seam aquifers and their shallow depth should prevent them from being substantially impacted by groundwater withdrawal and subsequent aquifer compaction.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Conclusion

The cumulative impacts for this alternative would be similar to Alternative B with some exceptions. The removal of the buffer zone around coal mines would result in increased drawdown within the mines from CBM production. After mining has ceased, the added dewatering will need to be remediated by the mine operators. Remediation bonds executed by the mine operators prior to operations will need to be honored. Unless the impact of the CBM production can be separated from impacts by the coal mine, the remediation bond will force the mine operator to spend more money to remediate the aquifer. Coal mine operators may develop aquifer mitigation agreements with CBM operators prior to CBM production. The mitigation measures for this alternative would be similar to Alternative A.

Alternative D

Impacts from management objectives outlined in Alternative D would be similar to the impacts described under Alternative B.

Crow Reservation

Impacts to the Crow Reservation would be similar to impacts described in Alternative B.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to impacts described in Alternative B.

Alternative E (Preferred Alternative)

Impacts to coal and existing coal mines would be the same as Alternative A because a buffer zone would not be required around existing coal mines.

Impacts to CBM resources would be the same as Alternative B if all coal seams are produced simultaneously or to Alternative C if coal seams are produced separately. Impacts to CBM production and wells would be the same as Alternative A because multiple seam production through a single well bore would not be required.

Impacts on conventional oil and gas resources would be the same as in Management Common section.

The production of CBM by state and private wells, and the venting of CBM represents the irreversible and irretrievable loss of the resource. Drainage by off-lease CBM wells represents the irreversible and irretrievable loss of the resource and royalties to the lessee of the lease being drained.

This alternative allows the operator to use best engineering practices to demonstrate in the Project Plan how they will develop their coal leases. The use of best engineering practices does not prevent the

irretrievable commitment of this resource but may reduce the amount of resource loss during development and production.

Crow Reservation

Impacts to the Crow Reservation would be the same as described in Alternative C. A buffer zone would not be established around the borders of the Reservation which could allow the drainage of CBM resources on the Reservation by adjacent wells. These impacts would be mitigated by a hydrologic barrier, communitization agreement, or spacing to protect reservation CBM resources from drainage.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to impacts described in Alternative C. These impacts would be mitigated by a hydrologic barrier, communitization agreement, or spacing to protect reservation CBM resources from drainage.

Conclusion

The cumulative impacts for this alternative would be similar to Alternative B. The major difference would be impacts to other resources and land uses from the disposal of produced water. Produced water could be injected, disposed of onto the surface, disposed of into water bodies, or used for beneficial uses. Disposal of water produced with CBM should not impact mineral resources.

Under this alternative, impacts would be similar to Alternative B with the exception that injection of produced water would not be required. Injection of produced water into a subsurface formation approved by the state would be one water management option available to operators under this alternative. Other produced water management options would be making produced water available for beneficial uses and treating, as needed, produced water before being discharged onto the surface or into bodies of water. Impacts from produced water management options are described in other resource sections, such as hydrology and soils.

Weathered landscape with exposed Fort Union Coal Formation

Hydrological Resources

Assumptions

CBM development has the potential to impact surface water and groundwater resources in the planning and CBM emphasis area. The following assumptions form the framework for analyzing the impacts:

- The productive life of a CBM well is estimated to be 20 years.

- The average groundwater production rate, over the estimated 20-year life of a CBM well in Montana, is expected to be 2.5 gpm (ALL 2001b). This average rate accounts for initial, short-term CBM groundwater production rates that can be as high as 20 to 25 gpm per well, followed by steady declines in the rate of groundwater production over the life of an individual CBM well as groundwater levels within the producing area are stabilized. The average estimated producing rate was calculated based on data from CBM wells that have been producing at the CX Ranch site near Decker, Montana. Water production data from these wells were obtained from the MBOGC, normalized to the age of each well and averaged to determine a decline trend. The decline rate was extrapolated for a total production period of 20 years. Water production rates were then estimated based on the extrapolated trend line over the entire 20-year period and averaged to determine the estimated 20-year average rate of 2.5 gpm. The maximum total field discharge would occur in years 6 and 7 of the RFD, when production rates per well would be 7.1 and 6.1 gpm, respectively.

  In addition to performing trend analysis, water production rates were compared to water production rates for CBM wells in Wyoming. It is reasonable to consider CBM water production rates in Wyoming while determining an average rate for CBM development in Montana because of hydrogeologic similarities. In 1997, the average water production rate in the Wyoming portion of the Powder River Basin was approximately 11.9 gpm (WOGCC 2001). Through the first eight months of 2001, the average water production rate for a total of 5,762 CBM wells had decreased to approximately 7 gpm (WOGCC, 2001). This trend of decreasing average water production rates supports the average values used for purposes of impact analysis in Montana, especially considering that many of the wells included in the Wyoming analysis are still in early stages of production.

  It is important to understand that the estimated 20-year average production rate was determined from a relatively small number of wells in a discrete area in the Powder River Basin of Montana. Actual rates could vary by area as a result of variations in coal thickness, aquifer recharge, aquifer characteristics, and other geologic and hydrologic circumstances. This is especially important when considering potentially productive areas outside the current producing area and potentially productive areas in Blaine, Park, and Gallatin Counties.

  It is also important to recognize that the 20-year average rate is very different than the rate used in the Wyoming CBM EIS (BLM 1999b). For Wyoming, the BLM used a snapshot derived from 1997 production data that represented water production rates in the initial production stages of a CBM well. Had the BLM in Wyoming chosen to use an average rate over the entire life of a CBM well, that average would align more closely with the 20-year average assumed for impact analysis in Montana.

- The quality of CBM-produced groundwater throughout the planning area is assumed to be the same as the quality of CBM-produced groundwater from the CX Ranch field near Decker in the Powder River Basin (ALL 2001b).

- It is assumed that the sodium content of water produced from CBM wells is the target contaminant that determines the usefulness of the water for crop irrigation. Irrigation is the primary beneficial use for the majority of water resources in watersheds expected to have the greatest potential for CBM development, especially with respect to the Montana portion of the Powder River Basin. Sodium causes osmotic stress to plants and destroys texture of clayey soils; these combined effects make sodium content, and especially SAR, a point of emphasis when gauging impacts to water resources from CBM water. Other parameters such as TDS, bicarbonate, nitrogen, and barium concentration may be locally important in determining restrictions to beneficial use. Ammonia and fluoride were limiting factors for the permit at the CX Ranch.

- MDEQ regulates surface discharge of water produced with oil and gas in the state of Montana, except on Indian lands where EPA regulates surface discharge of produced water. The state of

Montana does have numeric water quality standards for some, but not all, water constituents. To facilitate analysis, a range of water quality criteria is assumed based on discussions with representatives of the MDEQ and representatives of other state and federal cooperating agencies. Watersheds in the CBM emphasis area, which essentially includes the Montana portion of the Powder River Basin, can generally be categorized as either high-quality or low-quality. High-quality streams include the Tongue River, Little Bighorn River, and others that may be similarly characterized. Streams that would be categorized as low-quality include the Powder River, Little Powder River, Bighorn River, and other streams that are relatively low in quality. Numeric water quality criteria for SAR, EC, and bicarbonate were developed for these watersheds (MDEQ 2001c). These particular parameters were chosen because of their significance with respect to CBM development and environmental impacts. SAR is the most restrictive criterion as it represents a potential threat to soil condition and crop vigor. EC is an important measure for monitoring productivity of soils. Bicarbonate is a criterion that affects aquatic biota; bicarbonate shows a range of toxicities as measured by researchers (Mount et al. 1997, Ranney 2001). Numeric criteria for high-quality watersheds include a range of SAR from 2 to 12, EC of 1,000 micro-siemens per centimeter (µS/cm), and bicarbonate from 1,000 to 1750 milligrams per liter (mg/l). For the low-quality watersheds, a range for SAR from 9 to 12, EC of 1,600 µS/cm, and bicarbonate from 1,000 mg/l to 1750 mg/l were assumed. CBM development within the Powder River Basin of Wyoming and Montana has the potential to impact surface water quality within the watersheds of the entire basin. The states of Wyoming and Montana recognize this concern and, in an effort to protect the water quality within the Powder River Basin, have entered into an 18-month interim memorandum of cooperation. The two states will cooperate to protect water quality in the Powder River Basin while allowing for CBM development. A copy of the interim memorandum of cooperation can be found in the Hydrology Appendix. The interim memorandum of cooperation is intended to specifically protect the downstream quality of the Powder and Little Powder watersheds that enter Montana from Wyoming. The agreement establishes interim thresholds only for EC in the Powder River at the state line based on monitoring data from the Moorehead, Montana, gauging station. The criteria for EC are expressed in monthly maximum values that are not to be exceeded. The two states are also concerned with SAR and bicarbonate, but lack sufficient data. For the Little Powder River, monitoring of the EC, SAR, and TDS will be performed by the state of Montana to determine if these levels change appreciably. If considerable changes are detected, the state of Wyoming will be notified, at which time Wyoming will perform investigations to determine if CBM activities are responsible and adjust its regulatory position to ensure the compliance with the spirit of the agreement. Further, Montana has accepted Wyoming's anti-degradation policy to be protective of Montana's water quality.

For Alternative C, all CBM production water is discharged continuously, and there is no storage or treatment. Because the thresholds to protect irrigation apply only during the irrigation season, this assumption results in an underestimate of the number of wells that could discharge without exceeding the thresholds.

- CBM Discharge Rate: 2.5 gpm/well (single well 20-year average)
- Beneficial Use: 20%
- Conveyance Loss: 70%
- Effective Discharge to Rivers: 24%
- CBM Water Quality: EC of 2207 µS/cm (mean of CX ranch CBM produced water); SAR of 47; same values were used for all drainages
- Stream Flow Rates: low mean monthly flow rates as shown in Table 3-4
- Stream Water Quality: low flow EC and SAR as shown in Table 3-5
- EC and SAR Limits: based on no reduction in infiltration EC-SAR relationship further limited by suggested MTDEQ thresholds (high level): SAR <= 12 for the Powder, Little Powder, and Mizpah Rivers, SAR <= 2 or 12 for all other streams
- Cumulative Impacts from Upstream Development: All upstream development including development in Wyoming is evaluated for each watershed. If multiple stream gauge locations occur in a watershed, the projected number of wells is divided equally among the reaches represented by the stations
- Allocation Factors: 50/50 between Wyoming and Montana

Impacts From Management Common to All Alternatives

Conventional Oil and Gas Production

Conventional oil and gas production can produce large volumes of water that could impact surface and groundwater resources because of the quality of the produced water. Since 1953, the MBOGC has regulated the use and disposal of water produced in association with the production of oil and natural gas in order to mitigate the potential for impacts to the environment. The use of surface impoundments is controlled by BLM and the state. BLM permits water disposal pits (surface impoundments) on federal leases. The permitted surface impoundments are those designed primarily for evaporation. Any impoundments constructed in the state, including those involving federal land or minerals, would require approval from the MBOGC. Further, the MDEQ permits any point source discharges to surface waters (e.g., streams), including those that could result from surface impoundments. Conventional oil and gas is typically produced from depths below usable aquifers and below coal seams. Regulations require the isolation of oil and gas producing zones from other reservoirs containing possible hydrocarbons or from aquifers that contain usable water. Underground Injection Control (UIC) regulations also require safeguards to isolate injection zones from other zones that contain hydrocarbons and from aquifers that contain usable, or potentially usable quality water (i.e., groundwater containing less than 10,000 mg/l of total dissolved solids). Produced water that has a TDS concentration of less than 15,000 mg/l can be discharged to permitted surface impoundments. As a result of the existing regulations, the impact on surface water and groundwater resources from conventional oil and gas production is minimal.

Impacts from Management Specific to Each Alternative

Alternative A

Alternative A consists of the existing CBM management scenarios. The following are the impacts expected from CBM exploration, production, and abandonment.

Exploration

CBM exploration activities on state, fee or BLM-administered mineral estates would not result in additional impacts to surface water or groundwater. Exploration wells would be tested but not commercially produced. Testing of CBM exploration wells involves pumping the wells for several weeks; however, the volume of groundwater removed is moderate and is not expected to impact nearby water wells or springs. Recovered produced water and drilling wastes would be contained in impoundments or tanks and would be disposed of in accordance with regulations for conventional oil and gas wastes.

Production

CBM water production would continue to be allowed within the CX Ranch CBM field, but at a level approximately 20 percent above current conditions; this would constitute a total of 250 producing wells. The majority of produced waters would continue to be discharged to the Tongue River with small amounts being diverted to surface impoundments, used for stock watering, and for use by coal mines to control dust.

The projected level of CBM production at CX Ranch would have an impact on the quality and quantity of surface water within the area. The discharge of CBM-produced waters to surface water would be in accordance with the provisions of the existing MPDES Discharge Permit that allows for the discharge of up to 1600 gpm (3.3 cfs) into the Tongue River. The maximum discharge would result in a river flow volume of approximately 178 cfs of water with an average SAR value of 2.0 (up from 1.1) during base flow, and 1,470 cfs of water and an average SAR value of 0.5 (up from 0.4) during times of high flow. Water would continue to be delivered to the discharge points by pipeline to avoid soil erosion along the pipeline route. The change in water quality noted above would not affect current water use and would be within assumed water quality criteria. The increase in flow volume would not be sufficient to cause added erosion to stream banks or streambeds. An increase in soil erosion resulting from the construction of additional well pads and lease roads could occur adding to the suspended sediment load of area surface waters.

The 250 producing CBM wells at the CX Ranch field would also have an impact on groundwater resources within the area. Production at this level would result in increases to groundwater drawdown levels within the three coal seam aquifers being produced. Groundwater drawdown currently extends at least 1.8 miles beyond the edge of CBM production at the CX Ranch field. Increasing the size of the field by approximately 20 percent would add to the drawdown, which, with the increased production, is estimated via computer modeling to eventually extend up to 14 miles from the

edge of production (Wheaton and Metesh 2001). Groundwater impacts could also take the form of dry springs caused by coalseam aquifer drawdown This phenomenon could be expected to take place also up to 14 miles from production. Water released to unlined surface impoundments has the opportunity to infiltrate into shallow aquifers, causing measured impacts to the depth to water in the alluvial aquifers and alluvial wells.

Abandonment

Abandoned well pads would be restored to their original condition with the only impact having been the short-term increase in suspended sediments in area surface waters resulting from the increased erosion of disturbed soil. CBM wells that are not produced would be abandoned in accordance with existing regulations and with procedures for the abandonment of oil and gas wells to protect groundwater resources, or converted to monitoring wells as directed by the BLM.

Crow Reservation

The Crow Reservation can expect few impacts from CBM development within Montana under this alternative. Continued development is expected in the CX Ranch field near Decker. Computer modeling has shown that coal aquifers could be impacted approximately 14 miles from production and this could impact water wells and springs on tribal land. Scattered exploration CBM drilling and testing could impact reservation groundwater.

CBM development in Montana and Wyoming could drain groundwater and methane from coal seams under the Reservation. If Wyoming CBM operators are able to discharge CBM water to either the Little Bighorn or Bighorn watersheds, there could be impacts to surface waters on the Reservation.

Northern Cheyenne Reservation

The Northern Cheyenne Reservation can expect continued impact by CBM development outside the reservation under this alternative. The CX Ranch has a permit to discharge CBM water to the Tongue River and this will continue under this alternative. Computer modeling has shown that CX Ranch production could impact coal seam aquifers 14 miles distant. This groundwater drawdown impact should not reach the Northern Cheyenne Reservation.

CBM development in Wyoming is not expected to impact groundwater under the reservation. If operators are able to discharge water into the Tongue River, the impact could be expected to reach surface waters in the reservation with attendant loss of water quality.

Conclusion

Montana-based CBM development, conventional oil and gas development, and surface coal mining would have the potential for impacts to surface water and groundwater resources in Montana. Under Alternative A, few CBM wells would be drilled and impacts would be limited in both magnitude and geographic extent. CBM development at the CX Ranch field would expand, although surface discharge volume to the Tongue River would be controlled by an existing permit. Groundwater impacts to coal seam aquifers from the CX Ranch would extend out as far as 14 miles from development. Scattered CBM exploration and testing would impact coal seam aquifers to a limited extent, but would not be expected to impact surface waters.

Coal seams that are the targets of surface coal mining operations typically contain groundwater. As a result of the presence of this water, coal mine operators must remove this water as it collects in the bottom of the pits in order to mine the coal. Map 4-2 shows coal mines in the planning area. These mines cover approximately 50,000 acres where coal seam aquifers have been impacted either by the removal, partial depletion, or total depletion of groundwater. In the mining areas around Colstrip and Decker, coal seam aquifers have been drawn down by as much as 75 feet near the coal mines, with a radius of impact of up to four miles from the mines (Wheaton and Metesh 2001). The discharge of groundwater pumped from mine pits would also affect surface water depending on the quality of groundwater within the mine vicinity and the quantity of groundwater discharged. In instances where the mines do not discharge because all of the recovered groundwater is used, there would be no direct impacts to surface water quality. Much of the groundwater pumped from the mine pits would be stored and used to control dust on roads, truck and train car loading areas, and the mine face.

During periods of precipitation, stockpiled soil cover and mine spoils can be eroded and transported to surface waters. Surface water quality within the vicinity of the coal mines would be impacted by increased sediment load resulting from the increased erosion associated with mining activities. This would be mitigated by the use of sediment settling ponds and the vegetation of overburden and topsoil storage areas. In some instances, mining activities require the diversion of streams or drainage areas that are within the area to be mined. Original topography, including

stream channels and drainage areas, would be restored during mine reclamation activities.

CBM development in Wyoming would have the potential to cause substantial impacts in Montana to surface water quality and groundwater resources. The large number of CBM wells forecast for the Wyoming portion of the Powder River Basin would manage produced water in some manner. The Wyodak EIS (BLM 1999b) projected that 6,000 CBM wells would be developed in the Wyoming portion of the Powder River Basin. To estimate impacts of this development scenario, the BLM estimated an average production rate of 12 gpm per CBM well for a discrete producing period (BLM 1999b). The level of development, combined with the assumed water production rate, would result in an approximately 1.1 percent increase (452 cfs to 457 cfs) in the average flow volume of the Powder River at Moorhead, Montana (BLM 1999b), and an increase of approximately 50 percent (22 cfs to 33 cfs) in the average flow volume in the Little Powder River at the Weston station, which is located approximately 20 miles south of the Wyoming/Montana border. Although these estimated increases are based on yearly averages, the Powder River flow volume could be increased by CBM related discharges more than 800 percent during low-flow periods. Flow volumes into the Little Powder River during times of extreme low-flow could consist almost entirely of discharged CBM produced waters due to the ephemeral nature of this and other watersheds in the Powder River Basin (BLM 2001b).

Surface water quality would be similarly affected by CBM water discharge with yearly average SAR values increasing from 4.0 to 4.1 in the Powder River and from 6.0 to 7.5 in the Little Powder River. Water quality parameters other than SAR would be impacted similarly to SAR, including chloride and barium, which can also result in both direct and indirect environmental impacts. Impact to the quality of water within the Powder River during low-flow periods is expected to increase water quality concentrations for compounds common to CBM produced water, including increases in the SAR from values that could be as low as 1 up to approximately 17. During low-flow periods in the Little Powder River, SAR is expected to increase from approximately 6.5 to an estimated value of approximately 9. The Wyoming EIS (BLM 1999b) did not address potential impacts to the Tongue River from discharge of CBM-produced waters within Wyoming. However, it is expected that impacts of similar magnitude to those predicted for the Powder and Little Powder could occur.

Following the release of the Wyodak EIS (BLM 1999b), the BLM reassessed the RFD for the Wyoming portion of the Powder River Basin and issued a new RFD (BLM 2001a). This more recent study indicates that the total number of CBM wells in the Wyoming portion of the Powder River Basin may approach 50,000 (BLM 2001a). An EIS using this level of development is in progress, but some extrapolations can be made from the existing EIS.

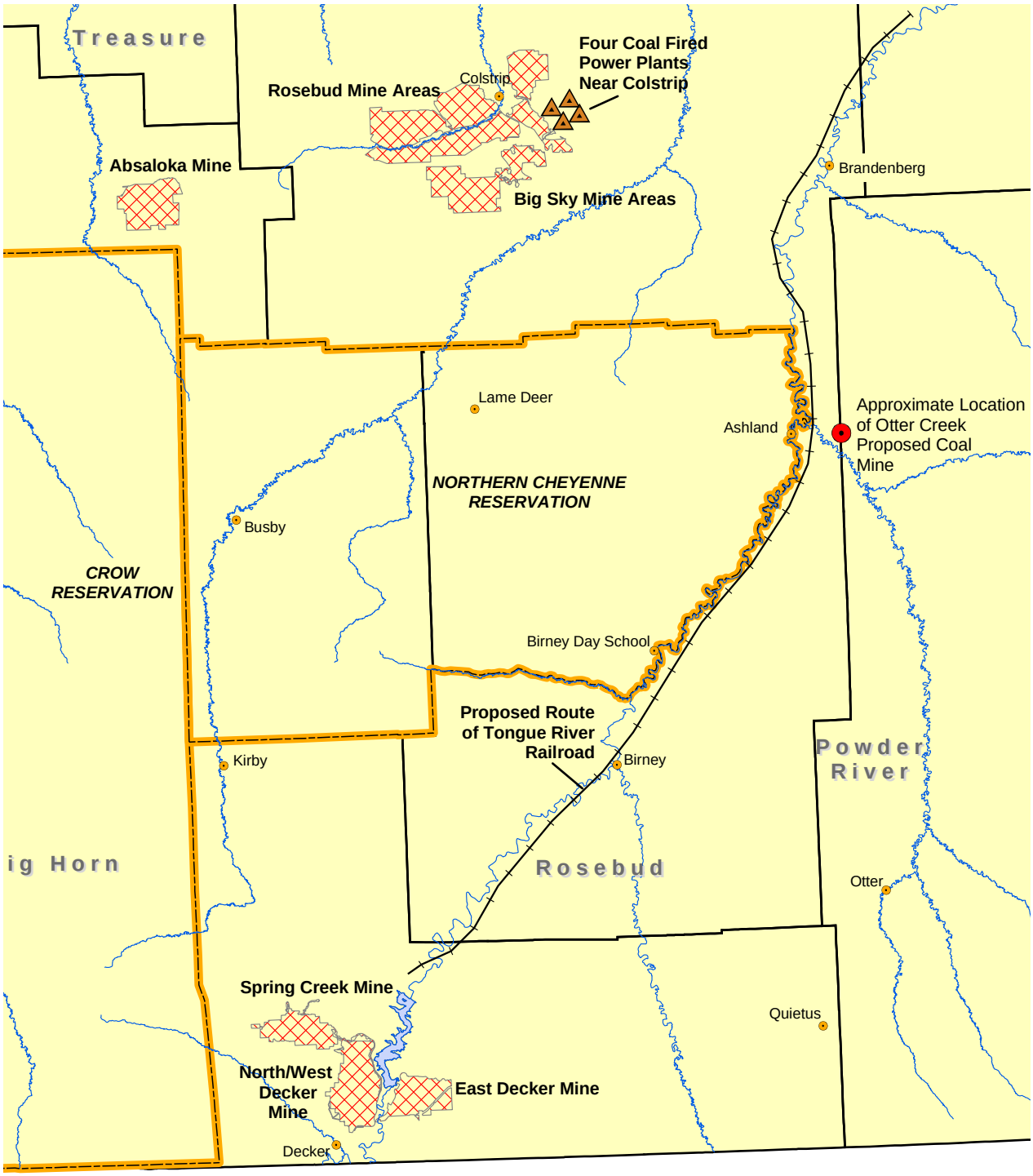
Rivers within the Wyoming portion of the Powder River Basin show considerable seasonal variation in terms of flow volume and water quality. The flow volume in the Powder River ranges from a maximum of 1,400 cfs to a minimum of 0.5 cfs. Water quality also varies because flow volume contains varying amounts of meteoric water added to the base-flow contributed by groundwater. If CBM water discharge rates are essentially constant throughout the year, resultant flows in the river would vary depending upon the ratio of CBM discharge to natural river flow. Impacts to the Powder River would include a 9 percent increase in the annual average flow volume (450 cfs to 500 cfs), as well as an increase in the annual average SAR value from 4.0 to 5.2. Impacts during natural low-flow periods, however, would cause the river to flow at rates 70 times normal with SAR values in excess of 17.

Annual average flow within the Little Powder River with the impact of CBM discharge water is extrapolated to increase from 22 cfs to 92 cfs and a resultant SAR up from 6 to 9. Depending on how CBM-discharges are managed in Wyoming, these flow rates and water qualities could be maintained during traditionally low-flow periods when the river is normally often dry, resulting in SAR and TDS values comparable to undiluted CBM water.

Impacts to surface water quantity and quality resulting from the increase in the number of CBM wells and the resultant increase in the volume of CBM water discharged in Wyoming would be possible. The Upper Tongue River watershed is currently the site of CBM production and it is expected that more development would occur. Impacts to the Tongue River in Montana would be commensurate with impacts to the Powder and Little Powder Rivers by Wyoming CBM production. These impacts would result in increases in surface water quantity and decreases in quality. This could result in 3 to 5 times more water entering Montana and an increase in SAR from 0.7 to 5. This is important because Tongue River water quality is the highest in the Powder River Basin and the river feeds the Tongue River Reservoir.

Groundwater resources in Montana could also be impacted by CBM production in Wyoming. CBM-producing wells in northern Wyoming would cause a

Map 4-2: Location Map, Regional Coal Mines



Legend

- Cities
- Rivers
- Coal Mines
- Native American Reservations

5 0 5 Miles

5,000 0 5,000 10,000 Meters

N W E S

DATA SOURCES

County Boundaries: 1:100,000 scale, Counties, Montana State Library/NRIS, Helena, Montana.
Cities: 1:100,000 scale, Cities, Montana State Library/NRIS, Helena, Montana.
Mines: Montana Bureau of Mines & Geology.
Otter Creek Site: EMRIA Report #1, 1975.

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drawdown of coal aquifers on adjacent land, with groundwater drawdown possibly extending northward into Montana. Groundwater computer modeling for the Wyodak EIS, which used the estimate of 6,000 CBM wells in Wyoming, indicates that the 5-foot drawdown level could extend up to 14 miles from the edge of production, given a 12-gpm per well rate of water withdrawal (BLM 1999b). The modeling values are based on assumptions made regarding the known geology of the Wyoming portion of the basin, which field data has shown to differ from the Montana portion of the basin. The Wyoming coal seams that have been developed are deeper and thicker than the seams in Montana. In addition, the 12-gpm water production value for the state was a "snap-shot" derived from current production data at a single point (1997) early in the life of the CBM play. The 20-year average rate of 2.5 gpm for Montana was derived from carefully organized data from a single CBM field considering production trends with time. Nonetheless, both the 12 gpm and the 2.5 gpm rates are projections that will be monitored and refined over time as CBM development proceeds. Given these groundwater modeling results and related assumptions, if CBM fields were located in Wyoming adjacent to the border with Montana, this could affect groundwater levels for a distance of up to 14 miles into Montana, assuming the parameters used in the Wyoming computer model are applicable to this area of Montana. Drawdown impacts of this magnitude would result in impacts on private lands, the Crow Indian Reservation, state-owned lands, and federal lands controlled by BLM.

Cumulative surface water impacts from Wyoming and Montana CBM development under Alternative A could be severe and could prevent the surface discharge of any Montana CBM water. If Wyoming CBM development reaches expected levels and if large quantities of water are discharged, Montana watersheds could be degraded to the point where water quality criteria (MDEQ 2001c) could prohibit any discharge. If, however, interstate agreements or Montana Water Quality Standards limit Wyoming discharges, the cumulative effects to surface water in Montana would not impact water uses in Montana. Cumulative groundwater impacts would be largest near CX Ranch and close to the Wyoming border.

Surface water discharge permits that limit the quantity or quality of discharged CBM water would mitigate the impacts from Wyoming CBM production and from expanded CX Ranch production. Mitigation agreements would be needed to replace water lost from drawdown of groundwater within aquifers and springs impacted by Wyoming CBM production, Montana CBM production, and Montana coal mines. If no replacement water is available for mitigation, there may be a need to restrict the volume of water produced if alternate sources, potentially from off-site locations, cannot be provided in lieu of local sources.

Alternative B

Alternative B consists of full-scale development of CBM with water produced from CBM exploration wells stored in tanks or impoundments, and water produced from CBM production wells injected into approved subsurface zones other than the seam it was produced from. The estimated 16,500 producing CBM wells would draw down groundwater levels within coal seam aquifers over several areas of the state, impacting water wells and springs within the area of drawdown. The construction of well pads and lease roads would result in surface disturbances that would increase the potential for soil erosion. No CBM water would be discharged to the surface.

Exploration

Full-scale CBM exploration would require water generated from the testing of CBM exploration wells be stored in tanks or impoundments on state and federal lands. Construction permits would require suitable mitigation measures to reduce leakage from impoundments. The estimated 2,000 dry CBM exploration wells would result in the short-term disturbance of approximately 2,000 acres of land at the well sites. These disturbed acres would be vulnerable to soil erosion that would cause run-off water impacted by suspended sediment. BMPs to curtail soil erosion such as water bars across lease roads, relieving and mulching cut-banks, and restoration of the surface would serve to mitigate erosion related impacts to surface water resources. Short-term testing of CBM exploration wells would not substantially impact area groundwater resources. However, groundwater modeling has suggested that substantial local drawdown may occur within the first year of production.

Production

Under Alternative B, CBM production is expected to be concentrated in the Powder River Basin, but could also develop locally in other portions of the state. This full-scale level of CBM development would result in the potential for impacts to surface water resources from increased soil erosion and the accidental releases of produced water. Full-scale development of 16,500 producing CBM wells would disturb an estimated 54,000 acres, which would increase the potential for soil erosion and the corresponding impact

to surface water. However, the implementation of BMPs described in the preceding paragraph would reduce the potential for impacts from soil erosion. The projected 16,500 production wells would generate an estimated average of 2.9 billion cubic feet of produced water per year over 20 years. This produced water would have an average TDS of 1,400 mg/L, and an average SAR value of 47. However, using the assumptions in the RFD, the extrapolated discharge trend line, it is calculated that the maximum discharge would occur in years 6 and 7 of the plan. During year six, 7,710 wells would be producing with an average discharge of 7.1 gpm per well, for a total discharge of 3.85 billion cubic feet of produced water in that year. 3.85 billion cubic feet of produced water would also be discharged in year 7 of the RFD; however, in that year there would be 8,970 producing wells with an average discharge of 6.1 gpm per well. Water management options under this alternative would consist of the injection of CBM-produced waters into approved subsurface zones; the surface discharge of CBM waters from production wells would not be allowed. Some of the produced water would be temporarily stored in tanks or impoundments prior to injection - storage would not be long-term, but these facilities could nonetheless fail, causing localized impacts to surface water and shallow groundwater. The implementation of BMPs concerning the location and construction of these impoundments would mitigate the potential for impacts to surface water from the stored produced waters. Berms around tank batteries would reduce the potential for impacts from leaks and catastrophic failures.

Groundwater resources would be vulnerable to impact from groundwater drawdown levels resulting from full-scale CBM production. The same volume of water produced would be removed from coal seam aquifers, resulting in impacts to water wells and springs. Surface water bodies and springs should not be impacted directly from groundwater withdrawal due to the depth and confined nature of the individual coal seam aquifers. Groundwater resources up to 14 miles from producing CBM fields would potentially be impacted by coal aquifer drawdown (Wheaton and Metesh 2001). During the 20-year planning period for CBM production, groundwater levels within coal seam aquifers could be drawn down over large, contiguous areas of the state. For example, the Upper Tongue watershed covers 590,000 acres and could hold 5,800 CBM wells as projected in the *Water Resources Technical Report* (ALL 2001b). These wells would produce an estimated combined total of 1.02 billion cubic feet of CBM-produced water per year. Over the life of the project, 60 percent of the groundwater could be lost to CBM production in this watershed. Following methodology detailed in the *Water Resources Technical Report* (ALL 2001b), total groundwater resources per watershed and groundwater depletion estimates after 20 years for other watersheds are listed in Table 4-2.

TABLE 4-2
GROUNDWATER DEPLETION BY CBM DEVELOPMENT IN THE MONTANA POWDER RIVER BASIN

Watershed	Potential CBM Producing Wells	Potential Produced CBM Water in 20 years (billion cubic feet)
Little Big Horn	675	2.5
Little Powder	200	0.7
Lower Bighorn	800	2.8
Lower Tongue	3,450	12.0
Lower Yellowstone	1,700	6.0
Middle Powder	2,100	7.4
Mizpah	125	0.5
Rosebud	3,600	12.6
Upper Tongue	3,850	13.5
Total	**16,500**	**58.0**

Note: Calculated maximum potential groundwater production by watershed and resulting depletion (billion cubic feet) after 20 years of CBM production. Details on the method used to calculate these numbers can be obtained from the *Water Resources Technical Report* (ALL 2001b).

The nature of the Fort Union Formation coal seam aquifers that contain the methane gas (i.e., layers of coal interbedded with shale layers having low vertical hydraulic conductivity) should minimize impacts to aquifers above these seams. Shale layers above the coal seam aquifers should provide some degree of protection from drawdown associated with CBM production from the coal seams. Shale layers are confining units that isolate aquifers, such as coal seams and/or sandstone units. The shale layers limit vertical migration of groundwater, thereby reducing leakage and loss of resource from overlying aquifers. Although production of CBM water will enhance cleat within the coal seams, it should not propagate vertical fracturing into the adjacent shale confining units. The impacts to shallow aquifers would more likely result from the disposal of CBM produced water by discharge to land or surface water bodies, re-injection, or one of many beneficial use options (e.g., controlled irrigation, dust control, storage impoundments, etc.).

Impacts on groundwater resources would occur but are difficult to quantify with the available data. As more of the groundwater is depleted, more area water wells and springs would be impacted and it would become more difficult to mitigate water well impacts by transporting water to residents. Depending on the distribution of the CBM development, aquifer drawdown could be concentrated in scattered producing areas. Mitigation agreements are expected to facilitate replacement of water lost to the drawdown of groundwater levels within area aquifers, but in areas of concentrated depletion (such as predicted for the Little Big Horn watershed), water supplies may not support water replacement. In such cases, agriculture that depends upon groundwater may be limited.

Recovery of the coal seam aquifers after production ends is a slow process involving recharge from undrained areas of the aquifer, infiltration from aquifers above the coal seams, and infiltration of precipitation from the surface. Modelers that assisted the Wyoming BLM determined that coal seams that have experienced substantial drawdown see recovery as a two-part process (BLM 2000). "After CBM development (and water removal) ends, within three to four years water levels in the coal aquifers are expected to partially recover to within 20 to 30 feet of pre-operational conditions. Complete water level recovery will be a long-term process, likely requiring hundreds of years for the removed groundwater to be replaced through the infiltration of precipitation." A similar recovery process is expected to occur in the Montana area of CBM interest with most of the recovery happening in a short time but full aquifer recovery not happening within the lifetimes of any of the state's residents. Local groundwater recovery conditions may be different but landowners, CBM operators, and land managers need to be aware of the possible impacts to coal seam aquifers in the vicinity of CBM production.

Deep injection of an estimated 2.9 billion cubic feet of produced water annually throughout the state would not impact coal seam aquifers. The injection of CBM-produced water has not been conducted in Montana, but is commonplace for waters produced from conventional oil and gas activities. In the year 2000, the state of Montana averaged 847 injection/disposal wells that disposed of 0.6 billion cubic feet of water every year (average injection of 128,000 bbl of water per well per year). Injection of CBM water is estimated to increase the number of injection wells to nearly 3,000. These new CBM injection wells would have an average injection rate of 265,000 barrels of water per well per year. This water would be injected into deep aquifers, whose water is not fit for use. Given the effectiveness of current injection regulations, the increase in injected volume resulting from CBM production is anticipated to have only a minimal impact on surface water or groundwater resources.

In those portions of Montana where CBM is developed outside of the Powder River Basin, CBM production is not expected to be as concentrated and hydrological impacts would be less. Limited CBM production in these areas would result in the localized drawdown of groundwater levels within coal seam aquifers with the extent of the drawdown estimated at less than 10 miles from the edge of production (Wheaton and Metesh 2001).

Abandonment

When the estimated 16,500 production wells are abandoned throughout the life of the resource in the planning area, 33,000 acres of soil would be disturbed for a short time period. This disturbed soil would be vulnerable to erosion and the resulting suspended material could be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would mitigate the potential for impacts to surface water resources resulting from soil erosion until groundcover and original site conditions are restored.

Crow Reservation

Surface water impacts on Crow Tribal Lands under Alternative B are expected to include those impacts noted in Alternative A with the added impacts of suspended sediment due to soil erosion and runoff from the disturbed acreage resulting from increased

CBM development in the vicinity of the Crow Reservation. Groundwater impacts will include those detailed in Alternative A as well as additional impacts from nearby wells in the RFD. The tribe can expect drawdown of coal seam aquifers from CBM wells within 14 miles of the reservation boundaries. This drawdown would impact water wells and springs within the reservation. In addition, because of the large presence of fee land within the exterior boundaries of the Crow Reservation, CBM development on those non-reservation lands would also cause impacts to surface water and groundwater in a manner consistent with other areas of the Powder River Basin.

Northern Cheyenne

Surface water impacts on Northern Cheyenne Tribal Lands under Alternative B would include those impacts noted in Alternative A with the added impacts of suspended sediment as a result of soil erosion and runoff resulting from increased CBM development in the area surrounding the Northern Cheyenne Reservation. Groundwater impacts on the reservation would be similar to impacts in other areas of the Powder River Basin. The tribe can expect drawdown of coal seam aquifers from CBM wells within 14 miles of the reservation boundaries, and this drawdown would impact water wells and springs within the reservation.

Conclusion

Impacts on surface water and groundwater as a result of Wyoming CBM development would be same as discussed under Alternative A. Impacts on surface water under this alternative will include those impacts listed under Alternative A plus the impact of suspended sediment generated by soil erosion taking place in the vicinity of CBM development as projected in the RFD.

CBM production in Montana under Alternative B would result in the withdrawal of approximately 23 percent of the groundwater resources in Montana's Powder River Basin watersheds. This production coupled to a similar level of development on the Crow and Northern Cheyenne reservations would cause the depletion of groundwater to increase to 35 percent. In water wells near CBM fields, the drawdown of coal seam aquifers could be in excess of 100 feet. Water well and spring mitigation agreements would facilitate replacement of groundwater lost to the drawdown of groundwater levels within these coal seam aquifers. Replacement of groundwater supplies may be difficult in some areas and may require supply from off-site sources.

Alternative C

Alternative C consists of the direct discharge of CBM-produced waters to the land surface. Impacts to water resources resulting from this alternative would be a combination of drawdown-related effects similar to Alternative B, and effects due to the large volume of CBM water being discharged to the ground, and allowed to flow into drainages and water bodies. Discharge to the ground would cause increased soil erosion between the discharge point and the nearest drainage. There would be a corresponding increase in the suspended sediment load in surface waters adjacent to CBM development. As CBM water slows along drainages, infiltration of the water would occur, resulting in rises in groundwater elevations, and shifts in the chemistry of the groundwater. In the long term, this would result in diffuse discharge of low-quality water into waterways as the CBM water flows downgradient in the alluvial aquifers until a perennial waterway is reached. That CBM water which is not infiltrated or evaporated en route would reach perennial waterways as point discharges. The addition of CBM water to drainages and surface water bodies, through both point and diffuse discharges, would increase erosion of the stream banks. The increased flow volume, changes in water chemistry, and loss of soil structure would result in increased suspended sediment loads. The chemistry of the surface waters would also be impacted, rendering it unsuitable for some uses by humans and wildlife.

Exploration

Similar to Alternative B above, the moderate volume of water generated by the testing of CBM exploration wells would be stored in tanks or impoundments to be discharged under the appropriate permits.

Production

Alternative C assumes that 80 percent of the volume of CBM water produced would be discharged directly to the land surface adjacent to the wellhead. Impacts to water resources would consist of those effects of drawdown described in Alternative B, soil erosion and the increase in suspended sediments in area rivers and streams, changes in the elevation of groundwater in alluvial aquifers, changes in alluvial aquifer water chemistry, and changes in the chemistry of perennial water bodies. Each CBM well would discharge at an estimated average rate of 2.5 gpm over 20 years. The maximum discharge would be achieved in years 6 and 7 of the RFD. The total discharge in years 6 and 7 would be approximately 58,500 gpm, from 7,710 and 8,970 wells respectively. The discharge at the CBM

wellhead would result in the erosion of soils creating gullies that would lead to natural runoff areas where the water would join natural drainage. These natural drainages or ephemeral portions of the water-course would also be impacted by increased erosion and would likely become more nearly perennial as result of receiving CBM discharge water. Before the CBM water reaches surface water, some portion would evaporate or infiltrate into the soil. The portion lost would depend upon season of the year, permeability of the soil, and the presence of a shallow, unconfined aquifer connected to surface water.

Produced water discharged to the surface would be released in several ways: directly to surface water or drainages, into on-drainage impoundments, and into off-drainage impoundments. These three methods would impact surface and groundwater in different ways. Water lost to infiltration or evaporation would depend upon the distance of transport to the surface water body, the amount of CBM water discharged, the physical characteristics of the drainage, and climatic conditions. Discharge to an impoundment constructed by damming an ephemeral drainage (on-drainage pond) would result in losses to both evaporation and infiltration. The infiltration would lead to groundwater doming under the pond that could rise far enough to intersect the ephemeral stream causing discharge to the stream during part or all of the year. Drainage impoundments would also prevent natural meteoric runoff from flowing down drainage and into perennial surface water bodies. Discharge to an impoundment constructed near the ridge-line separating drainages (off-drainage pond) would also result in losses to evaporation and infiltration, but the infiltration and groundwater doming associated with infiltration would have less tendency to intersect ephemeral drainages. In addition, saline seep may form below both off-drainage and on-drainage discharge reservoirs as salt laden waters seep out and intersect a confining layer and rise to the surface. All surficial discharges would have to be in compliance with a NPDES permit. A copy of the Montana general discharge permit for coal bed methane produced water is attached at the end of the *Hydrology Appendix*. The NPDES fact sheet can be obtained from the MDEQ.

Losses associated with evaporation would reduce water volume, but not reduce salt load, and would increase the salinity of the water remaining in the impoundment. How much evaporation takes place would depend upon residence time in the pond and climatic conditions of humidity, temperature, wind, and rainfall. Increased salinity in the stored water would act upon the pond's soil liner by causing dispersal of the clay particles in the soil. Increased salinity would tend to reduce the pond's permeability, reduce subsequent infiltration, and increase residence time in the pond.

It is likely that water that infiltrates into shallow, unconfined alluvial aquifers would be delayed in reaching surface water and not be completely lost to the system. BLM water modelers (BLM 2001b) estimate conveyance losses through evaporation and infiltration in the Wyoming portion of the Powder River Basin at 70 percent. The modelers did not estimate time delays associated with water that comes into contact with shallow, unconfined groundwater. The modelers also did not consider soil and shallow bedrock transmissivity values for Montana when they estimated conveyance losses. Given that only 80 percent of the total 2.9 billion cubic feet (BCF) of CBM produced waters would be discharged under this alternative, and given the 70 percent conveyance loss projection, approximately 0.7 billion cubic feet of CBM-produced water would directly enter area streams and rivers each year. An unknown percentage of the projected conveyance loss would enter shallow groundwater flow systems and eventually reach streams and rivers.

Discharged CBM water would have the ability to impact surface water in many watersheds. The *Water Resources Technical Report* (ALL 2001b) summarizes the water quality in watersheds of the CBM emphasis area. Existing water quality varies between the watersheds and between the seasons within one watershed. Water in the mainstream and tributaries is a combination of base-flow, originating from groundwater and run-off originating as precipitation. In the Montana CBM emphasis area, precipitation is of higher quality than groundwater. Therefore, surface water quality in the watershed would depend on the season. In the Montana CBM emphasis area, it is assumed that CBM water would be of lower quality than either meteoric water or local groundwater. When CBM produced water is discharged to the watershed, water quality would be reduced. The amount of reduction would depend on the constituent, the volume of CBM water, the quality of the CBM water, and the water quality of the receiving body. There would be three primary chemical constituents of concern when analyzing impacts related to CBM production. These include SAR, TDS as measured by EC, and bicarbonate. The MDEQ is in the process of setting statewide numeric water quality standards that would likely include these parameters. When the standards have been approved, they will serve as a framework for managing surface discharge of CBM produced water throughout the state. At issue is the fundamental bimodality of water quality in the CBM emphasis area.

Some streams and tributaries such as the Tongue River carry water of relatively high quality throughout the year (although the Tongue River also shows some decrease in quality when in base-flow) and support such uses as irrigation and various fisheries. Other streams such as the Powder and Little Powder have a lower quality and do not support a full range of uses throughout the year. Water quality in both the high- and low-quality streams seems to be a function of natural circumstances and pre-date CBM and conventional oil and gas development. CBM discharge permits would be based upon the uses designated in State water quality standards and existing water quality data.

Excess assimilative capacities would provide a broader range of options with respect to coordinating water management with CBM discharges in Wyoming and the Crow and Northern Cheyenne Reservations. Excess capacity would allow CBM operators to transport CBM produced water from one watershed where capacity is very low to another watershed where there exists excess capacity.

Surface waters would be further impacted by infiltrated water that contacts shallow groundwater sources and eventually discharge into surface water bodies. Infiltrated water that was stored in an impoundment would have elevated concentrations of some constituents as a result of evaporation. As this water infiltrates through the soil and bedrock, changes to its quality would occur from interactions with the soil, rock, and connate water. The impacts from this water would be difficult to quantify as the distance and residence time within shallow aquitards and shallow aquifers affect the quality of the water that might subsequently be discharged into the surface waters.

Under this alternative, produced water would also be placed into impoundments for use by livestock and wildlife. Water placed in impoundments can be lost to evaporation and seepage/infiltration into the soil below the impoundment. Impoundments are usually constructed of native soil present on site, however, local soils vary widely in their permeabilities as described in the *Soils Technical Report* (ALL 2001a). Impoundments constructed of sandy soils would allow more infiltration of produced water than those built from clay. Water stored in sandy impoundments would be more liable to seep into deeper soil horizons where the water would be able to increase the salinity of the soils. Produced water would also be able to seep into unconfined aquifers if these were present, modifying the quality of the native groundwater. The specific soil types and impoundment locations are unknown with regards to future CBM developments in Montana. The degree of produced water infiltration cannot be estimated without site-specific data.

Impacts on groundwater under this alternative would be the same as in Alternative B except that discharged water could infiltrate into soils and underlying aquifers. The produced water from the only Montana CBM field (CX Ranch) has an SAR value in excess of the water contained in most shallow aquifers, including the alluvial aquifers (ALL 2001b). If infiltration of CBM-produced water occurred, the water quality of the alluvium would be impacted.

Abandonment

Impacts on water resources caused by abandonment operations would be similar to impacts by produced water discharged to the surface. The two activities-soil disturbance at abandonment and 20 years of surface discharge-would combine to increase the suspended sediment load within area surface water streams and rivers.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts projected for the CBM emphasis area. The reservation can expect impacts to surface water in the form of increased flow volume and quality of various water quality parameters, including SAR, EC, and bicarbonate. The tribe can expect drawdown of coal seam aquifers from Wyoming and Montana CBM production for a distance of approximately 14 miles outside the reservation boundaries. In addition, potential CBM development on fee land within the external boundaries of the reservation could cause more direct impacts that would also be similar to those impacts described for the CBM emphasis area.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts projected for the CBM emphasis area. The reservation can expect impact to surface water in the form of increases in flow volume and quality of various water quality parameters, including SAR, EC, and bicarbonate. The tribe can expect drawdown of coal seam aquifers from CBM production in the area surrounding the reservation for distances of approximately 14 miles from the reservation boundaries.

Conclusion

Impacts from CBM development in Wyoming would be the same under this alternative as under Alternative A. Montana CBM impacts to surface water

as well as cumulative impacts would be more extensive under this alternative.

Impacts on groundwater would include those listed under Alternative B, as well as impacts from infiltration of surface water into shallow aquifers from impoundments and drainages. BMPs for surface impoundment construction, however, would mitigate impacts by incorporating clay into sandy soil impoundments, by the use of impermeable geomembrane liners, by not building impoundments where sandy soil occurs, by not building impoundments over alluvial areas, and by not building impoundments in natural drainage ways.

In terms of surface water, CBM development in Montana under this alternative would have impacts on most watersheds in the CBM emphasis area and elsewhere in the state where CBM development occurs. The impact of untreated CBM discharge on surface water quality in Powder River Basin streams in Montana was analyzed using the assumptions described at the beginning of this section and the expanded development scenario for the RFD excluding any dry holes or nonproductive wells. This impact analysis, summarized in Table 4-3 and Figure 4-1, is based on the assumption that CBM wells produce water at an average rate of 2.5 gpm/well with discharge reduced by 20 percent due to beneficial use and that 70 percent of the remaining discharge (80 percent) is lost during conveyance. The effective discharge to streams is 24 percent of the amount of water produced. An SAR value of 47 and EC value of 2207 μS/cm were used for all streams. Base stream flow rates—equal to the low mean monthly flows—were input, along with average values of EC and SAR for baseline stream water quality. All upstream development, including development in Wyoming, was evaluated for each watershed (MDEQ 2001c). Map 4-3 graphically depicts the expanded development potential including dry holes for each watershed in the Powder River Basin regardless of ownership.

Figure 4-1 shows that the discharge of untreated CBM produced water to streams would render all rivers, except the Bighorn and Little Bighorn Rivers, unusable for irrigation based on the EC-SAR relationship that represents no reduction in infiltration. The Bighorn and Little Bighorn Rivers also meet the additional limitation on SAR (<=12). The SAR values in these rivers after mixing with the RFD CBM discharge are less than 12. If the SAR criterion is 2 instead of 12, then only the Little Bighorn River would maintain acceptable water quality after mixing with the RFD CBM discharge (SAR <=2).

The following analysis uses the EC-SAR relationship and a cap of 12 on SAR to calculate the maximum number of CBM wells that could discharge before meeting an irrigation threshold. The assimilative capacity at the stateline stations was split equally between Wyoming and Montana. The calculated volume for CBM discharge and the corresponding number of average CBM wells are listed in Table 4-4. The discharge range for preserving downstream beneficial use would be 20 percent to 60 percent of the RFD projected amount for the Tongue, 8 percent to 46 percent in Rosebud, and less than 33 percent in the Little Powder River in Montana. On the Wyoming side, discharge would be less than 4 percent in the Little Powder, 40 percent in the Powder, and less than 70 percent in the Tongue. The ranges would vary due to differences in baseline water quality in the reaches of the streams, which results in differences in the assimilative capacity of each reach. These results are based on the assumption that the quality of CBM produced water is the same throughout the Powder River Basin and is represented by the water quality of the CBM wells at the CX Ranch on the Tongue River. If water quality parameters representative of the CBM water produced in the Little Powder and Powder Rivers are used as input to the model rather than the CX Ranch values, the amount of CBM produced water that could be released to the Little Powder and Powder Rivers would be greatly increased. If SAR is limited to 2 instead of 12 for all rivers except the Little Powder and Powder, very little CBM discharge would be accommodated in the rivers (Table 4-5). The discharge in the Tongue River would decrease to one fifth; with a SAR cap of 12 and no discharge of untreated CBM produced water would occur in either the Rosebud or Lower Bighorn drainages.

Surface water in high-quality watersheds would show increases in SAR from less than 1 to between 4 and 6. Surface water in low-quality watersheds would show a generalized increase in SAR from approximately 4 to 7. A few low- and high-quality watersheds would not have sufficient assimilative capacity to accept potential discharge predicted for full-scale development without using flow-based discharge permits or transporting produced water to watersheds having excess capacity. All discharges would need to be in compliance with a NPDES permit.

Cumulative impacts to surface water combines Wyoming CBM development occurring upstream of Montana's development. Wyoming impacts to Montana surface water are currently uncertain. One possibility is that the two states will maintain cooperation and management of discharges in a manner whereby surface water quality impacts from

Wyoming are minimal and do not drastically reduce assimilative capacity in Montana. If, however, the interim memorandum of cooperation between the two states expires or is replaced by a less restrictive agreement, Wyoming discharges to shared watersheds could increase, surface water quality could be reduced, and watersheds would have little or no additional assimilative capacity to accommodate produced water discharges from CBM development in Montana. This could proceed far enough that surface water in the Tongue, Powder, and Little Powder is at or above the assumed water quality criteria, and no Montana CBM water could be discharged to those watersheds.

In addition, suspended sediment impacts by way of direct discharge to land would affect all drainages in the Montana portion of the Powder River Basin and could affect other drainages where CBM development is sufficiently concentrated.

Area surface waters would be impacted by an increase in suspended sediments contained in the discharged CBM water. This increase in suspended sediment load would result from the increased erosion of soils due to surficial disturbances, CBM water runoff from the point of discharge to drainages, and from the increased erosion of stream banks resulting from increased water volume and increased salinity (which will cause clays to lose their cohesiveness and erode more easily).

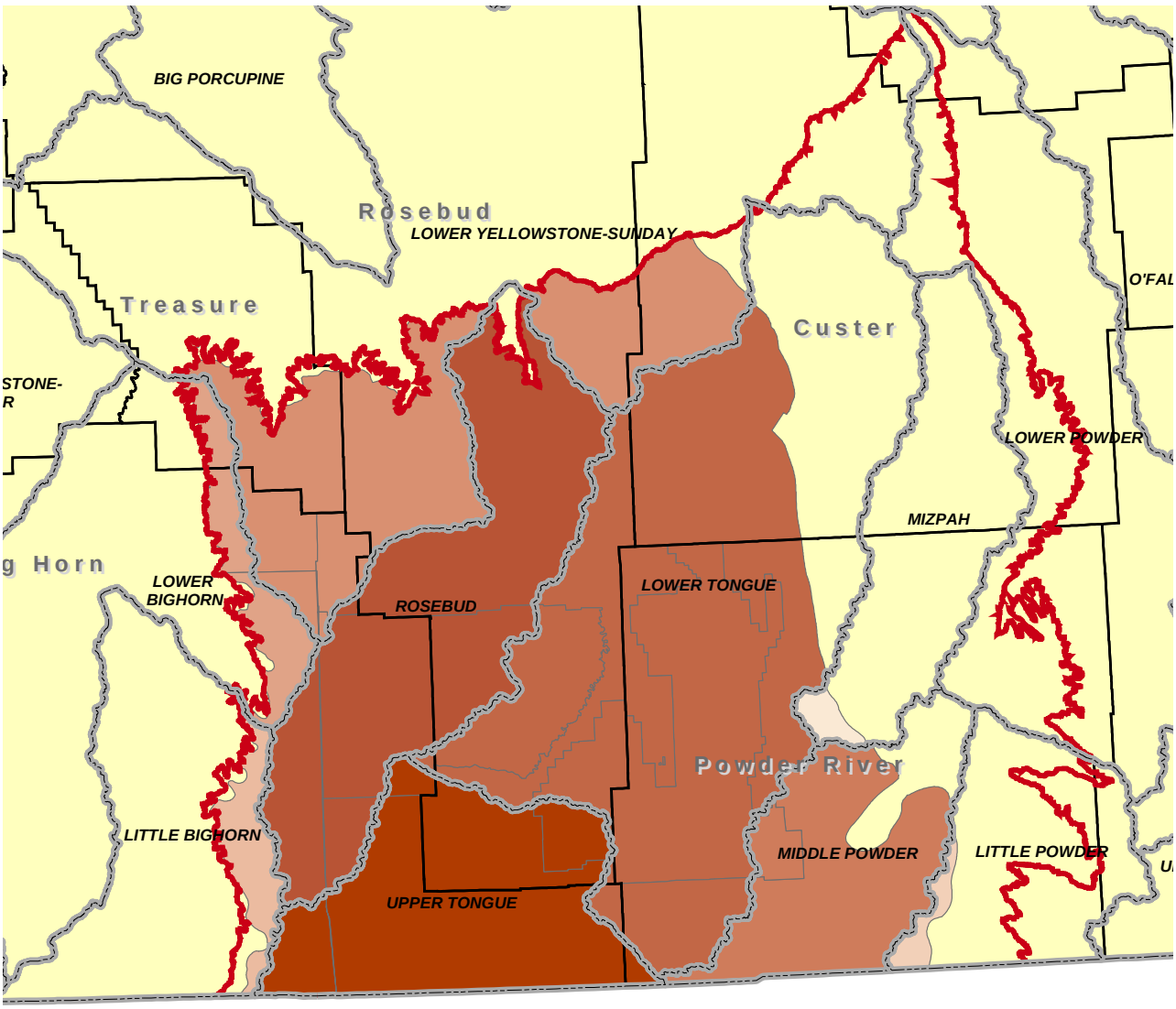
Table 4-6 summarizes the surface water SAR values that would be expected to result from implementation of Alternative C. The increase in suspended sediment content of surface water could affect its beneficial use, making the water unsuitable for drinking except after treatment. All of the watersheds in the CBM emphasis area would be vulnerable to impacts from an increase in suspended sediment. Discharge to ephemeral channels will also degrade the channel form causing increased deepening and widening.

TABLE 4-3
SUMMARY OF IMPACTS FOR IRRIGATION IN MONTANA

Location	Impact to Irrigation (EC and SAR Exceed Threshold)
Little Powder River at Dry Creek near Weston	Yes
Little Powder River near Broadus	Yes
Powder River at Moorhead	Yes
Powder River at Broadus	Yes
Mizpah Creek near Mizpah	Yes
Tongue River at State Line near Decker	Yes
Tongue River at Birney Day School Bridge near Birney	Yes
Tongue River by Brandenberg Bridge near Ashland	Yes
Tongue River at Miles City	Yes
Rosebud Creek at Reservation Boundary near Kirby	Yes
Rosebud Creek near Colstrip	Yes
Rosebud Creek at Mouth near Rosebud	Yes
Little Bighorn River by Pass Creek near Wyola	No
Little Bighorn River near Hardin	No
Lower Bighorn River near ST. Xavier	No
Lower Bighorn River at Tullock Creek near Bighorn	No

[1]Based on SAR threshold of 12

Map 4-3: Predicted Number of CBM Wells by Watershed for Expanded Development Scenarios Regardless of Ownership



Legend

Watershed Boundaries

Powder River Geologic Basin Bnd.

Predicted # of CBM Wells Per Watershed

- 225 - MIZPAH
- 280 - LITTLE POWDER
- 1050 - LITTLE BIGHORN
- 1200 - LOWER BIGHORN
- 2570 - LOWER YELLOWSTONE - SUNDAY
- 3170 - MIDDLE POWDER
- 5180 - LOWER TONGUE
- 5400 - ROSEBUD
- 5810 - UPPER TONGUE

1:1,400,000

0 3.75 7.5 15 22.5 30 Miles

0 12,000 24,000 48,000 Meters

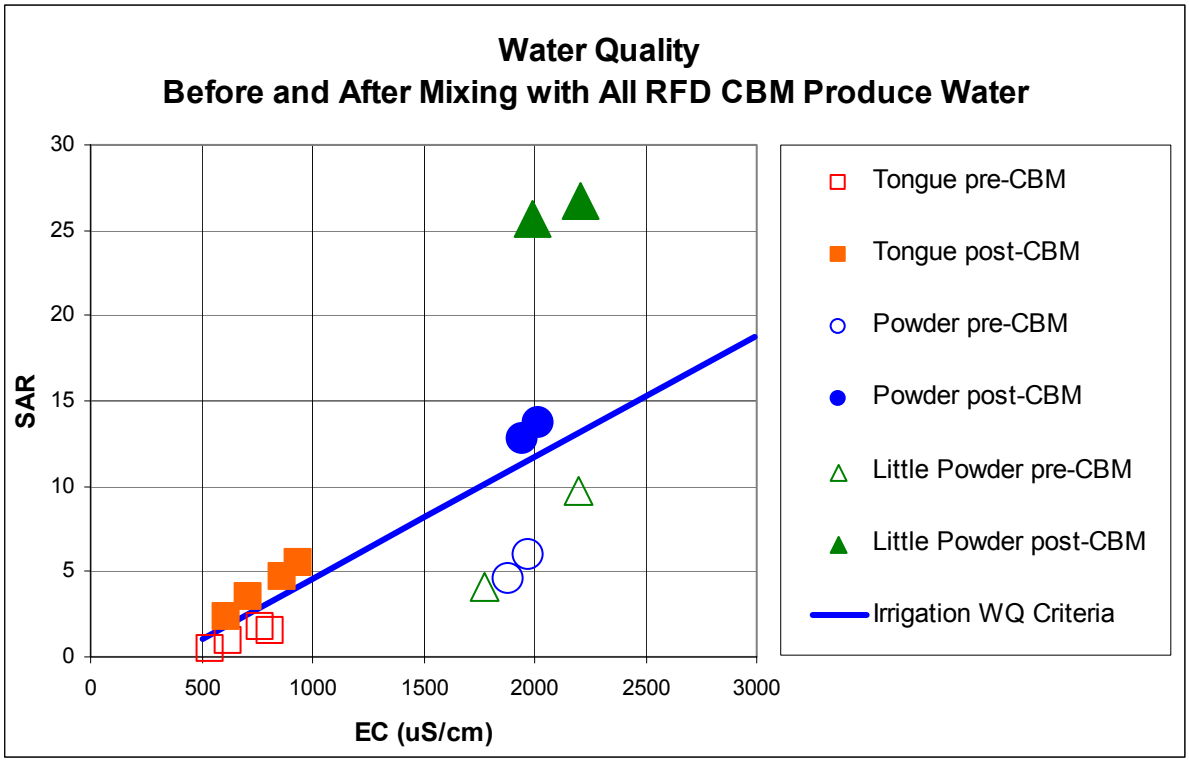
N W E S

This figure represents the predicted number of Coal Bed Methane Wells in the Montana Portion of the Powder River Basin by watershed based on the Reasonable Foreseeable Development Scenario for expanded development regardless of ownership. These wells represent the potential wells drilled including dry holes.

DATA SOURCES:

Counties: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, MT.
Reservations: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, MT.
National Forests: 1:100,000 scale, national forests, Montana State Library/NRIS, Helena, MT.
Parks: 1:100,000 scale, parks, Montana State Library/NRIS, Helena, MT
Development Data: BLM Reasonable Foreseeable Development Scenario
Coal Occurence: Tully, 1996.

NOTE: To be used as a reference graphic only. Some data represented are at scales greater than it's source.



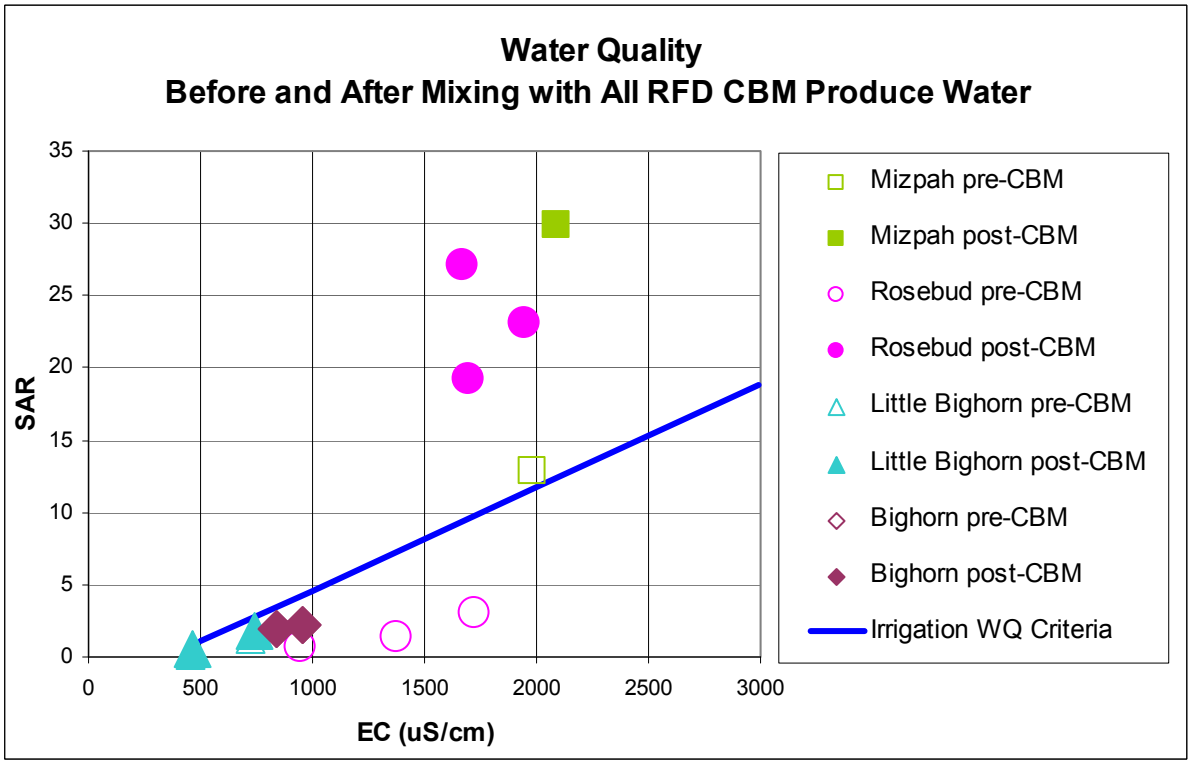


Figure 4-1. Water quality of Powder River Basin streams before and after mixing with the expanded development level of potential RFD CBM well discharge. This analysis used the maximum number of RFD potential producing wells regardless of ownership and assumed none would be dry holes or nonproductive.

TABLE 4-4
LIMITS ON CBM DISCHARGE AND NUMBER OF DISCHARGING CBM WELLS TO AVOID EXCEEDING IRRIGATION THRESHOLDS[1] FOR IRRIGATION IN MONTANA WITH SAR CAP OF 12

Location	Discharge Limit (cfs)	Number of CBM Wells	Fraction of RFD CBM Wells (%)
Wyoming			
Little Powder River at Dry Creek near Weston	0.1	91	4
Powder River at Moorhead	13.9	10356	39
Tongue River at State Line near Decker	2.4	1793	69
Montana			
Little Powder River near Broadus	0.1	91	33
Powder River at Broadus	14.5	RFD (3167)	100
Mizpah Creek near Mizpah	0	0	0
Tongue River at State Line near Decker	2.4	1793	62
Tongue River at Birney Day School Bridge near Birney	0.8	598	21
Tongue River by Brandenberg Bridge near Ashland	2.1	1588	61
Tongue River at Miles City	2.1	1602	62
Rosebud Creek at Reservation Boundary near Kirby	0.2	141	8
Rosebud Creek near Colstrip	1.1	834	46
Rosebud Creek at Mouth near Rosebud	0.4	285	16
Little Bighorn River by Pass Creek near Wyola	1.5	RFD (525)	100
Little Bighorn River near Hardin	3.4	RFD (525)	100
Lower Bighorn River near ST. Xavier	106.1	RFD (600)	100
Lower Bighorn River at Tullock Creek near Bighorn	63.2	RFD (600)	100

[1] Based on SAR threshold of 12.

TABLE 4-5
LIMITS ON CBM DISCHARGE AND NUMBER OF DISCHARGING CBM WELLS TO AVOID EXCEEDING IRRIGATION THRESHOLDS[1] FOR IRRIGATION IN MONTANA WITH SAR CAP OF 2.

Location	Discharge Limit (cfs)	Number of CBM Wells	Fraction of RFD CBM Wells
Wyoming			
Little Powder River at Dry Creek near Weston	0.1	91	4
Powder River at Moorhead	13.9	10356	39
Tongue River at State Line near Decker	2.4	1793	69
Montana			
Little Powder River near Broadus	0.1	91	33
Powder River at Broadus	RFD	RFD (3167)	100
Mizpah Creek near Mizpah	0	0	0
Tongue River at State Line near Decker	0.7	516	18
Tongue River at Birney Day School Bridge near Birney	0.0	0	0
Tongue River by Brandenberg Bridge near Ashland	0.0	0	0
Tongue River at Miles City	0.7	530	20
Rosebud Creek at Reservation Boundary near Kirby	0.0	0	0
Rosebud Creek near Colstrip	0.0	0	0
Rosebud Creek at Mouth near Rosebud	0.0	0	0
Little Bighorn River by Pass Creek near Wyola	RFD	RFD (525)	100
Little Bighorn River near Hardin	RFD	RFD (525)	100
Lower Bighorn River near ST. Xavier	0.0	0	0
Lower Bighorn River at Tullock Creek near Bighorn	0.0	0	0

[1] Based on a SAR threshold of 2.

Alternative D

Under this alternative, 80 percent of produced water would be treated prior to discharge and discharge would be accomplished by pipeline or constructed watercourse to the nearest body of water to eliminate soil erosion, the generation of suspended sediments, and the infiltration of treated CBM water. The treatment of CBM-produced waters would eliminate or greatly reduce SAR, EC, bicarbonate, and suspended sediment impacts to surface waters. Treatment would increase the beneficial uses of CBM water, but the volume of produced water that would be beneficially used is expected to stay the same, at 20 percent of the total water produced. All discharges would need to be in compliance with a NPDES permit.

Exploration

Any water generated by drilling and testing would be treated with 80 percent of the treated water discharged via pipeline and 20 percent used for beneficial purposes. Treatment would eliminate potential impacts to water quality and water quantity impacts would be minor because of the moderate volume produced from the testing of CBM exploration wells.

Production

Approximately 80 percent of CBM-produced water would be treated and discharged under this alternative. Because the water is piped to the receiving body of water, no conveyance losses are deducted. Table 4-7 presents the Montana Powder River Basin CBM development utilizing a tabulated average production rate of 2.5 gpm, the maximum discharges expected in years 6 and 7, and an assumed discharge rate of 80 percent via pipeline.

On average, over 20 years, discharged water would add about 1% to the total water discharged into the Yellowstone from the affected watersheds. Peak total discharge during years 6 and 7 would add about 1.35% to the total water discharged to the Yellowstone. In detail, every watershed except the Little Yellowstone-Sunday, the Lower Bighorn, and the Mizpah, experience at least a 10 percent increase in baseflow in at least one portion of the watershed. Rosebud Creek and the Little Powder would experience the greatest percentage change in baseflow during years 6 and 7, with 1,145 percent and 275 percent increases in baseflow respectively. These increases in flow volume would result in increased erosion in impacted watersheds. Since discharge water would be treated, the water quality of the streams would not be impacted. The treatment of CBM-produced waters could result in the generation of residues that would contain concentrated salts extracted from the CBM water. This waste would need to be analyzed on a case-by-case basis to determine its character and would need to be disposed of in an appropriate manner that could involve deep injection (i.e., Class II injection wells). Base-flow values listed in Table 4-7 may have already been impacted by CBM development in Wyoming. Cumulative impacts of CBM development in both Montana and Wyoming are listed below in the *Conclusions* section. The temperature of the receiving water bodies may also be affected by the increased groundwater discharge associated with this alternative. The temperature change that would result would depend on the water management practices employed for treating the CBM water. Given the high degree of natural variation in water temperature in this region, it seems unlikely that the resultant temperature shift would impact wildlife.

Impacts on groundwater from CBM production would be similar to Alternative B.

Abandonment

Impacts on water resources caused by abandonment operations would be similar to impacts under Alternative B. When the estimated 16,500 CBM production wells are abandoned over the 20-year life of the resource, 33,000 acres of soil would be disturbed for a short time period. This disturbed soil would be vulnerable to erosion and the resulting suspended material would be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would control soil erosion until groundcover and original conditions are restored.

Crow Reservation Impacts

Surface water impacts on Crow Tribal Lands under Alternative D are expected to include those impacts noted in Alternative B with the added impacts from the surface discharge of 80 percent of the produced water from all of the Montana CBM wells forecast in the RFD. Because the produced water would be treated prior to discharge, the reservation can expect impacts to surface water only in the form of increased flow volume. Groundwater impacts will include those detailed in Alternative B. The tribe can expect drawdown of coal seam aquifers from Wyoming and Montana CBM wells within 14 miles of the reservation boundaries.

TABLE 4-6
ALTERNATIVE C DISCHARGE SCENARIO, BY WATERSHED

Watershed	Average CBM Discharge (CBM_A) (bcf/yr)	Maximum CBM Discharge (CBM_M) (bcf/yr)	Average Stream Baseflow (bcf/yr)	7Q10 Stream Discharge (bcf/yr)	SAR of Receiving Water body at low flow	Resultant Discharges				Resultant SARs			
						Baseflow		7Q10		Baseflow		7Q10	
						CBM_A+BF (bcf/yr)	CBM_M+BF (bcf/yr)	CBM_A+7Q10 (bcf/yr)	CBM_M+7Q10 (bcf/yr)	CBM_A+BF (bcf/yr)	CBM_M+BF (bcf/yr)	CBM_A+7Q10 (bcf/yr)	CBM_M+7Q10 (bcf/yr)
Little Bighorn (Wyola)	0.06	0.13	1.90	1.48	0.04	1.96	2.03	1.54	1.61	0.80	1.64	1.01	2.07
Little Bighorn (Crow Agency)	0.06	0.13	0.41	NA	0.04	0.47	0.54	NA	NA	3.31	6.51	NA	NA
Little Bighorn (Hardin)	0.06	0.13	4.40	0.66	1.06	4.46	4.53	0.72	0.79	1.32	1.62	2.73	4.49
Yellowstone-Sunday (Myers)	0.19	0.38	133.00	NA	1.35	133.19	133.38	NA	NA	1.38	2.52	NA	NA
Little Powder (Broadus)	0.02	0.03	0.01	0.00	NA	0.03	0.04	0.02	0.03	NA	NA	47.21	47.21
Lower Bighorn (St. Xavier)	0.09	0.18	55.00	20.79	0.70	55.09	55.18	20.88	20.97	0.71	0.72	0.73	0.76
Lower Bighorn (Big Horn)	0.09	0.18	91.48	27.41	1.72	91.56	91.65	27.50	27.59	1.74	1.76	1.78	1.85
Mizpah (Mizpah)	0.02	0.03	0.82	0.00	6.31	0.84	0.85	0.02	0.03	6.47	6.54	47.21	47.21
Middle Powder (Moorhead)	0.22	0.45	4.80	0.03	4.02	5.02	5.25	0.26	0.48	4.51	5.00	27.84	0.76
Middle Powder (Broadus)	0.22	0.45	6.30	0.28	4.02	6.52	6.75	0.51	0.73	4.39	4.78	10.45	1.85
Rosebud (Kirby)	0.40	0.80	0.06	0.0032	8.88	0.46	0.86	0.40	0.80	27.11	32.96	44.70	45.90
Rosebud (Colstrip)	0.40	0.80	0.24	0.00	8.88	0.64	1.04	0.40	0.80	16.98	21.53	47.21	47.21
Rosebud (Rosebud)	0.40	0.80	0.28	0.00	8.88	0.68	1.08	0.40	0.80	16.14	20.41	47.21	47.21
Upper Tongue (state line)	0.42	0.83	5.70	1.32	0.96	6.12	6.53	1.74	2.15	2.14	3.22	5.51	8.90
Upper Tongue (TR Dam)	0.42	0.83	5.50	0.69	0.96	5.92	6.33	1.11	1.52	2.19	3.29	8.70	13.59
Lower Tongue (Birney DS)*	0.79	1.58	5.80	1.42	0.96	6.59	7.38	2.21	2.99	3.08	4.93	8.17	12.95
Lower Tongue (Ashland)*	0.79	1.58	6.50	2.21	0.77	7.29	8.08	3.00	3.78	3.23	5.39	7.20	11.83
Lower Tongue (Miles City)*	0.79	1.58	6.10	0.25	1.36	6.89	7.68	1.04	1.83	3.49	5.36	23.99	31.06
Total	**1.79**	**3.57**											

*CBM Discharge into the Lower Tongue is the sum of the amount anticipated to be discharged into the Upper Tongue plus the amount anticipated to be discharged into the Lower Tongue, as all water in the Upper Tongue will flow into the Lower Tongue.

CBM_A = Average Projected Coal Bed Methane Related Discharge (20 Year Average)

CBM_M = Maximum Projected Coal Bed Methane Related Discharge (Years 6 and 7 of the RFD)

BF = Average Stream Baseflow

7Q10 = Ten Year Seven Day Minimum Flow (Calculated by USGS)

Assumes SAR of CBM water is 47.21

Assumes 20% beneficial use and a 70% conveyance loss

Precipitation of calcite is not calculated although the resulting waters are saturated with respect to calcite for many locations.

NA = Date is not available for these values.

TABLE 4-7
ALTERNATIVE D DISCHARGE SCENARIO, BY WATERSHED

Watershed	Average CBM Discharge (CBM_A) (bcf/yr)	Maximum CBM Discharge (CBM_M) (bcf/yr)	Average Stream Baseflow (bcf/yr)	7Q10 Stream Discharge (bcf/yr)	Resultant Discharges			
					Baseflow		7Q10	
					CBM_A+BF (bcf/yr)	CBM_M+BF (bcf/yr)	CBM_A+7Q10 (bcf/yr)	CBM_M+7Q10 (bcf/yr)
Little Bighorn (Wyola)	0.08	0.16	1.90	1.48	1.98	2.06	1.56	1.64
Little Bighorn (Crow Agency)	0.08	0.16	0.41	NA	0.49	0.57	NA	NA
Little Bighorn (Hardin)	0.08	0.16	4.40	0.66	4.48	4.56	0.74	0.82
Yellowstone-Sunday (Myers)	0.24	0.48	133.00	NA	133.24	133.48	NA	NA
Little Powder (Broadus)	0.02	0.04	0.01	0.00	0.03	0.05	0.02	0.04
Lower Bighorn (St. Xavier)	0.11	0.22	55.00	20.79	55.11	55.22	20.90	21.01
Lower Bighorn (Big Horn)	0.11	0.22	91.48	27.41	91.59	91.70	27.52	27.63
Mizpah (Mizpah)	0.02	0.04	0.82	0.00	0.84	0.86	0.02	0.04
Middle Powder (Moorhead)	0.28	0.56	4.80	0.03	5.08	5.36	0.31	0.59
Middle Powder (Broadus)	0.28	0.56	6.30	0.28	6.58	6.86	0.56	0.84
Rosebud (Kirby)	0.50	1.00	0.06	0.0032	0.56	1.06	0.50	1.00
Rosebud (Colstrip)	0.50	1.00	0.24	0.00	0.74	1.24	0.50	1.00
Rosebud (Rosebud)	0.50	1.00	0.28	0.00	0.78	1.28	0.50	1.00
Upper Tongue (state line)	0.52	1.04	5.70	1.32	6.22	6.74	1.84	2.36
Upper Tongue (TR Dam)	0.52	1.04	5.50	0.69	6.02	6.54	1.21	1.73
Lower Tongue (Birney DS)*	0.99	1.97	5.80	1.42	6.79	7.77	2.41	3.39
Lower Tongue (Ashland)*	0.99	1.97	6.50	2.21	7.49	8.47	3.20	4.18
Lower Tongue (Miles City)*	0.99	1.97	6.10	0.25	7.09	8.07	1.24	2.22
TOTAL	**2.24**	**4.46**						

*CBM Discharge into the Lower Tongue is the sum of the amount anticipated to be discharged into the Upper Tongue plus the amount anticipated to be discharged into the Lower Tongue, as all water in the Upper Tongue will flow into the Lower Tongue.
CBM_A = Average Projected Coal Bed Methane Related Discharge (20 year average)
CBM_M = Maximum Projected Coal Bed Methane Related Discharge (Years 6 and 7 of the RFD)
BF = Average Stream Baseflow
7Q10 = Ten Year Seven Day Minimum Flow (Calculated by USGS)
Assumes that 20% of the water is put to beneficial use, and that there is no conveyance loss.
As the CBM water would be treated prior to discharge, there would not be an appreciable effect on the chemistry of the receiving water body.
NA = Data is not available for these values.

Northern Cheyenne Impacts

Surface water impacts on Northern Cheyenne Tribal Lands under Alternative D are expected to include those impacts noted in Alternative B with the added impacts from the surface discharge of 80 percent of the produced water from all of the Montana CBM wells forecast in the RFD. Because produced water would be treated prior to discharge, the Reservation can expect impact to surface water in the form of increased flow volume. Groundwater impacts will include those detailed in Alternative B. The Tribe can expect drawdown of coal seam aquifers from Montana CBM wells within 14 miles of the reservation boundaries.

Conclusion

Treatment and discharge of produced water from Montana would result in impacts through increased river flow volume. Since this water is treated, the impacts to water quality would depend on the level of treatment. The level of treatment will determine the resultant quality of the receiving stream, if CBM produced water is treated to higher quality it would improve the quality of the receiving stream when discharged. Flow volumes in some watersheds would change only slightly, but some watersheds would see flow increase, especially during times of traditionally low-flow. The impacts could include bank erosion, riparian area alteration, and loss of indigenous habitat. All discharges would need to be in compliance with a NPDES permit.

These increased flow volumes could be overshadowed by impacts due to Wyoming CBM produced water discharge. Impacts on Montana watersheds from Wyoming CBM discharge would be the same under this alternative as under Alternative C. Depending upon the fate of the interim memorandum of cooperation between the states of Montana and Wyoming, discharges of Wyoming CBM water into watersheds shared by Wyoming and Montana could be minimal or several times larger than the Montana discharges. Cumulative impacts to surface water could include localized erosion and stream alteration. These impacts would be similar to those caused by major rain events, but would be concentrated into small producing areas rather than spread over the entire watershed.

Impacts from surface impoundments would be similar to impacts under Alternative C except that produced water would be treated prior to storage, lessening the chances for increasing the salinity of sub-soils and shallow, unconfined aquifers.

Drawdown impacts to groundwater would be the same as under Alternative B.

Alternative E (Preferred Alternative)

Impacts under Alternative E (Preferred Alternative) would be similar to impacts described in Alternative C. However, Alternative E emphasizes the beneficial uses of produced water from CBM wells. Further, Alternative E does not set limits that surface discharges would be limited to treated water as in Alternative D, or untreated water as is the case with Alternative C. Alternative E could include produced water discharges that involve both treated and untreated water, so long as NPDES requirements are met. Furthermore, water produced from CBM wells could be managed in a much broader fashion than has been analyzed in any of the previous alternatives by emphasizing beneficial use of CBM water. A Water Management Plan would be required prior to exploration or production. Water management options would include injection, treatment and discharge, impoundment, direct discharge, or any other operator proposed methods, provided that they are addressed in the Water Management Plan, and the plan is approved by the appropriate agency. The Water Management Plan must address both site-specific conditions and regional cumulative effects of CBM development. The plan would address the proposed water management practices and their effects on soil, water, vegetation, wildlife, stream channel stability, and any other resources reasonably expected to be impacted by the actions.

Exploration

Similar to Alternative C above, the moderate volume of water generated by the testing of CBM exploration wells would be stored in tanks or lined (clay or geotextile) impoundments to be discharged under the appropriate permits.

Production

Similar to Alternative C above, an average of 2.5 gpm of water will be produced by each of the 16,500 CBM wells expected to be developed in the CBM emphasis area. But unlike Alternative C, the Preferred Alternative allows wide latitude in produced water management. In addition to surface discharge, injection can be used, with the proper permits, to dispose of water into shallow coal aquifers or deep aquifers that contain water either above or below 10,000 mg/l TDS. CBM water could also be used for new beneficial uses. The combination of emphasizing beneficial use and increased flexibility for managing produced water should increase water used for beneficial purposes, such as stock watering, irrigation, dust control, etc. Increases in beneficial use would also

result in decreased impacts resulting from surface discharge as compared to Alternative C. But because actual management practices are yet to be defined as far as the level of beneficial use and alternate water management practices (e.g., surface discharge), Alternative E assumes the same level of beneficial use as Alternative C. Therefore, impacts from Alternative E would be the same or less as those for Alternative C.

Abandonment

Impacts on water resources caused by abandonment operations would be similar to impacts under Alternative B. When the estimated 16,500 CBM production wells are abandoned over the 20-year life of the resource, 33,000 acres of soil would be disturbed for a short time period. This disturbed soil would be vulnerable to erosion and the resulting suspended material would be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would reduce soil erosion until groundcover and original conditions are restored.

Crow Reservation

Surface water impacts on Crow Tribal Lands under Alternative E (Preferred Alternative) are assumed to include those impacts noted in Alternative C. Because of the latitude in produced water management, however, impacts would be much less. Groundwater impacts will include those detailed in Alternative B. The Tribe can expect drawdown of coal seam aquifers from Wyoming and Montana CBM wells within 14 miles of the reservation boundaries.

Northern Cheyenne

Surface water impacts on Northern Cheyenne Tribal Lands under Alternative E (Preferred Alternative) are assumed to include those impacts noted in Alternative C. Because of the latitude in wastewater management, however, impacts could be much less. Groundwater impacts will include those detailed in Alternative B. The tribe can expect drawdown of coal seam aquifers from Montana CBM wells within 14 miles of the reservation boundaries.

Conclusion

Impacts under Alternative E (Preferred Alternative) on the important hydrological resources-surface water and groundwater as seen in springs as well as water wells are assumed to be the same as Alternative C. Operators may choose other options when managing their CBM water, however, with concomitant reductions in the volume of surface discharge. Cumulative impacts are similar to Alternative C in that impacts from the Wyoming portion of the Powder River Basin are difficult to predict. The existing interim agreement may be expanded to involve other constituents and other watersheds. However, future agreements may be more or less restrictive, or the agreement may expire with no replacement. These different scenarios will have an effect on Wyoming's impact on the hydrological resources of Montana.

Indian Trust and Native American Concerns

Assumptions

The state does not have an ITA responsibility; therefore, it is assumed that the state would not be able to enforce but would encourage the 2-mile buffer zone around the reservations as called for in the management objectives for Alternatives B and D. Furthermore, it is assumed that the BLM's trust responsibility includes being responsible for identifying and mitigating impacts from U.S. government and BLM-sponsored developments on or adjacent to the reservations.

Impacts From Management Common to All Alternatives

While the BLM would not have jurisdiction over Indian lands located on or off the reservation, the BLM would have a trust responsibility that encompasses oil and gas exploration. ITAs would be managed following the DOI Secretarial Order 3215, Principles for the Discharge of the Secretary's Trust Responsibility.

The conventional wells expected to be drilled within BLM-administered RMP areas would impact adjacent reservation lands by draining tribal hydrocarbons or groundwater, or even by allowing produced water to impact surface water resources or soil. Drainage by adjacent wells is addressed by 43 CFR Part 3162.2-2, which instructs the BLM on steps to be taken to protect Indian landowners from drainage.

The potential wells estimated for reservation development (12) coupled with the predicted wells (<25) adjacent to reservation lands, do not appear to represent a measurable increase in development on or near the reservation for the next 20 years. This level of development is not expected to impact tribal hydrocarbons or effect groundwater resources. Quantitatively, the direct land impacts from this small number of wells on reservation lands would be minor (less than 75 total acres permanently impacted) with regard to grazing lands, vegetation, biological resource etc.

Impacts From Management Specific to Each Alternative

Alternative A

Based on the limited development scenario presented under this alternative, the known locations of production wells (CX Ranch), the number of exploration wells, and the assessment of impacts on the other resource topics, no measurable ITAs are expected from the CBM activities planned under this alternative in Montana.

Conclusion

Impacts on ITAs from management decisions included in Alternative A, management practices common to all alternatives, and from projects evaluated under the cumulative effects analysis would be of no consequence to the physical resources with the exception of the Absaloka Coal Mine and the production and discharge of CBM production waters from Wyoming.

Mining activities at the 5,400-acre Absaloka Coal Mine facility located just north of the northeastern corner of the Crow Reservation has resulted in the irretrievable loss of the coal mined at approximately 5 million tons per year, and has removed or disturbed approximately 3,150 acres of topsoil. Additional impacts have been felt from the dewatering of the coal and the lowering of the surrounding groundwater by an estimated 75 feet (Wheaton and Van Voast 1998). Finally, the surface water within the adjacent vicinity of the mine has undergone a reduction in quality, resulting in impacts on the local watercourses and subsequent fields using these waters as sources of irrigation.

Development of CBM in Wyoming during the next 20 years has the potential to impact the surface water, groundwater, and methane resources of the Crow and Northern Cheyenne tribes. Drawdown of groundwater levels is an unavoidable impact from CBM development. Increased groundwater drawdown would be experienced along the southeastern boarder of the Crow Reservation adjacent to and up to 14 miles north of the Wyoming state line (Wheaton and Metesh 2001). The magnitude of impact to water wells and springs would depend on the location and number of CBM producing wells south of the state boundary. Depending upon their locations, natural springs and water wells on tribal lands could go dry.

Wyoming CBM production could also drain methane from tribal mineral resources. As groundwater is

drawndown and reservoir pressures decrease, methane is liberated from the coal matrix and becomes free to be produced or migrate. Modeling (Crockett and Meyer 2001) suggests that drainage of methane could occur at distances more than 5 miles from a producing CBM field. The Crow Reservation is adjacent to the Wyoming boundary and is close enough to be drained by CBM wells that may be drilled in Wyoming.

Full-scale CBM production in the Wyoming portion of the Powder River Basin would result in either widespread surface discharge of produced water to streams that flow north into Montana or be the impetus behind a state-to-state agreement limiting the discharge and preserving the water quality within these rivers and streams. Expected levels of development, if unregulated, could result in volumes of discharged water causing a notable increase in annual flow rates of the Powder, Little Powder, Little Bighorn and Tongue Rivers. A corresponding decrease in the quality of surface water would also be felt downstream from these Wyoming discharges. The percent increase in flow volume would be greater during periods of low-flow. These increases in flow volume could cause changes in river courses and result in erosion and impact to riparian areas as well as increased sediment load to the rivers and decrease in water quality due to increased suspended sediment. The resulting water quality may lose its usefulness for irrigation. Impacts to the Little Bighorn and the Tongue Rivers would be felt by the Northern Cheyenne and Crow members who use river water for irrigation.

The Northern Cheyenne have a large reserved water right in the Tongue River Reservoir. That stored water represents a marketable commodity and if it were to experience even a slight decrease in quality, it would affect the tribes' ability to market or use the water. Under this full-scale Wyoming discharge scenario, it is conceivable that the reservoir water quality would be diminished.

On the other end of the spectrum of possibilities, Montana and Wyoming may come to terms on a water quality agreement that would have the intention of preserving the current water quality. If this state-to-state agreement were to be ratified between Montana and Wyoming, it is likely that the water quality in the rivers that flow from Wyoming to Montana would experience little to no degradation, thus nullifying the previous full-scale scenario discussion.

Alternative B

Based on the development scenario presented in Alternative B and on the management objectives described under this alternative, potential impacts on ITAs include the drawdown of groundwater, reduction in surface water quality, and drainage of CBM.

The drawdown or depletion of the groundwater table within the vicinity of a producing Montana CBM field has been modeled by the MBMG at up to 14 miles from the edge of production (Wheaton and Metesh 2001). Without site-specific information, it is impossible to predict the degree of drawdown to a neighboring aquifer. In the case of the Crow and Northern Cheyenne, it is conceivable that the reservations' groundwater would be drawn down to some extent along the boundaries by both state and BLM-leased development. The drawdown of groundwater within the reservation would result in impacts on shallow stock and domestic wells and some surface springs. These impacts would reduce water pressure and in some cases render the complete loss of water from a well or spring.

The recognition of a 2-mile buffer zone around the reservations would effectively reduce and delay the drawdown that would be experienced by the tribes in these areas from BLM leased mineral development. In the case of development on either private or state fee lands, the state would not be subject to the same buffer zone restrictions, and therefore, the drawdown would be generated earlier and be to a greater horizontal and vertical extent. The effect of these combined drawdowns would create a long-term impact to the groundwater level.

The reduction of surface water quality from the management objectives in this alternative is almost negligible because the alternative calls for the injection of all produced water and the storage of all waters generated during exploration well tests. However, the potential exists for localized, short-term (less than 1 year) impacts from spills and ruptures associated with these water disposal methods. Undetected ruptures along water conduits feeding injection wells also would impact soils and create erosion problems within the immediate vicinity. These impacts are not expected to reach reservation lands under this management objective. Only the spilled or released waters entering associated watersheds near the reservations would be affected.

Drainage of CBM resources from Native American minerals is dependent upon local reservoir parameters. It is assumed that a single CBM well would drain the methane from a single coal seam over an 80-acre unit. Research by the BLM in the Wyoming portion of the Powder River Basin, however, suggests that drainage may be across a broader radius (Crockett and Meyer 2001) from BLM, private, or state lands. The Wyoming BLM estimates that considerable methane

drainage happens when 40 percent of the hydrostatic head is removed from the coal aquifer. Modeling by the Montana Bureau of Mines and Geology (MBMG) (Wheaton and Metesh 2001) suggests that the hydrostatic head of a producing coal seam could be reduced sufficiently to cause methane liberation at distances more than 5 miles from a producing CBM field. The reduction of hydrostatic pressure achieved by lowering the water table within a specific coal seam is necessary for CBM production. This reduction liberates the methane held in the coal matrix; however, the complex, site-specific aquifer conditions dictate the actual radius of methane drainage. Therefore, conclusions regarding methane drainage from tribal minerals need to be made on a case-by-case basis during development. CBM development would threaten to drain methane resources under tribal lands in the planning area.

The reduction of the hydrostatic pressure in a coal seam and the resulting liberation of CBM could also cause the methane to migrate along the path of least resistance and appear as an unchecked seepage at the surface. This scenario would be unlikely in view of the depths of the coal seams being explored (greater than 500 feet below the ground surface), the distance of foreseeable producing fields to the reservations and the relatively shallow groundwater wells used on the reservations for water production.

This alternative calls for the directional drilling of deeper coal seams, multiple completions in a single well bore, and the simultaneous development of all coal seams within a field. These techniques would increase the likelihood that CBM would be drawn from adjacent Indian mineral resources.

Mitigation

Mitigation agreements would be needed to replace water lost from the drawdown of groundwater within aquifers impacted by CBM production. These agreements would call for the replacement of the groundwater wells at the operator's expense. Surface water discharge permits that limit the quantity of CBM-produced water that is discharged would mitigate the impacts from Wyoming CBM production, as well as from expanded CX Ranch production. Potential hydrocarbon migration would be the subject of detailed monitoring and periodic drainage analysis conducted by the BLM as part of their trust responsibility (See *Monitoring Appendix* for details and frequency of monitoring). Monitoring and conducting drainage analysis would reduce the chances of correlative rights violations being brought to court. Native American development of reservation CBM resources is another potential mitigation measure that would ensure the Tribes receive their fair share of the CBM revenues.

Conclusion

Impacts on ITAs from management decisions included in Alternative B, from management practices common to all alternatives, and from projects evaluated under the cumulative effects analysis, would result in impacts to surface water quality, groundwater availability, and the irreversible loss of fluid and solid minerals.

The impacts on surface water quality and groundwater availability would be similar to those explained above and in the *Impacts From Management Common to All Alternatives* section. The surface water quality impacts would be similar to those described under Alternative A and range from the full-scale Wyoming discharge scenario to the no or very little degradation expected from the Montana-Wyoming Water Quality Agreement. The water drawdown from Montana CBM development under Alternative B, coupled with the development of CBM on the reservations, would result in a more widespread effect than just adjacent to the reservation boundaries. Considering the location of known coal occurrences, the groundwater drawdown would be experienced generally along the eastern portion of the Crow Reservation and across the entire Northern Cheyenne Reservation. The water drawdown would be contingent on the continuity of the coals, many of which are fractured, crop out, pinch out or have shale stringers. Impacts could not be detailed until the fields are developed.

The cumulative effect would also include the development of CBM on the reservations and the previously described impacts from the Absaloka Coal Mine. The timely development of CBM on reservations would reduce the potential for adjacent fluid mineral drainage, but increase the likelihood of proximity related impacts to the Absaloka Coal Mine. Impacts related to encroachment of the Absaloka Coal Mine would be similar to those previously discussed in the *Geology and Minerals* section of this chapter.

Alternative C

The differences in management objectives for Alternative C that would affect ITAs are the elimination of the buffer zone, direct discharge of a portion of untreated production water, and to some extent, the removal of the directional drilling and multiple completion requirements. Important to note is that, depending on the ranges of water quality criteria developed by the MDEQ to preserve current beneficial use of surface waters throughout the state and in particular in the CBM emphasis area, various levels of

impacts on surface water would occur. If the criteria imposed were to be relatively conservative, the discharge of CBM produced water would be limited into watersheds of both low and high water quality, resulting in minimal surface water quality impacts and increased treatment and use of alternative disposal methods. On the other hand, if the criteria were to be somewhat liberal and allow untreated discharge of produced CBM water into watersheds of higher quality, then impacts such as the following would be experienced: increased soil erosion and a corresponding increase in the addition of suspended sediment to surface waters adjacent to CBM development; the elevation of existing SAR, EC, and bicarbonate values for streams and rivers used by the tribes for irrigation; and the increase in flow that would result in riparian erosion and river course changes. These impacts are discussed in further detail in the *Hydrology* section of this chapter.

Impacts on groundwater would consist of the same drawdown effects as described in Alternative B, although the horizontal and vertical effect would be increased because of the lack of BLM buffer zone. The development of federal minerals near the reservations would increase the rate at which the groundwater is removed and discharged to the surface. Additionally, impacts on shallow aquifers from the infiltration of untreated produced water is expected where the soils have a coarser texture (sandy to loamy) and good internal drainage (ALL 2001a). Produced water less than 15,000 mg/l TDS can be discharged into permitted surface impoundments, which would allow infiltration of produced water into subsoil-thereby impacting shallow aquifers. Some of the shallow aquifers adjacent to reservation boundaries would be affected by this type of short-term infiltration.

The discharge of untreated produced water into drainages and ephemeral watercourses adjacent to well sites would cause an overall increase in erosion leading to gullying. Based on the *Soils Technical Report* (ALL 2001a), much of the soil would likely be susceptible to increasing sodicity when irrigated or land applied with water having a high SAR (generally greater than 12). The long-term consequence is an anaerobic, waterlogged, saline/sodic soil that can be reclaimed, but would be very difficult to mitigate.

Impacts on Native American hydrocarbons via adjacent production drainage would be similar to those described for Alternative B but the chances increase because of the lack of the BLM buffer zone. As previously mentioned, site-specific conditions control methane liberation and collection and therefore, to evaluate potential drainage, a case-by-case study is necessary. The removal of the directional drilling and multiple completion requirements from this alternative's management objectives would reduce the likelihood of added potential drainage from adjacent CBM operations.

With the removal of the buffer zones, encroachment on the Absaloka Coal Mine would be increased and impacts associated with the groundwater drawdown and inhibition of future coal resources—as discussed in the *Geology and Minerals* section of this chapter—would be felt.

Mitigation

Mitigation measures similar to those described under Alternative B would be helpful in delaying and reducing impacts expected from the Alternative C management objectives. Additional mitigation measures, such as the repair and lining of impoundments, would reduce untreated water infiltration and the effects to shallow aquifer quality. The loss of groundwater resources from the reservations could be mitigated through an agreement to increase the tribes' portion of water ownership in the Tongue River Reservoir. Other beneficial uses of produced water could be assigned to the tribes depending on water quality and quantity.

Conclusion

Impacts to ITAs from management decisions included in Alternative C, management practices common to all alternatives, and projects evaluated under the cumulative effects analysis would result in increased impacts to surface water quality, the increased reduction of groundwater availability, and the irreversible loss of liquid minerals.

The impacts to surface water quality would be increased over the degree of impact described in Alternative B, but the biggest factors influencing water quality would be the creation of a Water Quality Agreement between Montana and Wyoming, and the implementation of water quality criteria regarding degradation of Montana watersheds by the DEQ. CBM development on reservations would further increase the SAR value of available surface waters, adding to the chain reaction of impacts associated with erosion, sedimentation, riparian damage, and land use applications.

Impacts on the Northern Cheyenne's water right in the Tongue River Reservoir would be as described under Alternative A.

Impacts on groundwater drawdown and availability would be similar to those explained under

Alternative B, but without the buffer zone drawdown adjacent to the reservations, they would be increased both horizontally and vertically.

Without the buffer zone, additional monitoring and drainage analysis would be necessary to evaluate the case-by-case mineral drainage of adjacent fields. A detailed description of the planned monitoring to be administered by the BLM is included as the *Monitoring Appendix* to this EIS. As stated under Alternative B, the timely development of CBM on reservations would reduce the potential for adjacent liquid mineral drainage, but would increase the likelihood of proximity-related impacts to the Absaloka Coal Mine.

The impacts on lands irrigated by streams and rivers receiving untreated CBM discharge would be as described in the *Soils Technical Report* (ALL 2001a), and would be greatly dependent on the altered quality of the particular watershed being used. Increased soil erosion leading to gullying would be a result of development on the reservations along with the previously described erosion outside reservation boundaries.

Alternative D

The only differences in management objectives for Alternative D that would have an effect on ITAs is the treatment and piped conveyance of production water. This difference would reduce the impacts to erosion along ephemeral drainages, lower the sediment load in watercourses, and reduce the water quality impact to both surface water and groundwater. There would be an increase in available surface water for beneficial reuse because of the required treatment and lack of conveyance losses from the piped system of discharge. The lack of conveyance losses would increase the flow in receiving watercourses resulting in course changes and riparian alterations, as identified in Alternative A. Groundwater drawdown would be as described in Alternative B because of the use of the buffer zone by the BLM. Mineral drainage also would be the same as discussed under Alternative B, with the use of monitoring required to evaluate the case-by-case field conditions. Irrigated lands would be less affected by the use of treated waters, as described in the Soils section of this chapter. The Absaloka Coal Mine would experience the same groundwater drawdown impacts as described under Alternative B.

Mitigation

Mitigation measures similar to those described under Alternatives B and C would be helpful in delaying and reducing impacts expected from the Alternative D management objectives. The loss of groundwater resources from the reservations could be mitigated through an agreement to receive treated production waters for beneficial uses in prescribed amounts.

Conclusion

Impacts on ITAs from management decisions included in Alternative D, management practices common to all alternatives, and from projects evaluated under the cumulative effects analysis would result in increased surface water flow, reduction of groundwater availability, and the irreversible loss of liquid minerals.

Impacts on surface water quality would be similar to those discussed under Alternative B with regard to the influence of Wyoming's CBM production waters entering Montana and effecting the Northern Cheyenne water right in the Tongue River Reservoir. With the increase in flow from the treated waters in Montana, the overall SAR values would be expected to be adjusted downward, but only slightly. CBM development on reservations would further add to available surface waters once treatment is administered; groundwater drawdown would be the same as discussed in Alternative B. Soil erosion would be decreased because of the use of conveyance systems, which would result in the reduction of suspended solids in watercourses and the elimination of gullying. The impacts on lands irrigated by streams and rivers receiving treated CBM discharge would be reduced.

As stated under Alternative B, the timely development of CBM on reservations would reduce the potential for adjacent liquid mineral drainage, but would increase the likelihood of proximity-related impacts to the Absaloka Coal Mine.

Alternative E (Preferred Alternative)

The management objectives for Alternative E would result in surface water, groundwater and potential methane drainage impacts similar to those described in Alternative C. Noteworthy is the fact that the DEQ will set numerical criteria for their current non-degradation of surface water quality narrative resulting in either restricted discharge to most rivers and streams in the CBM emphasis area or flow based discharge with increased impoundment or discharge with some increase to the surface waters SAR, EC, and bicarbonate values. Regardless of what choice is made, impacts would resemble those described in the ranges analyzed under Alternative C in the *Hydrology* section of this chapter. There would be no discharge of produced water (treated or untreated) into the watershed unless the operator has an approved

National Pollutant Discharge Elimination System (NPDES) permit and can demonstrate in the Water Management Plan how discharge could occur in accordance with water quality laws without damaging the watershed.

Impacts on groundwater would consist of the same drawdown effects as described in Alternative C; however, water quality impacts from infiltration would be minimized as a result of the design and placement of impoundments. Impoundments proposed as part of the Water Management Plan would be designed and located to minimize or mitigate impacts to soil, water, vegetation, and channel stability reducing infiltration impacts to groundwater quality.

Impacts on Native American hydrocarbons via adjacent production drainage would be similar to those described for Alternative C because of the lack of a BLM buffer zone. As previously mentioned, site-specific conditions control methane liberation and collection and therefore, to evaluate potential drainage, a case-by-case study is necessary.

As discussed earlier under Alternative C, the Absaloka Coal Mine would be encroached on by CBM development but wells could not be drilled within permitted coal mining acres.

Mitigation

Mitigation measures similar to those described under the previous alternatives would be helpful in mitigating some of the impacts expected from the Alternative E management objectives, such as injection wells around the Reservation to maintain the hydrostatic balance, protecting Reservation water sources, and preventing methane migration.

Conclusion

Impacts on ITAs from management decisions included in Alternative E, management practices common to all alternatives, and projects evaluated under the cumulative effects analysis would result in a minimal decrease to surface water quality, the increased reduction of groundwater availability, and the irreversible loss of liquid minerals.

The impacts on surface water quality would be within the ranges analyzed under Alternative C of the *Hydrology* section.

Impacts to the Northern Cheyenne's water right in the Tongue River Reservoir would be as described under Alternative A.

Impacts on groundwater drawdown and availability would be similar to those explained under Alternative C. Monitoring and drainage analysis would be conducted by the BLM and MBOGC to evaluate the case-by-case mineral drainage of adjacent fields.

The impacts to lands irrigated by streams and rivers receiving CBM discharge would be as described in the *Soils Technical Report* (ALL 2001a), and would be dependent on the DEQ non-degradation numerical criteria being developed.

Lands and Realty

Assumptions

Gas from CBM wells is normally measured at the well site or on a collection line before mixing at field compression stations, making it possible for flow lines and compression stations to be shared by different operators to reduce development cost and surface land disturbance.

Split estate surface owners have the right to maintain control of non-CBM related access. Non-agreement between the surface owner and operator allows surface condemnation for access by the operator under the domain provisions of Montana's mining laws.

Operators are responsible for communicating requirements and stipulations to independent contractors working on behalf of the operator when performing various phases of CBM exploration and production development.

There are no expected disruptions to existing fiber optic, phone, gas, electric, or water lines as a result of the construction, production, or abandonment of project alternatives. It is the responsibility of the operator to identify whether buried lines exist within the pathway of new land-disturbing activities.

According to the Farmland Protection Policy Act, federal agencies involved in proposed projects that may convert farmland to non-agricultural uses must complete a USDA Farmland Conversion Impact Rating Form AD-1006. The form focuses on two farmland designations: prime farmland and agricultural lands of statewide importance. Prime farmland and agricultural lands designations are based on soil type and productivity and are not based on present use. The AD-1006 form would be completed for each APD application or as part of an Environmental Assessment (EA) checklist to assess impacts to agriculture on federal lands.

No physical displacements of residences or commercial property are predicted to result from project alternatives.

CBM-related, human activity increases fire hazards in the project area. The loss of vegetation by fire would impact all land uses including ranching, recreation, and agriculture, and would limit access to public lands because reclamation will be sensitive to soil disturbance.

The required reclamation plan by the operator would be reviewed and approved by BLM on federal lands, by the state on state lands, and by the landowner on private lands.

Impacts From Management Common to All Alternatives

Potential land use impacts would primarily consist of conflicts between conventional oil and gas activities and other uses of property, such as agriculture, residences, and coal mines. New realty authorizations for major gathering lines, major transportation lines, and power lines, for example, would impact rights-of-way (ROWs) and land segmenting. The development of oil and gas resources impacts agricultural production by taking land out of production and by soil contamination from drilling and production activities.

Surface disturbance associated with oil and gas activities, such as roads, well pads, and battery sites would remove those areas of agricultural production during the life of the road, well pad, or tank battery site. Removal of vegetation would reduce the acreage available for livestock grazing or crop production. Buried flowline and utility line routes would be seeded so the acreage would be temporarily removed from use for grazing or crop production. The infrastructure associated with oil and gas production could affect the movement or area available for livestock and could hinder irrigation systems.

Most existing roads would be lightly traveled by local residents, ranchers, and oil and gas workers. Use of unimproved roads would increase because of daily operations for a month at each site during development and testing of exploration wells. This road activity would be increased in general areas targeted for well development. Unimproved roads would be vulnerable to damage in adverse weather conditions. Public and private lands could be impacted by driving on soft or unstable road surfaces.

Residents and public visitors would be impacted by the sights, sounds, and delays caused by the construction and testing of exploratory and production wells. An increase in slow-moving vehicles would be an impact in areas not currently experiencing these activities. Creation of a temporary, unimproved, unrestricted access road to an area would allow public access and exposure of the property in a new way, and would expand the road system requiring maintenance by federal or state agencies and private landowners.

Public access to most wells would likely be limited because 65 percent of the land area is private; however, there would be conflicts with recreation (see the *Recreation* section of this chapter). Short-term

impacts would occur during road building, pad development, drilling, and production-related activities. Access for recreation on legally accessible public lands would increase as a result of the increase in unimproved roads. These impacts would be viewed as a benefit to sportsmen, who generally support increased vehicle access. Road densities on private lands would likely increase in the areas targeted for oil and gas wells, but property owners would be responsible for access control.

Produced water of quality suitable for livestock could be placed in impoundments in areas currently without such impoundments for livestock. This would enhance or expand livestock grazing. Construction disturbance would also force cattle onto previously unused range, further changing land use (see discussion on Livestock Grazing). Similar displacement would occur for wildlife, disrupting hunting on land designated for controlled or general hunts.

There may be a trespass impact to private landowners from the conversion of unroaded federal lands with a right-of-way that now allows access to private lands.

On private and public lands, road maintenance would be specified in the lease agreement as the responsibility of either the contractor or landowner.

Complete removal of the indication of vehicle passage and revegetation of two-track exploration on public lands would be important to prevent these temporary roads from becoming an established access through consistent misuse by four-wheel-drive and all-terrain vehicles, especially in areas historically not accessed by vehicles. The mitigation portion of the *Vegetation* section describes the seeding policy for reclaiming surface disturbances.

Impacts From Management Specific To Each Alternative

Alternative A

Impacts on multiple land use on public lands would be minimal because there would be no CBM production development on federal lands. State and private lands would have limited CBM production activities.

Exploration

The amount of new roads to be built with this alternative would be minimal relative to other alternatives. The primary land use impacts on federal and state lands are from short-term direct land use displacement by exploratory well pads and the creation of two-track trails across prairie or other lands from exploratory equipment. Impacts on private lands would be largely addressed in the contractual agreement with the private owners of the CX ranch.

Production

Newly created roads for CBM production would increase access across the CX Ranch that may displace or change the land use patterns on the land.

Abandonment

Two-track trails and associated motorized access created by CBM exploration on federal and state lands would be reclaimed after abandonment, unless otherwise authorized. New access created under a ROW may be reclaimed depending on the situation and the BLM and surface owner's desires. New motorized access in watersheds targeted for water quality restoration by MDEQ may require road reclamation as part of abandonment. Restoration based on water quality will be on a case-by-case basis with involvement from MDEQ. Abandonment and reclamation of roads on the CX Ranch could be highly variable according to the agreement with the surface owner. Abandonment impacts on private land cannot be determined because of this variability. Unwanted roads on the CX Ranch would be obliterated and revegetated according to the agreement with the lease operator.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative A. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts to the reservation. Trespassing from CBM related vehicles might increase because of activities adjacent to the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative A.

Mitigation

BLM guidelines for road reclamation described in the seeding policy (BLM 1999c) would be used to mitigate federal land disturbances and presented as a reclamation alternative for state and private lands.

Road and utility impacts experienced prior to reclamation are mitigated by requirements for repair or replacement in the site-specific review, or through

compensation for actual damages with damage payments. This mitigation is common to all alternatives.

The operator shall conduct all activities associated with the construction, operation, maintenance, and termination of the road and utility ROWs within the authorized limits of the federal ROW or state lease, land use license, or state ROW easement.

Conclusion

Alternative A would have the least land use impact among alternatives because of the limited number of exploratory and production wells within the project area. The greatest potential land use impact would be the ranching disturbance and displacement on the CX Ranch (see the *Livestock Grazing* section of this chapter).

Cumulative impacts for Alternative A include the increased road network to the CX Ranch, which may lead to increased public use and new development opportunities near the ranch. This increased road network may create future conflicts with current livestock grazing.

Alternative B

Exploration And Production

Short-term impacts of land uses during construction would consist of the physical intrusion by CBM crews and equipment, the local generation of dust and noise, and the limited obstruction of traffic. Long-term impacts include loss of existing land use, increased access from roads, and loss of land value.

Some surface landowners are unaware of the severed mineral rights, and even though compensated, would be displeased with the possibility of having well facilities located near dwellings. There are no legally required buffer distances between CBM facilities and residential, community, or government dwellings. Placement of roads and well pads near residential, business, and community dwellings may cause direct reduction of property values.

Although there may be no statute that covers buffer distances, State of Montana oil and gas leases include a minimum buffer distance of 200 feet. Reasonable additional buffers can be added as needed through stipulations on the lease or at the time of site-specific operating plan review.

Impacts from placement of roads, utility lines, pipelines, and well pads around communities may cause loss of future community development opportunities. These uses displace other surface uses like residential development and location of public parks and schools. There are safety and liability concerns.

Although private landowners and state land managing agencies would help decide road routes on their lands, as described in the *Mitigation* section, they would likely want to maintain some roads that benefit existing or future uses.

The increase in average daily traffic (ADT) of U.S., interstate, and state highways by action alternatives would be minor and is not expected to decrease their designed level of service within the CBM project area. Increased highway ADT over the 20-year life of the project would be largely from increases in demographics.

County roads in some portions of the project area will receive substantial CBM exploration and development traffic volumes. This large influx of CBM-related traffic on some isolated county and local roads will increase their associated road maintenance cost.

Short-term exploration impacts to farming include seasonal loss of crops during construction, interference with irrigation patterns, and increased introduction of noxious weeds.

Cropland area converted to production well pads and roads would be lost for the 20-year life of the project. Based on estimates in the *Vegetation* section, 20 percent of wells on state-permitted land in Blaine, Gallatin, and Park counties would occur in cropland soils. Four percent of wells in the Powder River RMP area and 8 percent of the wells in the Billings RMP area would occur in cropland soils. Specific long-term impacts include land displacement; alteration of existing flood and center pivot irrigation systems; modification of farming operations near and around well pads and access roads; potential for proliferation of noxious weeds; surface and groundwater quality losses; farming operations that are no longer commercially viable at certain locations; economic losses associated with all of the above; and lower land values.

Direct impacts on commercial woodlands would be caused by the immediate harvest of timber in ROWs and well pad sites and the loss of timber growth in these areas during the life of production and time of regrowth to merchantable trees. The income loss for the tree growth loss is reflective of time to grow merchantable trees, which is 50 to 100 years after reclamation of ROWs and pad sites. New roads on public forest lands may become part of the existing road system and their ROWs would be a permanent

loss of timber production. The increased use of four-wheel-drive and all-terrain vehicles would allow other vehicles to have extensive access once a route is established.

Roads from CBM development and CBM-related motorized activity may create conflict with timber cruising, logging, and hauling activities of an active timber sale. CBM-related traffic could increase traffic hazards with log-hauling trucks unless road use coordination occurs.

Indirect impacts from land clearing include wood fuel loading, introduction of noxious weeds; increases in insect population from slash buildup; and increased access for forest and fire management. CBM-constructed roads may not always be located in the best area for managing forest resources.

Abandonment

On federal and state lands, the access plan would create fewer two-track trails and roads than other development alternatives. Utility reclamation would occur with road reclamation because they are located in the same corridor. Public access would need enforcement to prevent the 20-year life of the CBM production road network from becoming part of the permanent public access network. On private lands, road abandonment would be highly variable as with the other alternatives because each landowner agreement would be different.

Regeneration time of timber to commercial size after CBM activities or other related land use would likely be 50 to 100 years. Road obliteration would include re-contouring the landscape and planting tree seedlings appropriate to the forest site.

A fire related to CBM activities or other land use disturbance will be a liability of the operator. Liability of fire is detailed in Statute 50-63-103 Montana Code Annotated (MCA).

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative B. If there were no CBM development on Tribal Lands, then impacts on the reservation, other than CBM related traffic discussed above, would be minimal.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative B.

Mitigation

Some road locations would be mutually beneficial to the present and future land uses of private surface owners and should be considered in negotiations. The operator would present to surface owners an environmentally preferred road construction plan and a road construction plan that compliments their economic preference. The use of a single corridor for transportation and utilities would be a preferred voluntary BMP for private lands.

Federal, state, and private lands will have all CBM-related roads reclaimed unless there is an alternative beneficial use for the road. The beneficiary user of the road will be responsible for its maintenance.

Dust abatement with the use of water or by rocking road surfaces would be used near residential and commercial dwellings to reduce indirect dust impacts to these land uses.

Lease operators would discuss compensation with county and local road and bridge departments when CBM-related traffic has caused increased road maintenance cost. There may be times when an operator or a group of operators may choose to provide maintenance for a particular road.

Trees would be commercially harvested from pipelines, utility, and road ROWs. Long-term loss of commercial timber production on these lands would be negotiated with the state and private landowners. Wood slash would be burned or "lopped and scattered" in an effort to control forest pests. If an outbreak occurs, insect spraying would occur as recommended by a forest specialist. The ROW holder must pay the BLM for merchantable timber cut in the ROW. The cut timber becomes the holder's responsibility.

CBM-related personnel will receive basic training and have fire safety and emergency phone numbers in all vehicles. Fire extinguishers will be carried and maintained in all vehicles. Under high fire warnings of summer, CBM employees may have fire-related restrictions directed by the land management agency. State trust lands requirements may also include additional equipment to be carried, such as shovels, pulaskis, etc. Various restrictions can apply to an area due to various levels of fire danger. These can include timing restrictions for work, avoidance of vegetation, having a backpack pump on equipment not capable of constructing a fire line, to total restriction of work or admittance to an area for Level 5 fire danger. Spark arrestors can be a requirement on equipment and vehicles.

There would be a need to increase enforcement of unauthorized use of roads and motorized trespass in an effort to educate the public that CBM-related roads are not part of the public road network. Funds from CBM proceeds may help support additional enforcement personnel.

CBM facilities, including roads, would be located away from or at the edges of agricultural lands to the maximum extent practical to reduce direct and indirect effects on agricultural resources and operations.

Disruption to irrigation facilities, including water canals, ditches, and pipelines; and other water conveyance systems would be minimized to the extent practical to allow irrigation to operate as designed.

If facilities such as fences or gates are damaged or displaced, they would need to be repaired or replaced according to landowner agreements.

Project traffic, such as truck convoys or heavy wide loads, would be scheduled to avoid disturbance to agriculture and other land.

Where possible, access roads would be placed on parcel boundaries to reduce impacts to residential property.

CBM-related traffic would maintain a safe speed that also controls dust when approaching adjacent residential dwellings. CBM-related roads, pipelines, and well pads would be placed away from residences and out of view from residences as much as possible. Displaced farmland, whether in crop production or not, should be reclaimed to original soil productivity in 1 to 3 years through adoption of standard reclamation procedures. Farmers would likely negotiate an agreement that requires the salvage, storage, and replacement of agricultural topsoil for reclamation.

Conclusion

Alternative B would have the least impact to present land use of the four development alternatives (B, C, D, and E). The types of displacement would be the same, but the amount of displacement would be less. For example, the required use of a transportation corridor for both road and utility lines in a one-way pattern reduces the direct surface disturbance by an estimated one-third compared to a grid pattern, multiple corridor approach.

Common land use impacts from roads, pads, pipelines, and utility lines include direct loss of agriculture, timber, grazing, recreation, and wildlife habitat and increased potential of wildfire. Indirect impacts include limited road access; dust, noise, and reduced property values; and increased local road maintenance cost, production, water storage, and ground injection, which reduces the potential direct and indirect impacts to other surface land uses.

Most direct and indirect impacts are mitigated through reclamation and financial compensation. Unmitigated impacts include displaced, non-monetary uses like public access, fire hazards, noise disturbance to livestock, and noise and dust to residents and communities.

Cumulative impacts for Alternative B include increased fire hazards from CBM exploration and development, which are the largest potential cumulative economic and environmental impacts to future land uses. The loss of range, timber, habitat, dwellings, access, and other impacts would not be recovered for a long time.

Road networks created for CBM development would increase access for fighting fires and create fuel breaks.

Alternative C

The less stringent access plan, separate placement of pipelines, utility lines, lack of buffers, and use of production water, would lead to an increase in surface land disturbance when compared to the other alternatives.

Exploration And Production

On federal and state lands, two-track roads created by exploration need to have access restrictions enforced to prevent them from becoming part of the permanent trail system or road network. New production roads may be placed along existing trails or be placed in the more traditional road grid system, which allows multiple routes from any production intersection. The traditional road grid system used for CBM production will create the highest density of roads and increase maintenance cost to land management agencies. On private lands, road placement would be a contractual agreement with the surface owner as described in the *Assumptions* section.

Surface disturbance from roads, pipelines, and utility lines is estimated to be approximately 30 percent greater than Alternatives B and D (see Table 2-2 in Chapter 2) because there are not the same road and utility restrictions to this alternative. Surface disturbance and its impact to agriculture is similar to Alternative B because most agriculture is on private lands. The potential impacts from production water discharges are also similar for the same reason.

CBM production water may have high levels of salinity or sodicity, which can cause negative impacts to agriculture with continued use. The saline level of the average CBM production water is near the threshold for causing yield reduction. Reduction in yields would be expected in salinity-sensitive crops like alfalfa, corn, and clover hay. High SAR production water would reduce water infiltration, especially in clay soils, and would increase erosion. CBM water with combined high SAR and low EC can cause notable reductions in the water infiltration rate of irrigated crops (ALL 2001b). Repeated sprinkler-applied CBM water high in saline can cause salt accumulation near the soil surface and cause foliar damage to certain crops. Dewatering coal seams may lead to release of methane gas that can contaminate neighboring agricultural and residential wells (ALL 2001b). The contamination of wells is a possibility that cannot be estimated in either amount of methane per well or by proximity of a well to a CBM field. Any contaminated well could be rendered unusable, and if the well is within a closed structure, increased ventilation is required to reduce buildup to explosive quantities.

It must be assumed that the historic road grid system used for CBM development is a worst-case scenario allowed under this alternative when there are no existing disturbances. The road grid system would create the densest road network and largest surface disturbance by providing multiple access to all the wells in the 80-acre well spacing proposal.

Abandonment

Land use displacement from road disturbances would be an assumed 20-year loss on federal, state, and private lands as in Alternative B, except there is more displacement on federal and state lands with this alternative. Land use displacement on private lands would have varying degrees of reclamation based on whether road placements benefit long-term private operations.

Reclamation of roads and utility lines on federal and state lands would need to receive strict access enforcement to prevent off-road recreationists from converting reclaimed roads, pipelines, and utility ROWs into unimproved road and all-terrain vehicle trails. This appears almost insurmountable, considering the linear miles of roads and utility corridors that would be created under Alternative C.

There is limited access to many small federal land parcels within the project area. CBM lease operators would create roads to these parcels and increase access and potential public use of the federal parcels. Neighboring private owners who have contributed access to the federal and state parcels may incur increased trespass problems similar to Alternatives B and D.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative C. If there were no CBM development on Tribal Lands, then impacts on the reservation, other than increased CBM related trespass problems discussed above, would be minimal.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative C.

Mitigation

The mitigation measures described in Alternative B would be used with the addition of the following.

The increased road network on federal and state lands with this alternative will likely increase road maintenance costs. In those high-impact areas on public lands, the operator may need to negotiate maintenance support either by financial assistance or by maintaining certain roads themselves. New CBM production-related roads on public lands would be obliterated and revegetated after the 20-year term of the lease. Revegetation would follow BLM protocol (BLM 1999c). There would be a need to increase enforcement to prevent unauthorized public use as described in Alternative B. Private landowners should have opportunity to comment on road placement.

High levels of salinity and sodicity can be diluted with surface irrigation water to negate EC-related crop reductions or SAR-related infiltration problems. Subsurface water levels should be tracked to identify whether methane gas could potentially contaminate adjacent wells.

Conclusion

The management objectives of Alternative C would result in the most impacts to present land uses among the four development alternatives (B, C, and D). The type of surface disturbances are no different than other alternatives except that the displacement is estimated to be one-third greater than Alternatives B and D. The two main causes for the increased surface disturbance and land use displacement are from not having transportation corridors and use of a traditional road grid system where there are no existing disturbances.

Cumulative impacts would be the same as described in Alternative B, with the exception of additional impacts to surface coal mining, the Tongue River Railroad project, and the improvement to county roads, etc.

Alternative D

Short-term transportation impacts on federal and state land uses would be the same as Alternative B. However, the long-term transportation impacts would be greatest because road obliteration and reclamation might not occur under this alternative and would permanently displace present and future land uses. The roads would become part of the public transportation system and would increase vehicle access on federal lands. The existing public road network may receive substantial traffic during production, requiring increased maintenance cost by public agencies. The new roads on federal lands that are not reclaimed would become the maintenance responsibility of the corresponding public agency.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative D, with an emphasis on CBM vehicle trespassing.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative D.

Mitigation

Public land management agencies would want more decision-making responsibility with CBM-related road placement to prevent conflict with the long-range management goals of the public resource area. After the 20-year oil and gas lease, the cost of road maintenance would convert to the agencies and future road maintenance expense needs would need to be negotiated with the lease operator.

Other mitigation relative to transportation impacts on public and private lands is the same as that described in Alternative B.

Conclusion

Alternative D has the same short-term transportation impacts as Alternative B but has the greatest long-term land use displacement impacts from the created permanent roads. The types of land use displacement with this alternative are the same as other development alternatives.

Most direct and indirect impacts are mitigated through reclamation and financial compensation. Unmitigated impacts include public access, fire hazards, disturbance to livestock, noise, and dust.

Alternative E—Preferred Alternative Impacts and Mitigation

Exploration and Production

The type of impacts from roads, pipeline and utility line in Alternative E are the same as those described in Alternative B except the extent of impacts from these disturbances are the same as described in Alternative C. This alternative, like Alternative C, will not require transportation corridors for the placement of roads, utility lines, and pipelines. Existing disturbances will be used as much as possible.

Land use displacement from road disturbances would be an assumed 20-year loss on federal, state, and private lands as with Alternatives B and C. CBM lease operators would create roads to small federal and state parcels never before road accessible to the public. Motorized trespass will be enhanced as a result of the increased road network on federal, state, and private lands from CBM-related exploration and development.

Agricultural-related impacts will be the same as those described in Alternative B.

CBM activities increases the likelihood of fire. Road networks created for CBM development would increase access for fighting fires.

The risk to surface water quality is the same as described in Alternative C.

Abandonment

Abandonment of roads, utility lines, and powerlines will be the same as described in Alternative C.

On private lands, road abandonment would be highly variable as with the other alternatives because each landowner agreement would be different.

Fire liability does not end at the time of abandonment but continues as long as fire can occur from CBM development-related activities. Liability of fire does not end at abandonment and is detailed in Statute 50-63-103 Montana Code Annotated.

Mitigation

Road mitigation described in Alternatives B and C would be largely used here with the exception of the following:

Operators will be required to submit a project plan when well densities are greater than one well per 640 acres. The operator must consult with surface owner for development of Project plan relative to location of roads and utility lines. This consultation must be presented in the plan.

A water management plan will be submitted as part of the Project plan. The water management plan will be required for every exploration Application for Permit to Drill and on a site-specific basis for management of production water. The plan will allow various disposal and discharge options if water beneficial uses are not harmed or degraded in accordance with water quality laws.

Conclusion

CBM operators will be required to submit a Project Plan when the proposed development for an area will exceed one well per 640 acres.

The type of impacts from roads, pipeline, and utility line in Alternative E are the same as those described in Alternative B, except the amount of impacts from these disturbances are the same as described in Alternative C. This alternative, like Alternative C, will not require transportation corridors for the placement or roads, utility lines, and pipelines. Existing disturbances will be used as much as possible.

New roads would remain open or closed at the surface owner's discretion. Ones to be closed will be rehabilitated upon abandonment.

There will be no degradation of a watershed from water releases. A Water Management Plan would be required for every exploration Permit to Drill. First priority for discharged water would be for beneficial uses.

The potential for fire hazard is the same as Alternatives B, C, and D.

Livestock Grazing

Livestock forage and petroleum development would be generally compatible because exploration activity would be temporary and operational activities require a small area for equipment. Livestock grazing on rangeland would continue during CBM and conventional oil and gas development.

Assumptions

Affected acres and animal unit months (AUMs) were calculated assuming all CBM activity would be located on grazing lands. AUM losses were predicted separately for the two BLM RMPs and the state because of differences in permits and land grazing capacities. Surface disturbance assumptions are detailed elsewhere in this chapter. This analysis is focused on the CBM emphasis area, but can be used for inference to similar areas throughout Montana. It is assumed that existing roads and fence crossings would be used for oil and gas operations as much as possible.

Impacts From Management Common to All Alternatives

Impacts on rangeland would occur from the loss of vegetation for livestock grazing; the disruption to livestock management practices; and loss of grazing capacity from construction of well pads and roads. Each well would present its own set of unique circumstances that would be mitigated to minimize impacts. With the exception of minimal short-term forage loss, these impacts would only last as long as construction activities were ongoing. Controlling livestock movement by maintaining fence line integrity would be essential for efficient livestock and range management. The construction of roads and pipelines would bisect fences, which would require placement and maintenance of cattle guards and gates. The current development of oil and gas and CBM on state land would require installation of cattle guards on fence lines to prevent livestock escape. The impacts of oil and gas development would result in the loss of about 833 AUMs in the Billings RMP, 830 AUMs in the Powder River RMP, and 359 AUMs on state-permitted rangelands. These losses would be reduced to a total of 735 AUMs during the production phase of oil and gas activities.

While roads, trails, and well pads would block traditional cattle trails, this network of new roads would provide livestock producers with improved access to remote livestock facilities and grazing areas. However, road systems would interfere with livestock dispersal and cause decreased forage efficiency because cattle tend to congregate and travel along roads. The relatively high volumes of exploration vehicle traffic would present a hazard to livestock. Heavy traffic on temporary access roads would increase the risk of collision with stock, resulting in injury or death of the animals. Airborne dust stirred up by heavy exploration vehicles would settle on forage along the road. The dust would affect the palatability of grass and forbs up to 1/4 mile from the road. Livestock forage would be killed by accidental spills of crude oil, high saline-produced water, or drilling fluid.

Areas of soil disturbance, such as results from construction, may experience an influx of noxious weeds. Noxious weeds reduce rangeland value to livestock by displacing preferred forage species. Severe infestations would result if weeds are not controlled, decreasing rangeland capacity for grazing. Additionally, some weed species are poisonous to livestock, causing illness, internal injury, or death when ingested.

Mitigation

The following mitigation measures would minimize grazing impacts associated with CBM and conventional oil and gas development:

- Repair or replace damaged or displaced facilities such as fences or gates according to landowner requirements.
- Minimize project-related construction equipment and vehicle movement except on specific access roads to avoid disturbance of grazing land.
- Clearly define responsibility for fence, gate, and cattle guard maintenance and for noxious weed control in APDs and right-of-way grants, and require both as conditions of granting a new APD or right-of-way grant.
- Develop a reclamation plan for all areas that have been disturbed during production, and specify techniques for reclamation of well pads, pipeline rights-of-way, and roads.
- Site facilities to avoid or minimize impacts on livestock waters.

Impacts From Management Specific to Each Alternative

Alternative A

Under Alternative A, exploration wells located on BLM-permitted rangelands would result in the temporary loss of 30 AUMs for the Billings RMP rangeland and 39 AUMs for the Powder River RMP rangeland. There would be no production activities in BLM planning areas under this alternative and, therefore, no impacts from production. State-permitted exploration and production wells located at CX Ranch would result in a loss of 272 AUMs. Revegetating parts of the well pads during production would reduce the losses to 194 AUMs. The mitigation measures would be the same as those discussed in the *Impacts From Management Common To All Alternatives* section above.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative A. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on livestock grazing on the reservation. If there is CBM development on the reservation, then reductions in AUMs from BLM, state and private lands could be inferred to the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative A.

Conclusion

During the next 20 years, disturbances from CBM development, conventional oil and gas development, and other projects considered under the cumulative effects analysis would result in the loss of about 863 AUMs in the Billings RMP, 869 AUMs in the Powder River RMP, and 955 AUMs on state-permitted and private rangelands. These losses would be reduced to a total of 929 AUMs during the production phase of CBM and conventional oil and gas activities. After production ceases and lands used for production and mining are abandoned, most land can be returned to production (excluding permanent roads and facilities).

Alternative B

Alternative B considers expanded development of CBM resources. Table 4-8 presents the predicted AUMs that will be lost from exploration, construction, and production on both BLM and state grazing lands. Losses from exploration would be mostly temporary (less than 5 years) and would be reclaimed after exploration activities cease. Revegetating parts of the well pads during production would reduce construction losses to those shown below under operation losses.

Impacts on livestock grazing would be reduced under this alternative through the requirement of transportation corridors, using multiple completions per well bore and directional drilling, injecting produced water instead of storing on-site in impoundments, and rehabilitating new roads at the end of the well lifetime. All of these would help to minimize the area of surface disturbances shown in Table 4-8 by up to 35 percent during construction and 40 percent during production, thus reducing the number of AUMs lost. The mitigation measures would be the same as those discussed in *Impacts From Management Common To All Alternatives* section above.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative B. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on livestock grazing on the reservation. If there is CBM development on the reservation, then reductions in AUMs from BLM, state and private lands could be inferred to the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative B.

Conclusion

During the next 20 years, disturbances from CBM development in state, BLM, Native American, and USFS planning areas; conventional oil and gas development; and other projects considered in the cumulative effects analysis would result in the loss of about 18,500 AUMs. These AUM losses would be partially recovered during the production phase of CBM and oil and gas activities, and after production ceases and lands used for production and mining are abandoned. The requirement of transportation corridors, injection of produced water (less land needed for impoundments), and multiple use of drilling pads would help to minimize livestock grazing losses up to 35 or 40 percent.

TABLE 4-8
NUMBER OF PREDICTED ANIMAL UNIT MONTHS (AUMS) LOST TO EXPLORATION, CONSTRUCTION, AND PRODUCTION

	AUMs Lost to Exploration	AUMs Lost to Construction	AUMs Lost to Operation
Billings RMP	11	340	209
Powder River RMP	152	4,430	2,275
BLM Sub-total	163	4,770	2,484
State/Private Lands	250	7,190	4,420
Total	**413**	**11,960**	**6,904**

Alternative C

Under this alternative, impacts to livestock grazing would be similar to Alternative B with the following exceptions: transportation corridors and collocation of wells would not be required, thereby increasing the number of disturbed acres and AUMs lost compared to Alternative B (see Table 4-8); suitable CBM discharge water could be used for livestock watering reducing the amount discharged; and the discharge of produced water to the surface would increase erosion and cause increased surface disturbance to livestock. Other impacts would include the possibility of an increase of noxious weeds and a decrease in forage material if produced water that is too high in saline content is discharged on the land surface, and possible health effects if livestock consume produced water that is unacceptable (ALL 2001a). Generally, water is acceptable for livestock if the TDS is lower than 10,000 mg/l and the EC is less than 16,000 µS/cm. Some CBM water has also been found to exceed standards for fluoride (2 mg/l) and aluminum (0.2 mg/l) (ALL 2001b). Discharging untreated CBM-produced water on the ground surface at the well pad would lead to increased localized soil erosion and gullying, which could also lead to disrupted grazing patterns, undermined fencing, and reduced forage. Mitigation measures would be similar to Alternative B.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative C.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance could be greater since transportation corridors and collocated wells are not required. Surface discharge of untreated produced water could result in increased forage loss, erosion, gullying, grazing pattern disruptions, and fencing undermining. Forage losses could be permanent because of soil sterilization by saline water applications. This amount would vary depending on the quality and quantity of water discharged. Watering livestock represents only a small portion of the estimated 20 percent beneficial reuse assumed under this alternative, but would still result in a small amount of impacts reduction to the other resources.

Alternative D

Under this alternative, impacts on livestock grazing would be similar to Alternative C with the following exceptions: impacts from drilling and collocation of wells would be the same as Alternative B; transportation corridor and road impacts would be similar to Alternative B; discharged CBM-produced water would be treated and not discharged directly at the well site; and there would be a reduction to forage losses from increased land application of produced water through irrigation applications. This would be a

favorable impact from having more treated water available in the winter and arid months available for livestock watering and irrigation of grazing lands.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative D.

Conclusion

Cumulative impacts would be similar to Alternative C with some exceptions: impacts from drilling and collocation of wells would be the same as Alternative B; transportation corridor and road impacts would be similar to Alternative B; there would be a reduction to forage losses from increased land application of produced water; and there would be less soil and forage loss from erosion of soils.

Alternative E (Preferred Alternative)

Under this alternative, impacts on livestock grazing would be similar to Alternative B with the following exceptions: transportation corridors and collocation of wells would not be required, thereby increasing the number of disturbed acres and AUMs lost compared to Alternative B (see Table 4-8); suitable CBM discharge water could be used for livestock watering reducing the amount discharged; Water Management Plans would be designed on a site-specific basis to allow for no degradation to the quality of the watershed and have a priority for beneficial use, which could include livestock watering and irrigation (benefits for livestock); and surface owners would be more involved in planning and decision making processes.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative E.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance could be greater since transportation corridors and collocated wells are not required. There would be less soil and forage loss from erosion of soils. Beneficial use of produced water by watering livestock would reduce, by a small amount, the impacts to other resources. The surface owners will also have more input into Project Plan, which may affect livestock grazing.

Paleontological Resources

Assumptions

Surface occupancy is prohibited within paleontological sites on BLM minerals in the planning area. As an exception, modification or a waiver may be applied for under similar circumstances as mentioned in the *Cultural Resource* section, provided it can be demonstrated that the paleontological resource values can be protected or undesirable impacts can be mitigated.

Impacts From Management Common to All Alternatives

Within the planning area, several localities have been found to contain noteworthy paleontological resources. The Bridger Fossil and East Pryor Mountains are classified as Areas of Critical Environmental Concern (ACEC) because of their paleontological resources.

Mitigation

The BLM APD contains guidance for registering and mitigating damage to paleontological resources discovered while constructing well pad sites. Other mitigation activities would include oil and gas leasing, which will not be allowed on the 575 acre Bridger Fossil Area ACEC site. Underground explosives for geophysical exploration for oil and gas will not be allowed. Other geophysical exploration methods for oil and gas will be allowed if the method will not damage the paleontological resource. If monitoring indicates damage to fossils as a result of the geophysical activity, it will no longer be allowed.

Impacts From Management Specific to Each Alternative

Alternative A

Impacts from this alternative would be similar to those described in the *Impacts From Management Common to All Alternatives* section above, with some exceptions. In CBM development there would be no geophysical exploration that could result in the destruction of paleontological resources. Other impacts would include vandalism and removal of fossils by amateur fossil collectors resulting from increased accessibility to remote areas.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts to paleontological resources on the reservation. Impacts on Tribal Lands are discussed in more detail under the *Cultural Resources* section.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Conclusion

Cumulative impacts under this alternative would include the effects from CBM development, conventional oil and gas development, the proposed Tongue River railroad, and surface coalmining activities. Known paleontological resources within the planning area would be protected by Section 6 of the lease terms. NSO stipulations applied to known paleontological resources would help protect those sites.

Alternative B

Impacts from this alternative would be similar to Alternative A with some exceptions. Under this alternative, development would result in increased access to remote areas. The impacts of increased access would include increased vandalism and removal of fossils by amateur fossil hunters.

Crow Reservation

Impacts to the Crow Reservation would be similar to those described in general for Alternative B.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Conclusion

Cumulative impacts under this alternative would be similar to Alternative A with the exception of increased CBM development resulting in increased vandalism and removal of fossils from increased access to remote areas. Mitigation measures would be similar to Alternative A.

Alternative C

Impacts from this alternative would similar to Alternative B with some exceptions. Under this alternative, increased surface disturbances from not using ROW corridors would result in increased impacts to unknown paleontological resources and increased access to remote areas. The impacts of increased access would include increased vandalism and removal of fossils by amateur fossil hunters.

Crow Reservation

Impacts to the Crow Reservation would be similar to those described in general described above for Alternative C.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusion

Cumulative impacts under this alternative would be similar to Alternative B with the exception of increased surface disturbance resulting from the lack of ROW corridors, vandalism and removal of fossils from increased access to remote areas. Mitigation measures would be similar to Alternative A.

Alternative D

Impacts would be the same as described under Alternative B.

Alternative E (Preferred Alternative)

Impacts under this alternative would be similar to Alternative C with some exceptions. Under this alternative, the potential for project plan stipulations could affect the amount of surface disturbances. Directional drilling may be performed on deeper coal seams and would decrease surface disturbances. The potential for impacts from surface disturbances resulting from the placement of underground utilities would increase impacts to paleontological resources.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described above for Alternative E.

Conclusion

Cumulative impacts under this alternative would be similar to Alternative C with the exception of the potential changes to surface disturbances resulting from the Project Plan stipulations. Efforts would be taken to minimize the impacts to paleontological resources by minimizing the total surface disturbance. Mitigation measures would be similar to Alternative A.

Recreation

Assumptions

Recreation areas were detailed in Chapter 3. Most of the recreation resources in the study area consist of dispersed activities such as hunting and fishing. BLM has stipulations to protect recreation areas receiving concentrated public use and reservoirs used for recreational fishing. Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. In general, the demand for recreational activities will increase proportionately with the increase or decline of regional populations.

Impacts From Management Common to All Alternatives

Recreation areas are potentially impacted by surface-disturbing activities. The activities that involve the use of heavy equipment (road construction, well drilling, pad construction, pipeline and utility placement, etc.) would result in changes to the natural landscape, which would cause the most surface disturbance and have the greatest impact on recreation areas. Other activities, such as increased travel and vandalism resulting from access improvements, and increased erosion resulting from surface disturbances, can also impact recreation areas. These activities can produce indirect impacts to recreation areas such as fires, hazardous waste spills and cleanups, changes in livestock grazing patterns, and wildlife habitats.

BLM has stipulations to protect recreation areas receiving concentrated public use and reservoirs with fishes. The state also has stipulations for protection of recreation areas including prohibiting activity within 100 feet of streams, ponds, lakes, or other water facilities. Additional state stipulations include a 1/8-mile buffer for rivers, lakes, or reservoirs, and a sensitive areas stipulation that may be used when field staff receive comments regarding recreation areas. Most of the recreation resources in the study area are dispersed activities, such as hunting and fishing, and are not developed recreation sites. Exploratory activities such as drilling and testing would temporarily displace game species locally. Installation of oil and gas production facilities in areas used for hunting, hiking, and other dispersed recreational activities would infringe on the solitude and rural characteristics of the area. The oil and gas infrastructure and activities would reduce the number of game animals in the area or force some game animals to leave the area which would reduce or eliminate certain hunting activities. Hunters would be concerned about shooting around facilities and equipment.

Exploration and production would create new roads, which would provide easier motorized access to areas that may not have been accessible before. Motorized recreation user groups would see this as a benefit to their sports, and would appreciate increased access to streams, lakes, and hunting areas. Non-motorized recreational enthusiasts who seek solitude and quiet, including backpackers, hikers, and some hunters and anglers, would not benefit from road development. As formerly remote areas become more accessible and competition for limited resource escalates, conflicts among these user groups would occur.

Increased human access and increased human activity associated with exploration and development would result in increased legal and possibly illegal harvest of fish from nearby drainages. Increased legal harvest would be a recreation benefit as fishing opportunities are more accessible to a wider range of people and game regulations are adapted to accommodate the increased fishing pressure. However, if increased illegal harvest causes fish populations to drop below a sustainable level, fishing as a recreational resource would be affected.

Increased access typically causes an increase in vandalism and the need for law enforcement. As recreation in public lands becomes more popular, undeveloped recreation sites would generally require more time and attention and have the potential to become developed sites, if use becomes concentrated to that level. Exploration and production activities may cause some ranches to be closed to hunting access via surface agreements.

Mitigation

Mitigation activities include avoiding location of oil and gas facilities in established recreation sites or undeveloped sites having concentrated use, and coordinating timing of exploration activities to minimize conflicts during peak periods of use.

Impacts From Management Specific to Each Alternative

Alternative A

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be

mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally. There would be no production activities in BLM planning areas under this alternative and therefore no impacts from production on BLM land.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for recreation in general. If there were no CBM development on Tribal Lands, then there are expected to be minimal impacts on recreation on the reservation. Impacts on hunting and fishing from trespassing described above should be emphasized because of Native Americans' reliance on these resources.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Impacts from surface disturbance would be minimized by using existing disturbances where possible, and by allowing aboveground utility lines. The mitigation measures would be the same as those discussed in the *Impacts from Management Common to All Alternatives* section above.

Conclusion

Cumulative impacts under this alternative would include the effects of Alternative A combined with conventional oil and gas development and other projects discussed under the *Cumulative Impacts and Projects Evaluated* section above. These would include impacts from nearby activities such as mining or power generation facilities, which can result in increased use due to increases in population associated with additional available jobs. In addition, the construction of the Tongue River Railroad would result in the loss of 264 acres of BLM land that could provide hunting opportunities for the public. (Note: surface mining is getting ready to expand by 4,000 acres under permit request now. See this chapter's *Introduction* section.)

Alternative B

Alternative B would allow development with single-lane roads and turnouts. Upon abandonment, new roads would be rehabilitated and closed. Impacts from this alternative would be similar to Alternative A with the addition of increased CBM development resulting in increased access, resulting in increased impacts on dispersed recreation activities such as hunting and fishing.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative B.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives section above.

Conclusion

The residual impact of this alternative is increased CBM development, which would result in increased access to remote areas and increased vandalism.

Cumulative impacts under this alternative would be similar to those described under Alternative A, but on a large scale because of CBM development.

Alternative C

Under this alternative, impacts on recreation areas would be similar to Alternative B with the following exceptions: transportation corridors are not required, thereby increasing the number of disturbed acres and opportunities for access; and discharge of produced water may be directly to the ground, which would increase erosion. Increased erosion could lead to a reduced amount of land available for recreation activities and could disrupt habitat for game species.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative C. If there were no CBM development on Tribal Lands, then the additional impact exceptions mentioned above would be minimal, if any, to recreation on the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives section above.

Conclusion

The residual impacts of this alternative are similar to Alternative B. The exception would be that surface disturbance from roads would be greater, increasing the opportunity for access to remote areas and the discharge of water, which would increase erosion and potentially damage lands used for recreation.

Cumulative impacts would be similar to those described under Alternative A, but on a large scale because of CBM development.

Alternative D

Under this alternative, impacts to recreation resources would be similar to Alternative B, however water management would include measures to eliminate soil erosion by piping discharged water to the nearest body of water. Also, under this alternative, new oil and gas roads would remain open or closed at the surface owner's discretion. Without a firm commitment to close new roads, impacts and benefits from additional roads as discussed above would occur.

Crow Reservation

Impacts to the Crow Reservation would be similar to those described above for Alternative D.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives section above.

Conclusion

The residual impacts of this alternative would be similar to those described under Alternative B.

Cumulative impacts would be similar to those described under Alternative A but on a larger scale due to the expanded CBM development.

Alternative E (Preferred Alternative)

Alternative E, the Preferred Alternative, would allow CBM development subject to existing planning restrictions and balances CBM development and the protection of the natural environment. Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally. Impacts from surface disturbance would be minimized by using existing disturbances where possible however, transportation corridors are not required, thereby increasing the number of disturbed acres and opportunities for access.

Crow Reservation

Impacts to the Crow Reservation would be similar to those described above for Alternative E.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives.

Conclusion

The residual impacts of this alternative are similar to Alternative B. The exception would be that surface disturbance from roads would be greater, increasing the opportunity for access to remote areas.

Cumulative impacts under this alternative would be similar to those described under Alternative B.

Social and Economic Values

Assumptions

It is assumed that the average CBM production well in Montana produces about 125,000 cubic feet per day (MBOGC 2001b). Using a gas price of about $4.00 per thousand cubic feet, the average well would generate about $182,500 per year in total income. Income-producing wells on average are expected to last between 10 and 20 years, with an average production life of 15 years. Exploration wells do not produce income.

The social and economic analysis in this chapter is based on the RFD rate of development over a 20-year period. During this 20-year period, all CBM wells would be drilled and production would peak. However, because CBM wells typically produce for 10 to 20 years, a well drilled in year 20 would continue to produce until year 40. Thus, social and economic consequences of production and abandonment would continue for up to 20 more years beyond the period assessed here.

The number and type of jobs related to CBM development would vary with the project phase, exploration, development, production, or abandonment. During exploration and development, the majority of jobs created would be for well drillers and pipeline installers along with specialty positions such as land surveyors, supervisors, and geologists. A number of related support personnel (e.g., truck drivers and material handlers) would also be required during these activities. During production, most new jobs would be for maintenance and repair workers and their supervisors. During abandonment, field workers, support workers, and their supervisors would be in demand.

To simplify this analysis, all dollar amounts (e.g., wages and other project-related income) are reported in current dollars with no adjustment for inflation over time.

Impacts From Management Common to All Alternatives

Impacts on social conditions would include changes in employment and population; changes in the services provided by governments; the effects of drilling and related activities on rural lifestyles in the project area; the effects of changes in employment opportunities on communities; changes in levels of traffic, noise, visual resource impacts, and psychological stress levels; and the effects of population change on local housing, schools, and services.

Direct economic impacts of the project would include changes in personal income resulting from new employment of oil and gas workers; purchases of services from local area vendors; lease, royalty, and production payments; taxes and other government levies; impacts resulting from changes in environmental quality; and related changes in the fiscal health of county, state, and federal governments. Indirect impacts would include induced economic activity from local purchases of equipment, supplies, and services; induced economic activity from purchases of goods and services by project workers; and changes in the sources of income for local governments. The largest economic benefit from CBM development is the methane itself, measured by the revenues obtained by the companies involved in developing the resource. It is assumed that most of these revenues will go to out-of-state companies. Montana's share of that benefit will come mostly in the form of natural gas taxes and royalties, discussed below.

Conventional oil and gas development would have economic impacts on landowners, communities, county governments, reservations, and the state and Federal governments. When hydrocarbons are produced and sold, the operator is responsible for paying the mineral owner and governmental entities in the form of taxes and royalties. New employees generally would be needed as wells are added; for example, drilling contractors and other contractors would be required to service and supply the wells to maintain production. At the same time, an increase in wells would impact the community through an influx in population which, in turn, would result in increased pressure on community services such as schools, roads, medical facilities, and other public services.

Property values would be affected by full field development. Small ranchettes located within the area would increase in value because of the demand for additional housing. Full-size ranches would be impacted by the increase in activity accompanying development. This could include such factors as the change in rural character of the land. Ranchers choosing to sell their ranches would receive less monetarily if the ranch sells without mineral rights attached. Outfitting would be impacted from increased road development, causing a decline in outfitting income.

Oil and gas development would impact social and economic resources through influence on area employment, taxes, Payments in Lieu of Taxes,

royalties to mineral owners, and county, state, and federal services. It might also affect local environmental resources, from which many residents make their living. Conventional well development is projected at between 595 to 2,325 additional oil and gas wells over the next 20 years. This level of industrial activity (average 116 wells per year) would have negligible impact on the social economic resources of the area.

Impacts From Management Specific to Each Alternative

Alternative A

Employment and Unemployment

The location and distribution of the exploratory wells by county is not known, and therefore, this analysis assumes that the wells in the two RMPs are distributed across those areas and the wells to be drilled statewide are also distributed geographically in proportion to the RFD estimates for development. The production wells are assumed to be confined to the CX Ranch in Big Horn County.

Average numbers and types of jobs and their associated wages are estimated based on a recent report on the economic impacts of CBM development in the Powder River Basin (ZurMuehlen 2001), which assumes the following ratios: 49 jobs per 160 wells for exploration/development; 9 jobs per 160 wells for production; and 12 jobs per 160 wells for abandonment. As shown in Table 4-9, the estimated number of jobs created under Alternative A would range between 175 (Year 1) and 14 (Years 8 through 19), for an average of about 32 jobs per year over the period. This change would be small compared to the total employment in the CBM emphasis area (183,000 in 1998). For Alternative A, it is assumed that all wells would be abandoned by year 20 of the project.

Measurable indirect changes to local employment would not be anticipated for Alternative A. The purchase of equipment, supplies, and services related to the proposed wells would have some impact but likely would not be distinguishable from the existing economic activity in the CBM emphasis area and in the state.

Thus, few or no new jobs would be created indirectly. New employment created directly and indirectly for Alternative A would be small in relation to total employment in the CBM emphasis area (183,000 in 1998), and therefore, it would not be expected to result in changes to current county or state unemployment rates.

Demographics

Employees who would fill the CBM jobs would likely be a mixture of current residents from the surrounding areas and those who would be drawn to the project and its employment opportunities from around the region. It is assumed that local labor (i.e., those within commuting distance of the CBM well locations) would be used to the extent available; however, many of the new jobs would likely be filled by new migrants to the region. The degree to which the jobs would be filled by current residents would depend on a number of factors, including job skills (including Native Americans living on and off the reservations). The extent to which workers who move to the region for new jobs would bring families with them would depend on a number of factors, most notably the duration of the job in a given location. Assuming a mixture of single employees and those with families, it is estimated that, on average, each new employee would bring one additional person to the region. Even if all the jobs (175 during Year 1) were filled by new migrants to the region and resulted in new persons moving to the area, the total new population (perhaps 350 persons) would be small compared to the total regional population (287,000 in 2000). There would likely be some concentration of new residents associated with jobs in Big Horn County related to the CX Ranch. Given that any new population would be spread over both time and geographic area, no impact on demographics would be anticipated from Alternative A.

Social Organization

Housing Units and Vacancy

Only small changes in the supply or demand of permanent or temporary housing are anticipated as part of Alternative A. This follows from the small changes in employment and population discussed above.

Public Services and Utilities

The relatively small scale of CBM well development proposed for Alternative A would not result in any substantial changes in the ability of county, state, or Federal governments to provide public services or utilities. The basis for this conclusion is the lack of additional temporary or permanent population and the associated lack of demand for additional public services.

TABLE 4-9
ALTERNATIVE A: ESTIMATED WAGES AND JOBS FOR WELL DEVELOPMENT, PRODUCTION, AND ABANDONMENT
(WAGES REPORTED IN CONSTANT DOLLARS)[1]

Year	Wells Drilled per Year	Initial Development Jobs	Initial Development Wages[2]	Wells Producing per Year	Production Jobs	Production Wages	Wells Abandoned per Year	Abandonment Jobs	Abandonment Wages	Estimated Total Jobs	Estimated Total Wages
1	525	161	$4,662,656	250	14	$539,063				175	$5,201,719
2	150	46	$1,332,188	250	14	$539,063				60	$1,871,250
3	150	46	$1,332,188	250	14	$539,063				60	$1,871,250
4	100	31	$888,125	250	14	$539,063	375	28	$972,656	73	$2,399,844
5				250	14	$539,063	100	8	$259,375	22	$798,438
6				250	14	$539,063	100	8	$259,375	22	$798,438
7				250	14	$539,063	100	8	$259,375	22	$798,438
8				250	14	$539,063				14	$539,063
9				250	14	$539,063				14	$539,063
10				250	14	$539,063				14	$539,063
11				250	14	$539,063				14	$539,063
12				250	14	$539,063				14	$539,063
13				250	14	$539,063				14	$539,063
14				250	14	$539,063				14	$539,063
15				250	14	$539,063				14	$539,063
16				250	14	$539,063				14	$539,063
17				250	14	$539,063				14	$539,063
18				250	14	$539,063				14	$539,063
19				250	14	$539,063				14	$539,063
20				250	14	$539,063	250	19	$648,438	33	$1,187,500
20-Year Total	**925**	**283**	**$8,215,156**	**250**	**281**	**$10,781,250**	**925**	**69**	**$2,399,219**	**634**	**$21,395,625**

NOTES:

[1]Data for jobs per well and wages (ZurMuehlen 2001).

[2]Wages paid for initial development phase for well drillers and pipeline installers was estimated at $6,600 per well (Langhus 2001)

Attitudes, Beliefs, Lifestyles, and Values

The information reflected in the public comments and newspaper reports summarized in Chapter 3 indicate a range of attitudes and beliefs with respect to the development of CBM and its relationship to the lifestyles and values of area residents.

As discussed in Chapter 3, the majority of public comments received during scoping related to concerns about impacts on the environment, and water quality and quantity in particular. The possibility of unfavorable economic impacts resulting from environmental impacts is also a concern. Other concerns include possible increases in traffic levels, noise, visual resource impacts, and psychological stress associated with changes to the surrounding built and natural environment.

The limited development of CBM proposed for Alternative A likely would be experienced by the communities in the CBM emphasis area as a continuation of existing oil and gas development practices in the region and in the state. As a result, these actions by themselves would likely be perceived as generally consistent with the attitudes, beliefs, lifestyles, and values of most population groups (e.g., ranchers, Native Americans, small town residents).

Personal Income

Wages paid to project employees would contribute to the total personal and per capita income of every county where employees reside. As shown in Table 4-9, total direct wages from Alternative A over 20 years are estimated at about $21 million, and would range from a high of $5.2 million (Year 1) to a low of $539,000 (Years 8 through 19).

Any of the producing wells proposed for operation on the CX Ranch would generate new personal income, depending on ownership. Individuals who own the mineral rights to their land and lease those rights to developers as part of the existing management scenario would receive additional income from rents or royalties. Although only a small percentage of landowners own mineral rights, the royalty income to any one individual would still be substantial over many years if a given well is highly productive. Individuals on whose land CBM is developed but who do not own the mineral rights to their land would receive one-time payments as compensation for land disturbance. However, given the small scale of production anticipated, these changes to personal income likely would have only a small effect on the per capita income of the CBM emphasis area or the state as a whole.

Additional personal income for residents of the counties and the state would be generated by circulation and re-circulation of dollars paid out as business expenditures and as state and local taxes.

Government Revenues

The primary source of government revenues generated by the project would be from taxes levied on property, equipment, income, and natural gas output generated by production wells. Exploratory wells would generate government income only to the extent the associated temporary facilities are subject to local property taxes.

Oil and Gas Income

Royalties of 12.5 percent are typically earned for oil and gas production on state and federal lands. About 50 percent of royalties paid to the federal government are generally returned to the state from which they originate. Assuming the 250 production wells on the CX Ranch proposed for Alternative A each generate about $182,500 in gross production income per year (assuming production of 125,000 cubic feet per day and a price of $4.00 per thousand cubic feet), the total annual gross income would be about $45.6 million per year for an average of 15 years. About 12.5 percent, or $5.7 million, of this new income would accrue to the state, federal, or private mineral owner annually.

Rents on state and federal lands leased for oil and gas development are bid competitively, with the lowest bid being $1.50 per acre. Resulting government income would depend on the specifics of leases on the CX Ranch; however, it is assumed that additional income would accrue to the state and federal government.

Taxes

Income Taxes

A portion of the taxable income (wages, rent or royalty income, and land disturbance payments) generated by Alternative A would accrue to the state as income tax revenue. Income taxes would be paid on the annual wages paid for the average 32 jobs per year discussed under *Employment*. Dividing the estimated total wages over 20 years by the estimated total jobs for the same period (Table 4-9), the average annual salary per job would be about $34,000. Income in Montana is taxed according to a graduated rate structure with rates ranging from 2 percent to 11 percent of taxable income; the average rate in 2000 was about 3 percent (Montana Department of Revenue 2001). It is important to note that these sums are already included in the estimates of personal income (income taxes are a transfer of personal income to the state). Thus,

estimated income tax revenues from an annual average of 32 jobs at $34,000 would range from $21,800 (2 percent tax rate) to $119,700 (11 percent tax rate), with a likely amount closer to $32,600 (3 percent tax rate) based on recent history. The project would result in an increase in state tax revenues to the extent that new income is created that didn't previously exist in the state.

Property Taxes

Both real and personal property are subject to property taxes. Personal property would consist of structures, equipment, and materials used for the proposed exploration and production of CBM. Taxes on real property would be based on changes in the assessed value that result from improvements to the property. Each county in which facilities were located would assess tax levies and apply them to the taxable value of the relevant facilities. The levy would be based on the total value of property multiplied by a tax rate or rates specific to the property location (i.e., county and special service districts). Any such additional property taxes would contribute new income directly to both the county tax base and the local economy. It should be noted that property taxes on business equipment (e.g., drilling equipment) will likely be phased out by 2006, reducing the total taxes that would be collected.

Given the limited nature of CBM exploration and development proposed in Alternative A, changes in taxes are not expected to be substantial for any given county. The exception is Big Horn County, where the new production wells are proposed. Additional county tax revenues would be anticipated. Property tax revenues would be a cost to CBM development companies and landowners and a benefit to the counties and the state.

Natural Resources Taxes

The products of natural resource extraction in Montana, including natural gas, are subject to state natural resource taxes, including local government severance taxes (LGST). Any new production of natural gas generated by the 250 production wells in Big Horn County would be subject to such taxes. Severance taxes are distributed to a variety of state and local funds and would contribute positively to the state and local economies.

Other Taxes

In general, the local and state economies would benefit from sales of goods and services by local businesses to oil and gas operators associated with the project. However, because there is no sales tax in Montana, local sales of goods and services associated with CBM development would not generate increases in tax revenues.

Water Resource Values

The purpose of a discussion of water resource values in the economics section of this report is to acknowledge that the existing surface and groundwater resources in the CBM emphasis area have an economic value that is part of the overall economy of the area and that alterations to these resources, if not mitigated, would have economic impacts to water users or to the regional economy. Affected users would include those who depend on surface water or groundwater for irrigation, ranching, municipal water needs, home water needs, landscape needs, and any other business and household need of water from a surface water body or well.

Given the relatively limited scale of CBM development proposed for Alternative A, effects on water resources and water resources economics would be relatively limited (see the analysis in the *Hydrological Resources* section). For Alternative A, untreated water from exploration would be placed in holding facilities for beneficial re-use, which would provide an economic benefit to affected water users. No discharge to waters of the United States would be allowed for BLM-authorized exploration wells; the state would permit discharge for the CX Ranch field of up to 1,600 gpm. Because of the small scale, no economic impacts to downstream surface water users would be anticipated.

Localized groundwater depletion would result over time (more than 5 years) from the CBM wells proposed for Alternative A.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for social and economic values in general. It is assumed that no CBM wells would be developed on the Native American reservations initially, and therefore social impacts would be more likely to affect those individuals living off the reservations or whose activities are conducted off the reservations. Native American development is considered as part of the cumulative effects potential. Few, if any, tax revenues would accrue to Tribal governments as a result of off-reservation CBM development. It is likely that a smaller number of Native Americans who are interested in the development of energy resources for the long-term social and economic betterment of tribal members

would perceive or experience fewer impacts from CBM development.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

It is assumed that any such impacts would be addressed by mitigation agreements between developers and groundwater users, thus avoiding economic impacts to groundwater users.

Conclusions

The existing management scenario is essentially a continuation of existing oil and gas industry practices in the CBM emphasis area and would not result in social impacts (e.g., only small changes in employment, population, demand for services, etc.), and would have only a small effect on economic conditions in the CBM emphasis area, as well as environmental and social conditions.

As described above, the new jobs and related social and economic impacts from Alternative A would be small, with the exception of the proposed production wells in Big Horn County, which would result in positive economic impacts in that county. Future development in the area, such as the Tongue River Railroad and further expansion of existing surface coal mines, would likely have a number of larger social and economic impacts (e.g., creation of more jobs and income), which would be additive to the impacts from Alternative A described above.

Alternative B

Employment and Unemployment

Estimated direct employment from CBM under the development scenario for the 20-year project life is presented in Table 4-10. (Wage information is discussed under *Economics*.) The number and type of jobs involved would vary with the project phase. The types of jobs would be the same as those described for Alternative A.

As shown in Table 4-10, development (drilling of about 18,300 wells over 20 years) would result in an estimated average of 851 jobs per year, with a range from 334 (Year 1) to 943 (Year 18) for all project phases combined. The actual number of jobs in a given year would depend on the actual number of wells drilled, in production, or abandoned in that year. Abandonment of wells during years 21-40 would result in an estimated 1,054 additional jobs, for an average of about 53 jobs per year during that period.

The additional jobs created would be small compared to the total employment in the CBM emphasis area (183,000 in 1998). However, given that most of the CBM wells would be located in three counties (Big Horn, Powder River, and Rosebud), a large number of the jobs would be concentrated in those counties. Because some of these jobs would go to non-local residents, the actual number of new jobs in the study area would be less.

The water management conditions included in Alternative B would require injection wells, the installation and operation of which would be associated with additional jobs. Water injection wells would be required at a rate of about 1 per 10 CBM wells. This would result in an increase in jobs and wages of about 10 percent over those reported in Table 4-10 for all phases of the project combined.

In addition to the direct jobs created by the project, some additional jobs would be created indirectly through additional work for persons in related support industries such as truckers, material suppliers, inspectors, and various other specialists. One estimate is that one indirect job would be created for every four direct jobs created (ZurMuehlen 2001).

The effect of the new jobs on current unemployment rates in the area would be moderate. Although the new direct jobs would help boost total employment in the emphasis area, the increases would be limited to those sectors and individuals with the appropriate skills for the jobs and to those geographic locations where the jobs are located. For example, the relatively high unemployment rates (about 9 percent) in the mining sector in Big Horn and Rosebud counties would be decreased if unemployed persons gain employment from the new CBM development.

Any new jobs filled by new residents (see the *Demographics* section) would increase the number of employed persons in a given county but would not decrease the number of unemployed persons. To the extent that indirect jobs are created by the project, some increased employment in other service industries also would occur.

Demographics

As with Alternative A, employees who would fill the CBM jobs would likely be a mixture of current residents from the surrounding areas and those who would be drawn to the project and its employment

TABLE 4-10
ALTERNATIVES B, C, D, and E: ESTIMATED WAGES AND JOBS FOR WELL DEVELOPMENT, PRODUCTION, AND ABANDONMENT (WAGES REPORTED IN CONSTANT DOLLARS)[1, 2]

Year	Wells Drilled per Year	Initial Development Jobs	Initial Development Wages[3]	Wells Producing per Year	Production Jobs	Production Wages	Wells Abandoned per Year	Abandonment Jobs	Abandonment Wages	Estimated Total Jobs	Estimated Total Wages
1	900	276	$7,993,125	510	29	$1,099,688	390	29	$1,011,563	334	$10,104,375
2	1,100	337	$9,769,375	1,220	69	$2,630,625	390	29	$1,011,563	435	$13,411,563
3	2,000	613	$17,762,500	2,830	159	$6,102,188	390	29	$1,011,563	801	$24,876,250
4	2,200	674	$19,538,750	4,640	261	$10,005,000	390	29	$1,011,563	964	$30,555,313
5	2,000	613	$17,762,500	6,250	352	$13,476,563	390	29	$1,011,563	993	$32,250,625
6	1,500	459	$13,321,875	7,750	436	$16,710,938	0	0	$0	895	$30,032,813
7	1,300	398	$11,545,625	9,050	509	$19,514,063	0	0	$0	907	$31,059,688
8	900	276	$7,993,125	9,950	560	$21,454,688	0	0	$0	835	$29,447,813
9	900	276	$7,993,125	10,850	610	$23,395,313	0	0	$0	886	$31,388,438
10	700	214	$6,216,875	11,550	650	$24,904,688	0	0	$0	864	$31,121,563
11	550	168	$4,884,688	11,900	669	$25,659,375	200	15	$518,750	853	$31,062,813
12	550	168	$4,884,688	12,250	689	$26,414,063	200	15	$518,750	873	$31,817,500
13	550	168	$4,884,688	12,600	709	$27,168,750	200	15	$518,750	892	$32,572,188
14	550	168	$4,884,688	12,950	728	$27,923,438	200	15	$518,750	912	$33,326,875
15	550	168	$4,884,688	13,300	748	$28,678,125	200	15	$518,750	932	$34,081,563
16	450	138	$3,996,563	13,550	762	$29,217,188	200	15	$518,750	915	$33,732,500
17	450	138	$3,996,563	13,800	776	$29,756,250	200	15	$518,750	929	$34,271,563
18	450	138	$3,996,563	14,050	790	$30,295,313	200	15	$518,750	943	$34,810,625
19	400	123	$3,552,500	14,100	793	$30,403,125	350	26	$907,813	942	$34,863,438
20	300	92	$2,664,375	14,050	790	$30,295,313	350	26	$907,813	908	$33,867,500
20-Year Total	18,300	5,604	$162,526,875		11,090	$425,104,688		319	$11,023,438	17,013	$598,655,000
Annual Average	915	280	$8,126,343.75		554	$21,255,234.38		16	$551,171.88	851	$29,932,750

NOTES:

[1]Data for jobs per well and wages (ZurMuehlen 2001).

[2]The water management conditions included in Alternative B would require injection wells, the installation and operation of which would be associated with additional jobs. Water injection wells would be required at a rate of about 1 per 10 CBM wells. This would result in an increase in jobs and wages of about 10% over those reported in Table 4-26 for all phases of the project combined.

[3]Wages paid for initial development phase for well drillers and pipeline installers was estimated at $6,600 per well (Langhus 2001).

opportunities from around the region. It is assumed that local labor would be used to the extent it is available; however, for Alternative B it is likely that many additional workers (e.g., drill rig crews) from outside the area would be needed, especially during the peak employment years of the project. It is assumed that drill rigs from a variety of locations-both Montana and Wyoming-would be used, depending on supply and demand at any given time. The potential for new population is greatest in the counties where the number of CBM wells to be drilled is greatest: Big Horn, Powder River, and Rosebud counties (about 90 percent of proposed CBM wells would be drilled in these three counties; see Table 4-11). As with Alternative A, it is estimated that, on average, each new employee would bring one additional person to the region. Assuming, as a worst-case scenario, that all of the jobs were filled by new migrants to the area, as many as 1,986 people (993 x 2) might be added to the region during the peak employment year (Year 5). The new population would be spread over a relatively large geographic area and likely would be concentrated in larger populated areas. An increase of this magnitude would be small compared to the total regional population (287,000 in 2000). However, the new population could be concentrated in the three counties with the most CBM wells (see Table 4-11). Because these three counties have a relatively small combined population (about 24,000), population change within these counties could be substantial. Of the approximately 24,000 persons in the three counties, about 10,400 or 44 percent are Native American (see Table 3-16).

TABLE 4-11
TOTAL PROPOSED WELLS AND PERCENT BY COUNTY
(ALTERNATIVES B, C, D, AND E)

County	Wells to be Drilled	% of Total
Big Horn	7,000	38.3%
Blaine	10	0.1%
Carbon	400	2.2%
Carter	0	0.0%
Custer	300	1.6%
Gallatin	15	0.1%
Golden Valley	0	0.0%
Musselshell	150	0.8%
Park	25	0.1%
Powder River	6,700	36.6%
Rosebud	2,800	15.3%
Stillwater	700	3.8%
Sweetgrass	25	0.1%
Treasure	25	0.1%
Wheatland	0	0.0%
Yellowstone	150	0.8%
Subtotal	18,300	100.0%
Combined Total: Big Horn, Powder River, and Rosebud counties	16,500	90.2%

Social Organization

Housing Units and Vacancy

Depending on the type and duration of the jobs (e.g., long-term production supervisor versus drill rig crew member), new employees in the area would seek either temporary housing (hotels, apartments, trailer parking) or permanent housing (homes to purchase or to rent long-term). Individual choices about where to live are hard to predict and vary with personal preference, in addition to the supply of housing and availability of services in a given location and the mobility demands of a given job. The relatively limited supply of temporary and permanent housing in the smaller communities in the CBM emphasis area would limit the number of new employees (and families, if applicable) who would be able to live there without additional housing and related services. The larger communities, such as Billings or Gillette, Wyoming, have a greater supply of temporary and permanent housing and would be likely settlement locations for people employed by the CBM industry. In part because of the general trend of migration within Montana from the east to the west during recent years, vacant housing is available in a number of communities. As discussed in Chapter 3, vacancy rates for both temporary and permanent housing are adequate to high in the CBM emphasis area. This information, combined with the large size of the geographic area and the dispersed nature of the new job opportunities and associated new population, suggest that adequate housing opportunities would be available in the larger communities and might not be available in some of the smaller communities.

Public Services and Utilities

Impacts on the ability of local governments to provide public services and utilities would be related to the ability of the service providers to adapt to relevant fiscal or physical changes from CBM development. Affected services typically include police and fire protection, emergency medical services, schools, public housing, park and recreation facilities, water supply, sewage and solid waste disposal, libraries, roads, and other transportation infrastructure. Given the large geographic scale of the CBM development scenario, it is infeasible to quantitatively assess the relationship of the project to these individual services. However, because the changes in population discussed above would be moderate and dispersed throughout the CBM emphasis area, any resulting increases in demand on public services and utilities are anticipated to be within the capacity of the providers. For example, the three counties (Big Horn, Powder River, and Rosebud) in which most of the CBM wells are proposed to be drilled would also receive the greatest amounts of property tax and other government revenue (see the *Economics* section) that would fund improvements or other changes to services.

The alternatives being considered include varying management objectives with respect to the construction of roads and utilities. Although the construction and maintenance of utilities would be funded by the users, the majority of new roads created to access CBM wells would subsequently become county roads. To the extent local governments opt to maintain these roads after this time, additional revenue would be required to balance the additional costs required to do so.

Attitudes, Beliefs, Lifestyles, and Values

The large scale development of a large number of CBM wells in the planning area would likely conflict with the attitudes, beliefs, lifestyles, and values of many individuals and population subgroups in the area (e.g., farmers, ranchers, small town residents, Native Americans, retirees, etc.). Drilling, testing, and operation of CBM wells would result in increased traffic from trucks and other vehicles; noise from traffic and the operation of generators and drilling and other equipment; visual resource impacts from the construction of the wells themselves as well as power lines and related electrical infrastructure; and psychological stress associated with unwanted change, division in the community, or other impacts. The population subgroups would be affected to the degree to which their lifestyles and values are inconsistent with such impacts.

The majority of individuals in the planning area are understood to have traditional rural lifestyles in which the relatively quiet and pristine surroundings are an important value. They would likely find this level of CBM development inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. This would be particularly true for Big Horn, Powder River, and Rosebud Counties in which the majority of the wells would be developed. Large-scale CBM development could be viewed as part of a gradual transition away from traditional rural and agricultural lifestyles. A smaller group of people in the area who are more interested in the potential economic benefits of CBM development would likely perceive or experience fewer impacts with respect to lifestyles and values.

Large-scale CBM development is likely to conflict to some degree with traditional Native American values

which emphasize preservation of cultural heritage and a reverence for the natural environment. Native American groups could be affected by increases in noise, impacts on visual resources and plant populations, etc., in particular as they affect locations and resources used for spiritual or religious purposes. It is assumed that no CBM wells would be developed on the Native American reservations initially, and therefore impacts would be more likely to affect those individuals living off the reservations or whose activities are conducted off the reservations. Native American development is considered as part of the cumulative effects impact potential. It is likely that a smaller number of Native Americans who are interested in the development of energy resources for the long-term social and economic betterment of tribal members would perceive or experience fewer harmful impacts from CBM development.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

The subsurface discharge of produced water would likely be seen as consistent or somewhat inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. Impacts on groundwater would be the same for Alternatives B, C, D, and E, with the primary impact being the drawdown of groundwater.

Personal Income

Wages paid to CBM workers would contribute to the total personal income in the county where the employees reside. As shown in Table 4-10, wages would be generated from all three project phases. Over the first 20 years of the project, total wages paid for all phases of the project would be an estimated $598 million. Estimated annual wages would range from $10 million in Year 1 to almost $35 million in Years 18 and 19. Although this much estimated personal income would be generated by the project, it would not all be experienced as "new" income within a given county or the state. New income would be the difference between the income of workers before CBM development and the income after CBM development.

A number of the producing wells in the development scenario would generate new personal income for those who own the land or the mineral rights, as stated under Alternative A. The circulation and re-circulation of direct income (including royalties to private owners) generated by the project would generate additional (indirect) personal income throughout the region.

Government Revenues

Oil and Gas Income

Assuming each of the approximately 16,500 production wells anticipated for Alternative B generate about $182,500 in gross production income per year of operation, the total annual gross income would vary depending on the number of wells in production in a given year. As shown in Table 4-10, the estimated number of producing wells ranges from 510 in Year 1 to 14,100 in Year 19. It follows that the estimated annual gross income would range from $93 million (Year 1) to $2.5 billion (Year 19). Most of this revenue would go to methane companies located out of state. The 12.5 percent royalty collected on this annual income would range from about $12 million (Year 1) to $322 million per year. It is estimated that about one-half the well sites would be permitted on minerals administered by the federal government (BLM) about 5 to 10 percent on state (fee) minerals, and the remaining 40 to 50 percent on private minerals. As a result, about half of the royalty income would initially go to the federal government, with about half of the federal half being returned to the state. Thus, an estimated 30 to 35 percent of royalty income, between $4 million and $113 million in a given year, ultimately would accrue to the state. Given that total state revenues received from minerals management on state lands in FY 2000 was $11.6 million and total federal mineral revenues collected on Montana lands and disbursed to the state were $20.4 million in FY 2000 (see Chapter 3), new state revenues from CBM would be substantial, especially during the peak years of the project.

Rents on state and federal lands leased for oil and gas development are bid competitively, with the lowest bid being $1.50 per acre. Resulting government income would depend on the specifics of the leases. It is assumed that additional income would accrue to the state and federal government from these rents.

Net government revenues would be reduced by costs incurred for monitoring and regulating CBM activity. These costs would be relatively small compared to the revenues generated.

Water treatment costs for Alternative B would be greater than for Alternative D and much greater than for Alternative C.

Taxes

Income Taxes

A portion of the taxable income (wages, rent or royalty income, and land disturbance payments) generated by Alternative B would accrue to the state as income tax revenue. Income taxes would be paid on the annual wages paid for the average 851 jobs per year discussed above under *Employment*. Dividing the estimated total wages over 20 years by the estimated total jobs for the same period (Table 4-10), the average annual salary per job would be about $35,000 (does not account for inflation over time). Income in Montana is taxed according to a graduated rate structure with rates ranging from 2 percent to 11 percent of taxable income; the average rate in 2000 was about 3 percent (Montana Department of Revenue 2001). It is important to note that these sums are already included in the estimates of personal income (income taxes are a transfer of personal income to the state). Thus, estimated income tax revenues from an annual average of 851 jobs at $35,000 would range from $596,000 (2 percent tax rate) to $3.3 million (11 percent tax rate), with a likely amount closer to 894,000 (3 percent tax rate) based on recent history. As discussed above, the project would generate new income tax revenue for the state to the extent that revenue generated by new jobs, for example, exceeds existing tax revenues. The income tax sums are already included in the estimates of personal income.

Property Taxes

See general discussion of property taxes for Alternative A. Only at the time when a given property is improved (i.e., a CBM well or other facilities are developed there) would estimated new property tax revenues be calculated. However, property taxes would accrue to counties roughly in proportion to the number of new wells. Big Horn, Powder River, and Rosebud counties would have the vast majority of new wells; therefore, they would be anticipated to experience the greatest increases in assessed values and the greatest increase in new county property tax revenues. These new revenues could help improve schools, roads, community services, and other county assets, after any new costs associated with CBM are accounted for.

Natural Resources Taxes

Natural resources taxes would be the same as described under Alternative A except based on 18,000 wells.

Other Taxes

Other taxes would be the same as described under Alternative A.

Water Resource Values

See introductory discussion to water resource values under Alternative A. Surface discharge of produced water would be prohibited, and therefore surface water impacts such as erosion and water quality would be avoided. In the absence of surface water impacts, no associated economic impacts to surface water users would occur. Water stored from exploration would provide a benefit to some water users.

The primary impact to groundwater resources is depletion of groundwater in the Powder River Basin watersheds affecting wells and springs.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for social and economic values in general for Alternative B. As shown in the RFD, 4,000 wells could be developed on the Crow Reservation. If this entire number of wells were developed, additional economic impacts would occur. Such impacts would generally be in the form of new jobs and employment opportunities, a drawdown in groundwater, and additional personal income and revenues from CBM development and production.

Access, damage payments, royalties, and taxes would be received by Indian allottees, and the Crow Tribe.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative. The additional wells that could be developed on the Northern Cheyenne Reservation would also total 4,000.

Mitigation

As stated in the *Hydrological Resources* analysis, water well and spring mitigation agreements would facilitate replacement of lost groundwater in most cases. Such agreements and mitigation would reduce potential economic impacts for groundwater users. Despite mitigation, increased electricity costs to users could result from deeper pumping of groundwater. Economic impacts to landowners could occur from coal bed methane, even with mitigation agreements. These include the legal fees borne by landowners, the time and hassle to landowners in reaching the

agreement, any litigation from excess damage, monitoring by landowners of development impacts, the degradation of their land beyond compensation, the aesthetic scars left by development in the local area, additional electricity to pump groundwater, and unknown risks of long-term damage to land during and after development.

Conclusion

The primary social impacts identified from Alternative B would be the new jobs created in the emphasis area as a result of development and change from a predominantly rural and agricultural based lifestyle. These new jobs would result in some demographic shifts as a result of people moving to the area. It is anticipated that the impact of added employment and population on social conditions would be small overall but that impacts in the three counties with the most CBM activity could be greater. Impacts would be both positive and negative. Alternative B would result in the generation of new personal and government income. New personal income would include the wages from both direct and indirect jobs created by the project, as well as income from land disturbance payments and mineral leases. Similarly, new local, state, and federal government income would be generated through the variety of means discussed. Over the long term, there is the possibility of a "boom and bust" cycle as CBM activity rises and falls.

As shown in the RFD scenario presented elsewhere in this document, in addition to the 18,300 CBM wells considered for Alternative B, an additional 8,050 CBM wells would be developed in this area in the future: 4,000 on the Northern Cheyenne Reservation, 4,000 on the Crow Reservation, and about 50 wells on USFS land. This number is about 44 percent of those proposed for Alternative B. If this entire number of wells was developed over the same 20-year period as the other 18,300 wells, additional economic impacts would occur. Such impacts would generally be in the form of new jobs and employment opportunities, additional population, additional demands on public services, a drawdown in groundwater, and additional personal income and government revenues from CBM development and production. Potentially large social and economic impacts also would result from other developments proposed for the area, including the Tongue River Railroad and expansion of existing surface coal mines. Economic impacts for the railroad have been addressed previously and are expected to be considerable. The impacts from these other developments would be additive to those identified above for Alternative B.

Alternative C

Employment And Unemployment

Employment and unemployment would be the same as described under Alternative B, except that there would be no additional jobs created from installation of injection wells, which would not be required for this alternative.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would be the same as described under Alternative B.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups are the same as for Alternative B.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

Alternative C would allow discharge of untreated water to the land surface. As indicated in the *Hydrology Resources* section, this discharge would result in erosion and water quality impacts. Such impacts would be inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. The primary reasons for this conclusion include the potentially large scale of this discharge, the potential for degraded water to negatively affect farming and ranching operations (e.g., reduce economic viability), increased noise, loss of natural scenery, and the inconsistency of this approach with the rural lifestyles and values discussed in Chapter 3.

Personal Income

Personal income would be the same as described under Alternative B, with the possible exception of decreases in farming or ranching income as a result of water quality and erosion impacts.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be about the same as described under Alternative B. Water treatment costs would be less than for Alternative B due to the allowance of discharge to the land surface (see Water Resource Values below).

Taxes

Income Taxes

Income taxes would be the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resources Taxes

Natural resources taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

See the discussions for Alternatives A and B. Alternative C would allow discharge of untreated water to the land surface. As indicated in the *Hydrological Resources* section elsewhere in this document, this discharge would result in erosion and water quality impacts. In turn, some downstream surface water users who depend on surface water resources for their livelihood would be affected (for example, if suitable irrigation water were no longer available or if ranch land were lost to erosion). See further discussion under Attitudes, Beliefs, Lifestyles and Values, above. Groundwater impacts would be similar to Alternative B. A difference is that no groundwater would be reinjected as it would for Alternative B, possibly increasing the risk of groundwater drawdown in some locations.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

No mitigation is proposed.

Conclusions

Residual impacts would be similar to those for Alternative B, except for impacts to lifestyles and water resource values, which would be greater for Alternative C than for Alternative B.

Cumulative impacts would be greater than for Alternative B, given the discussion regarding water resource impacts.

Alternative D

Employment and Unemployment

Employment and unemployment would be the same as described for Alternative B.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would be the same as described under Alternative B.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups are the same as for Alternative B.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

Treatment of most produced water and discharge via pipeline or other constructed water courses would eliminate most of the erosion and water quality impacts.

Personal Income

Personal income would be the same as described under Alternative B, with the possible exception of decreases in farming area ranching income as a result of water quality and erosion impacts.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be the same as described under Alternative B. Water treatment costs would be greater than for Alternative C and much less than for Alternative B.

Taxes

Income Taxes

Income taxes would be the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resources Taxes

Natural resources taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

See discussion for Alternatives A, B, and C. Most discharge would be treated and carried over land in pipes. Surface water impacts and the potential for resulting economic impacts to surface water users would be less than for Alternative C and greater than for Alternative B. Groundwater impacts would be the same as Alternative D.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

No mitigation is proposed.

Conclusions

Residual impacts would be similar to those for Alternative B, except with respect to impacts on water resource economics and related lifestyle impacts, which would be less than Alternative C but greater than Alternative B.

Cumulative impacts would be less than Alternative C and somewhat greater than Alternative B, given the differences in water resource impacts.

Alternative E (Preferred Alternative)

Employment and Unemployment

Employment and unemployment would be the same as described under Alternative B. It is assumed that the approximate number of additional jobs created from installation of injection wells required for Alternative B would also occur for Alternative E, except that the jobs would be associated with the variety of site-specific produced water management options allowed with that alternative.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would the same as described under Alternative B, except that the oil and gas roads would remain open or be closed at the surface owner's discretion, potentially increasing or decreasing the burden on public jurisdictions to maintain these roads.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups would be the same as for Alternative B.

Of the all the alternatives being considered for protection of water resources, Alternative E would likely be seen as the most consistent with the desired balance between environmental stewardship and economic development expressed in the scoping comments.

Personal Income

Personal income would be the same as described under Alternative B.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be about the same as described for Alternative B, although water treatment costs could be greater, thus potentially decreasing the net income to producers.

Taxes

Income Taxes

Income taxes would the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resource Taxes

Natural resource taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

Alternative E would be the most protective of water resources and water resource values of all the alternatives being considered. The activities proposed to prevent the degradation of surface and groundwater resources would substantially prevent erosion and water quality impacts.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Mitigation

No mitigation is proposed.

Conclusions

Residual impacts would be similar to those for Alternative B, with the exception of the reduced impacts on lifestyles and values and water resource values that would result from the proposed measures to prevent the degradation of water resources.

Cumulative impacts would be somewhat less than for Alternative B, given the greater degree of prevention and control of unfavorable water resource impacts.

Soils

Assumptions

Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. This analysis is focused on the CBM emphasis area, but can be used by inference on similar areas in Montana. A more detailed discussion of soils is presented in the *Soils Technical Report* (ALL 2001a).

Impacts From Management Common to All Alternatives

Impacts on soils would occur from various activities during the exploration, construction, operation, and abandonment of conventional oil and gas wells developed resulting in a loss of either soil resources or soil productivity. These impacts would include soil compaction under disturbed areas such as well sites and lease access roads, soil erosion in disturbed areas, and chemical impacts from spills of liquids. Some impacts would be unavoidable, such as those resulting from the construction of well sites. Other impacts would be mitigated by standard oil field practices, such as the use of berms around production facilities. Short-term impacts would occur typically during construction phases, including reclamation of construction sites.

Soils disturbed by the building of access roads, drill pads, and pipelines would be prone to accelerated erosion because of the removal of protective vegetation and litter cover during construction activities. This protective cover would bind the soil, provide desirable surface texture for infiltration of water and air, and protect the surface from water and wind erosion. Accelerated soil erosion would occur during the production phase in high traffic areas of the well pad or along access roads or in portions of the well pad that have not been properly graded. In areas where soils have high to severe erosion potential and are unstabilized, disturbance would result in accelerated erosion to the extent that damage to facilities and roadways may occur. Wind and water erosion on bare soil surfaces would cause more sedimentation in streams from runoff following rainfall or snowmelt. Impacts would be greatest on shallow soils of low productivity and on soils on moderately sloping to steep landscapes. Project activities would have minimal effect on slope stability because surface disturbance on slopes in excess of 30 percent would be avoided where possible. Where such disturbances cannot be avoided, mitigative measures required by MBOGC and BLM through the APD authorization process would be implemented to reduce erosion and protect watershed resources. Eastern Montana suffers from excessive wind erosion primarily from dry soil, sparse vegetative cover, and erodible soils.

Drilling activity-especially equipment transport-would cause soil compaction. The degree of compaction would be influenced by soil texture, moisture content, organic matter, and soil structure. Soils with a mixture of sand, silt, and clay compacts more than a soil with more uniform particle size. Coarse-textured sandy soils generally would be more compactable than fine-grained soils. Soil moisture would be the most critical factor in compaction. At field capacity, which is the amount of soil moisture remaining after a soil mass is saturated and allowed to drain freely for 24 hours, sufficient water remains in the pores to provide particle-to-particle lubrication and maximum compaction potential under load. Thus, moist but not wet soils would be most susceptible to compaction. Organic matter such as roots and humus would help reduce soil compaction. In general, the greater the organic matter content, the less compaction. Compaction would severely affect plant growth by inhibiting root penetration, limiting oxygen and carbon dioxide exchange between the root zone and the atmosphere, and severely limiting the rate of water infiltration into the soil. Compaction of soils would inhibit reclamation and natural revegetation of disturbed areas. Loss of topsoil and a decrease in soil productivity from soil layer mixing and compaction would impact the natural vegetation supported in the area, which in turn may affect forage and habitat for wildlife and livestock. The use of off-road vehicles and heavy equipment would cause soil compaction, which will lead to increased surface runoff and subsequent erosion. Effects will be most severe when off-road vehicles and heavy equipment are used during moist and wet soils conditions.

With development, the potential for impacts to soil from drilling and produced fluids would increase. Soil contamination from conventional oil and gas development in Montana would result mainly from leaking and improperly reclaimed reserve/brine pits. Produced hydrocarbons and fuel spills would occasionally cause impacts. Spills generally would not be large and the materials would be relatively immobile. Toxic and saline concentrations from the spilled fluids would be capable of sterilizing the soil.

Construction disturbances from conventional oil and gas production would lead to the disturbance of approximately 12,650 acres (9,817.5 acres of BLM lands and 2,832.5 acres of state lands) during the next 20 years. Revegetating parts of the well pads during production would reduce the area of disturbance to

4,600 acres. Most of these acres would be remediated after the hydrocarbons have been produced.

The area would be reclaimed as prescribed by an approved reclamation plan that includes revegetation to reduce soil erosion. Most soil disturbances and related erosion would be mitigated within 20 to 25 years after drilling the well. Exceptions would be sites with severe characteristics (slope and physical and chemical nature of the soils) or sites where saline water spills have occurred. Saline water would have a more persistent and detrimental effect on soil productivity. There would be some loss of soil through erosion as a result of surface disturbance, but this would be minimized with an approved surface use plan.

Additional disturbances would occur from coal mining in the CBM emphasis area, which is estimated at a total of 49,500 acres.

Prime Farmland

If prime farmland exists on federal or state surface where CBM development is proposed, the same type of reclamation plan is developed for it as with all such proposals. A difference would be that more topsoil probably would be available for reclamation purposes on a prime farmland site and would be identified in the reclamation plan prior to development.

If the site proposed for development were private surface, then the reclamation plan would be developed in consultation with and according to the wishes of the private land owner. Most likely, the reclamation plan on Federal versus state and private surface would be very similar.

No prime farmlands are known to exist on the federal surface. Privately-owned prime farmlands over federal and state leases that are impacted by roads or site development would be reclaimed in accordance with consultation with the private surface owner. This situation would be same for all alternatives.

Mitigation

The BLM *Gold Book* (USDI and USDA 1989) describes mitigation measures for well sites constructed over areas of steep topography to protect easily eroded soils. The existing BLM RMP provides for approval of surface occupancy on oil and gas leases on slopes in excess of 30 percent based upon mitigation of soil erosion, surface productivity after remediation, and mitigation of impacts to surface water quality. The *Gold Book* and APD Section A describe mitigation measures to protect riparian zones from exploration and production activity and lease access roads. The *Surface Use Program* section of the APD describes guidance for limiting lease roads and construction to mitigate erosion. 43 CFR Part 3162.5-1, *Environmental Obligations*, describes the requirements for stockpiling surface soil and the remediation of drill sites after well completion. Produced water can be released on the surface or to surface waters with the appropriate permits. The BLM *Seeding Policy* of October 27, 1999, lists guidelines for seeding practices in typical Montana soil types (BLM 1999c). These species are recommended for quick coverage of disturbed and impacted soils to discourage invasion of noxious weeds and attenuate soil erosion. During the leasing process and the site-specific operating plan review for oil and gas operations, TLMD specifies requirements to prevent erosion and destruction of the surface soils. TLMD requires that the surface lessee or surface owner be consulted regarding surface facilities and roads to minimize surface impacts.

Additional mitigating measures applied to federal leases reduce soil erosion and compaction impacts would be as follows:

- Incorporate federal legislation that addresses the protection of soils, including the Clean Water Act of 1972 and the Soil and Water Resources Conservation Act of 1977.
- Separate topsoil from subsurface soil and use the topsoil for reclamation purposes.
- During the production phase, the unused portion of the drill location would have topsoil spread evenly over the surface and reseeded at the recommended ratio per BLM recommended seed mixture.
- Limit construction activities to dry conditions to reduce soil compaction and rutting.
- Use BMPs and design construction to control erosion and sedimentation.
- If porous materials (subsurface) are encountered during the construction of any pit designed to contain fluids, a pit liner would be installed. This liner would prohibit the migration of fluids from the pit.
- Surface soil material should be stockpiled to the side of the routes where cuts and fills or other surface disturbance occurs during pipeline and road construction.
- Minimize stream crossings.

- Promptly revegetate cut-and-fill slopes to control surface erosion by wind and water.
- Maintain and continue erosion control measures and/or features after construction until adequate vegetative cover is re-established.
- Avoid road and well pad construction on slopes greater than 30 percent.
- Remove vegetation only when necessary; any organic matter in the soil helps avoid compaction.
- Subsoil or deep rip when soil is driest (usually late summer or early fall) in order to best remedy compaction prior to reclamation. When compaction is shallow (the result of using large low-pressure tires or tracked vehicles), conventional tillage or scarifying equipment can be used.
- Recontour and revegetate disturbed areas upon completion of construction.
- Construct water bars on slopes of 3:1 or greater. Water bars would be constructed on the contour.

Impacts From Management Specific to Each Alternative

Alternative A

Impacts on soils may occur from various activities during the exploration, construction, operation, and abandonment of CBM wells developed for the project and may result in a loss of either soil resources or soil productivity. The primary concerns include increased soil erosion, loss of topsoil, mixing of soil horizons, compaction, and contamination of soils from various pollutants. These impacts may result in a loss of either soil resources or soil productivity.

Under this alternative, all CBM water on BLM-administered land would be contained or beneficially used at the well site, while all CBM water on private lands would be discharged under the existing MPDES permit into the Tongue River (up to 1,600 gpm), impounded, or used for dust control at on-site coal mines.

Exploration

Under Alternative A for BLM lands, approximately 400 acres would be disturbed for exploratory wells. On state and private lands, approximately 275 acres would be disturbed during exploration. All produced CBM water during exploration will be contained; therefore, there would be no impacts to soils caused by high saline/sodium water applications.

Production

Because there will be no CBM production on BLM lands, there will be no impacts from production. Only state and private lands will have CBM production. During the construction of the well sites, access roads, utilities, and other facilities, 812 acres of soils will be disturbed. Revegetating parts of the well pads during production would reduce the state and private soil disturbances to 500 acres. Production water may be discharged to surface waters in accordance with the existing MPDES Discharge Permit that allows discharge up to the rate of 1,600 gpm into the Tongue River. This small increase in flow volume is not considered sufficient to cause added erosion to stream banks or streambeds. Produced water may also be used beneficially by industry and landowners, or stored in impoundments onsite. If the quality of the water were acceptable (not too high in SAR or salinity), there would be little or no additional impacts to soils from land application. If the quality of land-applied water were detrimental, further mitigation measures would need to be implemented to reduce the impacts to soils (ALL 2001a).

Abandonment

After reclaiming the exploratory wells, there will be 500 acres of soil disturbed long-term-all on state and private lands. The area will be reclaimed as prescribed by an approved reclamation plan including revegetation to reduce soil erosion. Soils would be recovered and erosion eliminated within 20 to 25 years, helped in part by mitigation. Exceptions may be sites with severe characteristics (slope and physical and chemical nature of the soils) or sites where saline water spills have occurred. There may be some irretrievable loss of soil through erosion as a result of surface disturbance, but this can be minimized with a well-developed and approved surface use plan. Soil beneath unlined surface impoundments would also require extensive reclamation because of accumulation of sodium during infiltration of water. The soils structure could be damaged severely, plant growth would be minimal, and accumulation of salt in the soils would likely lead to the soil being removed and disposed.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative A.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives section above. Additional mitigation measures are included in the *Soils Technical Report* (ALL 2001a).

Conclusion

During the next 20 years, disturbances from limited CBM development and exploration, conventional oil and gas development, coal mining, and other projects considered under the cumulative effects analysis would result in the disturbance of about 62,150 acres of soil. These disturbances would be reduced to about 54,100 acres during the production phase of CBM, conventional oil and gas activities, and coal mining. After production ceases and lands used for production and mining are abandoned, most land can be returned to production (excluding permanent roads and facilities). There would be minimal unavoidable, irreversible, and irretrievable impacts to soils. There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities. If the qualities of land-applied or impounded waters were acceptable, there would be little or no impacts to soils; but if water quality is detrimental, additional mitigation measures would need to be implemented.

Alternative B

Alternative B considers development of CBM resources, but with an emphasis in protecting soils and other natural and cultural resources. Impacts to soils would be reduced under this alternative by requiring transportation corridors; using a single trench for utilities and piping; using multiple completions per well bore and directional drilling; using temporary tank storage and injection of all produced CBM water; and rehabilitating new roads at the end of the well lifetime. All of these would help to minimize the area of surface disturbances, which would be up to a 35 percent or higher reduction in soil disturbances.

Exploration

Under this alternative, approximately 850 acres of BLM lands would be disturbed for exploratory wells. On state and private lands, approximately 1,000 acres would be disturbed during exploration. All produced CBM water during exploration will be contained; therefore, there would be no impacts to soils caused by high saline/sodium water applications. Losses from exploration would be mostly temporary and would be reclaimed after exploration activities cease.

Production

During the construction of the well sites, access roads, utilities, and other facilities, 16,200 acres of BLM soils and 18,900 acres of state and private soils will be disturbed. Revegetating parts of the well pads during production would reduce the BLM soil disturbances to 8,600 acres and state and private soil disturbances to 8,850 acres. Production water will be injected; therefore, no impacts will be made to soils from CBM waters.

Abandonment

Reclaiming all of the exploratory wells would provide vegetation cover to 1,850 acres of disturbed soils. Additional reclamation activities at the production wells and utility ROWs would further establish vegetation cover to these previously disturbed soils. The disturbed areas would be reclaimed as prescribed by an approved reclamation plan including revegetation to reduce soil erosion. Soils would be recovered and erosion halted within 20 to 25 years, helped in part by mitigation. Exceptions may be sites with severe characteristics (slope and physical and chemical nature of the soils). There may be some irretrievable loss of soil through erosion as a result of surface disturbance, but this can be minimized with a well-developed and approved surface use plan.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on soils on the reservation. If there is CBM development on the reservation, then disturbed soil areas could be inferred to the reservation using the same approach used in this section.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the *Impacts From Management Common To All Alternatives* section above. Additional mitigation measures are included in the *Soils Technical Report* (ALL 2001a).

Conclusion

During the next 20 years, disturbances from CBM development, conventional oil and gas development, coal mining, and other projects considered under the cumulative effects analysis would result in the disturbance of about 115,760 acres of soil. These disturbances would be reduced to about 87,090 acres during the production phase of CBM, conventional oil and gas activities, and coal mining. After production ceases and lands used for production and mining are abandoned, most land can be returned to production (excluding permanent roads and facilities). There would be minimal unavoidable, irreversible and irretrievable impacts to soils. There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities.

Alternative C

Under this alternative, impacts on soils would be similar to Alternative B with the following exceptions:

- Untreated CBM discharge water could be used for land application
- The discharge of produced water to the ground surface would increase erosion
- There would not be a 35 percent reduction in impacted soils due to specific management practices for transportation routes

The long-term impacts of using CBM water or diluted discharge water for agricultural purposes include crop effects, farming practice changes, irrigation management, and direct effects to soils. Based on the generally fine texture of the surface soils (clayey) in the emphasis area, much of the soil would likely be susceptible to increasing sodicity when irrigated or land applied with water having a high SAR (generally greater than 3 for some soils and greater than 12 for others). If sodic water is applied to these soils, the probability of soil dispersion (deflocculation) is high, causing infiltration and drainage decreases. The long-term consequence is an anaerobic, waterlogged, saline/sodic soil, which would be difficult to reclaim. Those soils with a coarser texture (sandy to loamy) and good internal drainage will be the least susceptible to increasing sodicity and salinity. Dispersed soil would also be subject to accelerated erosion leading to gullying, increased sedimentation, and harm to riparian vegetation and aquatic habitats. The native species composition in these effected areas also will change. CBM water discharge will have the cumulative effect of encouraging the establishment and proliferation of non-native and noxious weed species. As noted in the *Soils Technical Report* (ALL 2001a), there are fewer irrigated than non-irrigated acres along the Tongue and Powder Rivers, which, based on the RFD, is where a majority of the potential CBM activity would reside. However, if adequate water and suitable agricultural soils were available in areas adjacent to production, more irrigated land would be available for production and use. The use of high salinity/sodium CBM water may have long-term effects on crops, limiting crops to those that are more salt tolerant. Additional irrigation water would be required for leaching to ensure salts are moved out of the root zone. Increasing the frequency of irrigation may also need to be implemented to maintain soil water content and to decrease the effects of applying saline water (lower water-holding capacity and higher salinity levels). These increases in irrigation water amounts would lead to producers having to file for additional water rights or finding other sources of lower salinity water for leaching, as well as a potential for more saline seeps in areas irrigated with CBM water. The *Soils Technical Report* (ALL 2001a) discusses the impacts of discharging CBM waters to soils in more detail.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except water generated by testing CBM wells could be discharged to surface waters and the land surface-with impacts as discussed above.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except untreated water generated during production could be discharged to surface water with appropriate permits and to the land surface at the well pad. Impacts of land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would be rehabilitated and closed. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the *Impacts From Management Common To All Alternatives* section above. Additional mitigation measures for land applications of CBM waters are included in the *Soils Technical Report* (ALL 2001a), and include soil amendments for sodic soils, irrigation scheduling and leaching, and plant/crop selection.

Conclusion

Cumulative impacts would be similar to Alternative B, except that the surface disturbances would not be able to be decreased by up to 35 percent and surface discharge and irrigation of produced water would increase detrimental impacts to soils. Saline water has a more persistent and detrimental effect on soil productivity, especially when immediate mitigative measures are not followed for cleanup. One advantageous side effect would be that more water would be available for irrigation if acceptable agricultural land is available, but if acceptable qualities of water are not used, there could be an increased detrimental impact on additional soils.

Alternative D

Under this alternative, impacts on soils would be similar to Alternative B except that produced water would be treated prior to discharge onto the surface or for irrigation, and not injected, which would reduce the detrimental impacts caused by application of high-SAR water to soils.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except that water generated by testing CBM wells would be treated prior to discharge to surface waters and the land surface (instead of injection), which lessens the impacts caused by application of high-SAR water to soils.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except water generated during production would be treated prior to discharge to the land surface and to surface water-with appropriate permits. Impacts of the land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would remain open or closed at surface owner's discretion. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the Impacts From Management Common To All Alternatives section above. Additional mitigation measures for land applications of CBM waters are included in the *Soils Technical Report* (ALL 2001a).

Conclusion

Cumulative impacts would be similar to Alternative B with the exception that produced water would be treated prior to discharge onto the surface and not injected, which would reduce the detrimental impacts caused by application of high-SAR water to soils.

Alternative E (Preferred Alternative)

Under this alternative, impacts on soils would be similar to Alternative B except that produced water would be managed per a site-specific Water Management Plan with first priority being beneficial use of produced water; impoundments designed to minimize or mitigated impacts to soil, water and vegetation; an option for injection of CBM water; and no degradation of a watershed. All of these factors would reduce the detrimental impacts caused by application of high-SAR water to soils. There would

also not be a 35 percent reduction in impacted soils because of specific management practices for transportation routes-this percent will vary depending on site-specific Project Plans for ROWs agreed upon with the surface owners.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except that water generated by testing CBM wells would not be allowed to degrade the watershed, which lessens the impacts caused by application of high-SAR water to soils.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except water generated during production would be beneficially used, stored in impoundments, or discharged without impacts to the watershed. Impacts of the land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would remain open or

closed at surface owner's discretion. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow reservation under this alternative.

Mitigation

The mitigation measures would be the same as those discussed in the *Impacts From Management Common To All Alternatives* section above. Additional mitigation measures for land applications of CBM waters are included in the *Soils Technical Report* (ALL 2001a).

Conclusion

Cumulative impacts would be similar to Alternative B with the exception that produced water would be managed per a site-specific Water Management Plan that would be geared toward minimizing impacts to soil, water and vegetation, and surface owners would have more input in the Project Plan for the transportation corridors.

Solid and Hazardous Waste

Assumptions

All wastes generated by oil and gas including CBM that are Resource Conservation and Recovery Act of 1976 (RCRA)-classified wastes, such as paint wastes or RCRA-exempt wastes such as drilling wastes, would be disposed of in accordance with regulations. Any release of a hazardous material would be reported in a timely manner to the relevant agency or to the BLM via a Report of Undesirable Event (NTL-3A). Any release of a CERCLA substance would be reported in accordance with regulations.

Impacts From Management Common to All Alternatives

Typical solid waste refuse would be generated by oil and gas drilling and can be disposed of in local landfills. The largest volume of waste generated from drilling activities would be from the drilling mud and cuttings generated. These drilling wastes would be exempt from RCRA and are considered non-hazardous. Drilling mud containing less than 15,000 mg/l TDS can be disposed of on-site with the landowner's permission. The amount of waste generated should not exasperate the landfills in the area. Other impacts would result from spills of waste during maintenance activities, including waste oil from generators, paint waste from construction activities and other solid wastes from construction activities. Impacts would also occur from the use of pesticides and herbicides during access and construction activities.

Mitigation

The mitigation of solid and hazardous waste includes the disposal of all wastes according to federal and state regulations. Other mitigation activities would include a leak detection or monitoring system for hydraulic and lubricating systems, and drilling mud retention ponds. The mitigation of accidental spills and releases would involve the clean up and reporting of all spills in accordance with an approved Spill Prevention Control and Countermeasures Plan.

Impacts From Management Specific to Each Alternative

Alternative A

Impacts from Alternative A would be similar to the impacts described in the *Impacts From Management Common to All Alternatives* section above. The solid and hazardous waste generated during CBM exploration, production, and abandonment would be similar to conventional oil and gas. The drilling muds would be of lesser quantity because of the shallow drilling depths for CBM wells compared to conventional oil and gas.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there is expected to be minimal, if any, impacts from solid and hazardous waste on the reservation. However, regulations followed by the tribe would fall under the jurisdiction of the EPA and Tribal Laws.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusion

The cumulative impacts of this alternative would include the solid and hazardous waste generated from conventional oil and gas, the proposed Tongue River Railroad, surface mining activities, and CBM development. These other activities would result in increased production of both solid and hazardous waste that occur as part of general operation activities. Mitigation would be the same as management common to all alternatives.

Alternative B

The impacts from this alternative would be similar to the impacts under Alternative A. However, CBM development would result in larger quantities of solid and hazardous waste production.

Conclusion

The cumulative impacts from this alternative would be similar to Alternative A. However, the development of CBM, including the potential development of CBM on Indian reservations and USFS lands, would increase the volume of solid and hazardous waste generated. The increased volume of solid and hazardous wastes would result in local landfills reaching capacity sooner, while additional trucks used for hauling waste would increase traffic and air emissions, and would generate the need for the construction of new landfills-which would further disturb lands.

Mitigation activities would be similar to those described in the *Impacts From Management Common to All Alternatives* section above.

Alternative C

The impacts under Alternative C would be the same as for Alternative B.

Alternative D

The impacts under Alternative D would be the same as for Alternative B.

Alternative E (Preferred Alternative)

The impacts under Alternative E would be the same as for Alternative B.

Ute ladies-tresses orchid, *Spiranthes diluvialis*

Vegetation

Assumptions

The Miles City BLM *Seeding* Policy, dated October 27, 1999(c), lists guidelines for seeding practices by typical Montana soil types; it is assumed this policy will be implemented where appropriate. Recommended species are identified for quick coverage of disturbed soils, to discourage invasion of noxious weeds, and to attenuate soil erosion. Reclamation work will be considered complete when the disturbed area is stabilized, soil erosion is controlled, and at least 60 percent of the disturbed surface is covered with the prescribed vegetation.

Under all alternatives, most riparian areas and certain wildlife habitats (see the *Wildlife* section) are protected from direct impact under current stipulations on BLM land that restrict surface occupancy but not road crossings (BLM 1994).

Surveys to determine the presence of federally listed species would occur on BLM-managed land or mineral estate. The APD requires that BLM determine if the proposed development plan would affect any species listed as threatened or endangered.

Formal consultation with the FWS would occur for site-specific federal CBM projects developed under this EIS if a federally listed threatened and endangered (T&E) species or candidate or proposed species may be affected. Section 7(a) of the ESA requires that federal actions "are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or undesirable modification of its habitat." BLM policy for proposed and candidate species is to avoid actions that would jeopardize a species and require formal listing under the ESA.

Special management attention is given by state and federal agencies to state, BLM, and USFS Species of Concern. Agencies approve actions to avoid areas that would jeopardize a species and thereby require federal protection in the future.

The MBOGC environmental review includes an assessment of potential impacts to vegetation during construction and drilling operations. MBOGC policies require the operators to minimize the size of drilling pads and require complete restoration of the area once operations are complete (ARM 36.22). Mitigation plans are included with the environmental review to notify operators of requirements prior to construction.

For Federal actions, FWS is required to give Federal agencies consultation. They do not have this same requirement for state agencies. Even if a state agency requests a consultation, the FWS does not have the authority to do it. If a state or private CBM project triggers a federally related action, the FWS would need to be consulted for federally protected species, by the Federal agency.

The FWS would be consulted under Section 10 of the ESA if a federally related action is triggered.

On BLM lands, where specific stipulations do not exist or do not currently apply, there is a presumption that impacts on T&E plant species would be avoided through development and observation of specific conservation measures developed through consultation with FWS intended to avoid impacts on T & E species as required under the ESA.

Impacts on T&E plants on non-federal lands are less likely to be avoided through conservation measures because they are not protected.

Species of concern on all lands would likely receive a relatively high degree of protection at a metapopulation scale because federal and state agencies are committed to avoiding measures that would require listing protection under ESA. However, this would likely not protect all individuals or perhaps some populations within a metapopulation.

Field clearances and other required pre-exploration activities developed through this EIS process, and which are intended to identify site-specific occurrence of T&E species, would be conducted as specified, leading to knowledge of specific resources and implementation of appropriate avoidance actions and conservation measures discussed above.

Federal and state agency monitoring of exploration, development, and production activities are assumed to be adequate to ensure all lease conditions and ESA requirements are followed.

Preventing the spread of noxious weeds is easier, more successful, and less costly and time-consuming than reclamation or mitigation. Stipulations for current exploration authorizations within the Billings and Powder River RMP areas cover weed management and riparian/wetland management (BLM 1995). Under these stipulations, all categories of noxious weeds must be managed.

Policies for containment of noxious weeds on state lands are listed in the *Minerals Appendix*, Table MIN-5.

The BLM has co-developed an action plan for weed containment and eradication practices that will be implemented for all alternatives (BLM 1996). Pertinent sections of Appendix 3 from that document are reproduced in Table 4-12. The action plan applies to the State of Montana's list of weed species of concern (see Table VEG-7, *Vegetation Appendix*). This list includes species that are considered to be highly invasive and disruptive to natural systems. It is assumed that these weed-prevention activities will be required for CBM exploratory and production sites, roadways, pipelines, utility corridors, and other disturbed sites on BLM land except as specifically noted for some of the alternatives.

Impacts From Management Common to All Alternatives

Construction of facilities and roads would cause the primary effects on vegetation. For a developed well, a site about 40 percent of the original drill site would remain disturbed for the life of the well (20 years). However, unsuccessful exploratory sites would be reclaimed. Reclamation generally includes spreading topsoil and reseeding according to the landowner's request (private land) or the BLM *Seeding Policy*.

TABLE 4-12
EXAMPLE: PARTIAL DISTRICT-WIDE WEED PREVENTION SCHEDULE

Prevention Activity	When	Who Is Responsible
Clean off-road equipment with powerwash or high-pressure to remove all mud, dirt, and plant parts before moving into relatively weed-free areas.	All Year	Equipment Operators; Fire Crew
Re-establish vegetation on all disturbed soil from construction, reconstruction, and maintenance activities.	Spring/Fall	Project Proponent
Inspect gravel pits and fill sources to identify weed-free sources. Gravel and fill to be used in relatively weed-free areas must come from weed-free sources.	Spring/Summer	Surface Protection Specialist; Equipment Operator
Retain bonds (for mineral activity) for weed control until the site is returned to desired vegetative conditions.	All Year	Mineral Specialist
Include weed-risk considerations for environmental analysis for habitat improvement projects.	All Year	Wildlife Biologist
Provide weed identification training for field-going employees and managers.	Winter/Summer	Weed Coordinator
Distribute public information/brochures.	Spring/Summer	Public Affairs Officer
Include weed risk factors and weed prevention considerations in Resource Advisor (Environmental Specialist) duties on all Incident Overhead Teams and Fire Rehabilitation Teams.	Summer	Resource Advisor

Note: Revised from BLM 1996.

Small areas of vegetation would be lost to roads and drill sites for each well. Dust and vehicle emissions could reduce growth of vegetation adjacent to roads and drill sites. If disturbed areas are prepared and seeded properly, reclamation may further reduce the effects of dust. The effects of drilling on vegetation would be of particular concern under the following circumstances:

- When drill sites or roads are located within or cross riparian areas, wooded drainages, or wetlands
- Where drill sites or roads would cause sedimentation or channel down-cutting in riparian areas
- When drill sites or roads would be in areas that contain populations of special status plants
- Where operations could spread or encourage the growth of weeds
- In case of reserve pit leakage
- In the event of blowouts or wildfire

Drilling sometimes may occur in or near areas that support riparian vegetation or special status plants. If located in or at the head of drainages, drill sites and access roads can add sediment to streams and wetlands. Channel degradation can also occur. Heavy sediment loads or severe degradation would affect riparian vegetation. Roads and facilities are supposed to avoid sensitive areas "to the extent practicable." Therefore many, but not all, sensitive areas such as riparian areas and wetlands would be avoided.

Soil disturbance associated with drilling can cause weeds to spread. Of even greater concern is the long-distance transport of certain weed species by drilling equipment and vehicles. Weed spread is reduced if disturbed areas are re-vegetated during the season of disturbance or the next growing season as recommended (Table 4-12). All well drilling operations are covered by the County Noxious Weed Control Act, which holds landowners responsible for weed control. The contribution of oil and gas drilling to weed spread is comparable to other types of construction.

Because of the legal restrictions placed on the harm or take of federally listed species, direct impacts to these listed species would not occur on federal land. Indirect impacts to federally listed species such as habitat destruction will be addressed on a species-by-species basis. Federally listed plant species on non-federal land ownership may be impacted through conventional oil and gas activities because threatened and endangered plants on private lands are not covered by the ESA.

Mitigation

Site clearance surveys would be conducted prior to disturbance. Where necessary, operator plans would be adjusted as appropriate to avoid impacts to federally listed species or species of concern for the state.

During TLMD field reviews of site-specific oil and gas wells on TLMD lands, any species with special status are noted. The TLMD would coordinate with the Montana Fish, Wildlife and Parks (MFWP) to address management considerations.

Conclusions

There would be no impact on federal land to federally listed species. There may be impacts to federally listed plants on non-federal land and to other species of concern.

Impacts From Management Specific to Each Alternative

Alternative A

Previous authorizations have allowed selected CBM exploration in the Powder River and Billings RMP areas as well as selected well development and exploration on state lands.

Disturbance to vegetation is of concern because wildlife habitat and livestock production capabilities may be diminished or lost over the long-term through direct loss of vegetation (including direct loss of both plant communities and specific plant species). Indirect impacts, such as noxious weed invasion, erosion, reduced plant species diversity following reclamation, or lack of successful reclamation, could also cause vegetation loss. Under the No Action Alternative, only riparian habitat types and certain wildlife habitats (see *Wildlife* section) are protected under current stipulations (BLM 1995).

Direct impacts on vegetation would occur during land-disturbing activities associated with installation of exploratory or development CBM wells that remove vegetation to construct a facility (e.g., roads, drilling pads, mud pits, etc.). All direct impacts from exploratory wells are for the life of the well, then rehabilitated. Both temporary and permanent impacts would occur with installation of development wells.

DNRC uses buffer stipulations, and the no-surface-occupancy of navigable riverbeds and related acreage

stipulation on its oil and gas leases for protection of riparian habitat. The remaining four habitat types (grassland, shrubland, forest land, and barren land) may be affected in varying amounts by the existing authorizations for exploration and development. Table 4-13 summarizes the acreage that could be potentially impacted in the two RMP areas and the three counties under state-permitting jurisdiction.

Vegetation types to be potentially impacted were determined based on the extent of each vegetation type overlying coal beds. Impacts to specific vegetation types were assigned in proportion to their total acreage within an ownership (see Table 4-13). For example, there are 1,537,000 acres of grassland in the Powder River RMP area or 40 percent of the total area. Assuming that 200 acres would be permanently disturbed in the Powder River RMP area, 80 acres (40 percent) of permanent, direct impacts would be expected to occur in grassland. If natural communities from Table 4-14 are considered, grasslands would be expected to experience the largest permanent loss (580 acres), based on occurrence. Shrubland would be the next most permanently impacted habitat (174 acres), followed by forest land (114 acres), barren land (46 acres), and riparian habitat (56 acres). Of the 56 permanently impacted riparian acres, 20 are on BLM land, and most are protected by stipulation during exploration.

Indirect impacts may be as important as direct impacts for plants and habitats. As noted earlier, indirect impacts would include the effects of erosion, changes in wildlife and livestock distribution, unsuccessful reclamation, riparian community changes, and the spread of noxious weeds.

Erosion from roads and drilling sites can indirectly affect vegetation from high runoff velocities scouring the plants from the site or by sediment burying the plants. The extent of this potential impact would be determined by the effectiveness of erosion-control measures and the level of enforcement of stormwater management plans. Plant community impacts would be in the same proportions as discussed under direct impacts. The basis of this analysis is formed from the assumption that installation of erosion-control procedures and effective enforcement of stormwater management plans would occur. Implementation of erosion-control measures and stormwater management plans would result in no long-term impacts from erosion. Short-term impacts are still likely to occur from thunderstorm during first year and roadbeds active for 20 years.

A total of 250 acres may be reclaimed following temporary disturbance at state-permitted wells. Failure to adequately restore these acres to pre-disturbance conditions would result in a loss of native habitat. Present seeding mixes do not adequately restore shrub or forest sites because they do not include species other than grass. When shrub and forest sites are impacted, there would be a loss of structure and diversity of vegetation using the current seeding mix. If reseeding is successful, it would potentially reduce noxious weed invasion, erosion, and dust through restoration of plant cover.

TABLE 4-13
AMOUNT OF ACREAGE WITH UNDERLYING COAL BEDS IN EACH HABITAT TYPE (BY RMP AREA AND STATE LAND)[1]

Area	Grassland	Shrubland	Forest Land	Barren Land	Riparian	Agricultural or Other Land Not Included as Native Vegetation
Powder River RMP area	1,537,000 (40%)	920,000 (24%)	897,000 (23%)	210,000 (5%)	180,0002 (5%)	136,685 (4%)
Billings RMP area	1,022,000 (40%)	735,000 (29%)	372,000 (15%)	87,000 (3%)	105,0002 (4%)	206,287 (8%)
State-permitted land in Blaine, Gallatin, and Park counties	990,000 (56%)	152,000 (9%)	89,000 (5%)	75,000 (4%)	93,000 (5%)	359,151 (20%)

[1]Figure in parentheses indicates percentage of total acreage within the RMP area and state-permitted land.

[2]These acres are exempt from CBM development as a result of stipulations that omit this type from consideration for CBM exploration and development; they may be affected by water pollution and increased salinity.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there is expected to be minimal, impacts on vegetation for the reservation. The majority of impacts would be invasion of noxious weeds brought in by increased traffic on county and state roads leading to the scattered CBM exploration and development areas forecast under Alternative A.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The area of disturbance would be minimized to the extent practicable to reduce the area of direct impact to vegetation. All areas temporarily impacted would be reclaimed as soon as possible following disturbance (see Table 4-12). Abandoned well locations on BLM land or on the federal mineral estate would be reclaimed as per existing BLM permitting guidelines.

Mitigation measures are listed in Table MIN-5 of the *Minerals Appendix*. Erosion-control measures would be approved by BLM or the state to prevent impacts to native plant communities from erosion. Erosion-control measures would be inspected to ensure compliance.

Issuance of MPDES permits for discharge of produced water from state-permitted wells is required to protect riparian vegetation. Strict adherence to the BLM riparian protection stipulation would protect riparian areas from impacts during exploration and production.

The MBOGC environmental review includes an assessment of potential impacts on vegetation during construction and drilling operations. MBOGC policies require the operators to minimize the size of the drilling pads and require complete restoration of the area once operations are complete (Administrative Rules of Montana [ARM] 36.22). Mitigation plans are included with the environmental review to notify operators of requirements prior to construction. The Montana Department of Agriculture (MDA) regulates vegetative issues under all alternatives through the requirements in the County Noxious Weed Control Act (7-22-2201 to 2153, MCA). This act requires the re-vegetation of disturbed areas with a cover of beneficial plants. The revegetation plan must be approved by the local district weed board and must include weed-management procedures. The MBOGC requires operators to comply with the County Noxious Weed Control Act when reclaiming disturbed areas.

Under all alternatives, the TLMD requires the revegetation of any area of an oil and gas pad site not being used after drilling has been completed. Sites are typically seeded back to native grass species. Some areas on the pad and road may be devoid of vegetation and have gravel or scoria placed on the surface as long as the well is in production. The road and pad site would be re-claimed if the well is taken out of production.

The BLM has developed weed management guidelines that follow the Management Requirement Best Known Practices Prototype developed by the USFS (USDA 1991) for weed prevention during road building and mineral exploration. The BLM Integrated Weed Management Guidelines and the state regulations concerning control of noxious weeds would be implemented for noxious weed containment and suppression. Conservation measures would be implemented to ensure that as little native vegetation is disturbed as possible, as little recruitment of noxious weeds as possible occurs, and that all types of disturbance are revegetated as quickly as possible. Noxious weed control measures include removal of the plants by pulling, biological, or chemical means, or by destroying seed heads; by cleaning mud and plant debris from drilling and construction equipment before moving to a new site; or by revegetating disturbed sites quickly. In some instances, early successional plants that can hold the site for natural succession or until further restoration is put into place may be necessary to prevent the spread of noxious weeds.

Under all alternatives, operators on state land managed by TLMD are required to monitor mineral leases for noxious weeds and control any weeds that may be introduced. TLMD may place special restrictions on the lease in areas with serious noxious weed concerns or where introduction of noxious weeds would make control difficult. On state lands leased by the TLMD, they may require power-washing of all vehicles coming onto the site to prevent the introduction of noxious weeds.

User-created roads would result in additional loss of vegetation and increased potential spread of noxious weeds (USDI and USDA 2001).

State Species Of Concern

Where released production water increases flows in reaches dewatered from other activities, habitat for the orchid would be improved. Surveys will be conducted

in riparian areas that would be affected by production water release. If a state or private CBM project triggers a federally related action, the FWS would need to be consulted for federally protected species, by the Federal agency.

Direct and indirect impacts on other species of concern would be expected to some degree.

Conclusions

Up to 1,105 acres of native vegetation (excluding up to 20 riparian acres on BLM land) would be lost through CBM exploration activities and an additional 250 acres would be temporarily disturbed. Unspecified grazing impacts to native vegetation would occur if displaced animals concentrate in certain areas. Shrub, forested, and barren lands would not be restored using existing recommended seed mixes and some reclamation efforts may fail. Strict adherence to reclamation policies would result in no impact to vegetation from noxious weed infestations. However, these guidelines and regulations have been in place for many years and weeds continue to spread across central and eastern Montana. Therefore, some further infestations of noxious weeds would be expected. User-created roads would result in additional loss of vegetation and increased potential spread of noxious weeds (USDI and USDA 2001). No impacts on the Ute ladies'-tress would be expected.

Cumulative impacts may occur from coal mining operations. Coal mining occurs within the same area covered by this EIS. Vegetation will be destroyed within the disturbed area of a coal mine. As the mine area is reclaimed, topsoil is redeposited and reseeded to reestablish vegetation. Reseeding during reclamation activities will generally result in an increase in grasslands with less plant diversity than was present under pre-mining conditions.

Construction of the Tongue River Railroad from Miles City to Decker, Montana, would cross 17 tracts of BLM land containing 4,357 total acres and would require 264 of these acres as easement, contributing to cumulative effects when combined with CBM development. A total of 910 acres would be used for construction purposes. This land would have vegetation removed or damaged, and this area is a potential source of noxious weed expansion.

About 92 percent of the coal volume located in the Powder River basin occurs within Wyoming (Ellis et al. 1999) and as many as 50,000 CBM wells may be developed in the Wyoming portion of the basin. The direct and indirect effects of Wyoming CBM development would far surpass the effects of CBM development in Montana under Alternative A because of so many wells. Rivers entering Montana from Wyoming would be expected to have substantially higher flows and degraded quality, resulting in potentially substantial erosion of wetland and riparian communities and habitat degradation from higher SAR levels.

ESA provisions applied to other projects should avoid cumulative impacts to T&E wildlife species when considered in conjunction with CBM exploration and development.

Alternative B

As listed under Alternative A, four habitat types (grassland, shrubland, forest land, and barren land) will be affected in varying amounts depending on the alternative and the amount of habitat with underlying coal beds. Well development is estimated at 18,300 wells in the RFD. If these wells are distributed evenly over habitats by the proportion of habitats with bituminous coal beds, a total of approximately 59,475 acres would be directly impacted. Approximately 26,962 acres of grassland vegetation, 12,292 acres of shrubland, 8,525 acres of forest land, and 2,379 acres of barren land could be potentially impacted, if wells were distributed in proportion to the amount of acres in each habitat type. Direct impacts to riparian areas are similar to Alternative A.

Table 4-15 estimates the acres of direct impact for each action alternative based on information in Chapter 2. Direct vegetation loss by habitat type is assumed to be proportional to the relative amount of each habitat type shown in Table 4-14.

As discussed in the *Wildlife* section, water production and roads can alter the distribution of wildlife and livestock. As wildlife or livestock use is concentrated due to those factors, plant communities can be altered through overgrazing. Overgrazing tends to favor establishment and reproduction of annual and invasive plant species. These species tend to displace native plant assemblages. To the extent grazing animals concentrate in smaller areas, plant communities would change to less diverse, introduced plant communities. Most county weed control efforts focus on herbicide spraying, which reduces plant diversity even more.

Indirect effects include changes in wildlife and livestock distribution patterns as a result of machinery disturbance or removal of habitat.

TABLE 4-14
ACREAGE POTENTIALLY IMPACTED IN EACH HABITAT TYPE
(BY RMP AREA AND STATE-PERMITTED LAND)

Area	Grassland		Shrubland		Forest Land		Barren Land		Riparian		Other Areas	
	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary
Powder River RMP	80	0	48	0	46	0	10	0	10	0	8	
Billings RMP	80	0	58	0	30	0	6	0	8	0	16	
State-permitted Lands	420	140	68	23	38	13	30	10	38	13	150	50
Total*	**580**	**140**	**174**	**23**	**114**	**13**	**46**	**10**	**56**	**13**	**174**	**50**

*These estimates were arrived at using GIS data. Sweet Grass and Carter counties did not have enough bituminous coal beds to show up on those layers, therefore CBM well data for those two counties are not included in these estimates. The total acres of impact using GIS data are 1,393 acres. Total real impacts for all counties are estimated to be 1,488 acres.

CBM exploration activities could result in the recruitment of noxious weeds by disturbing present vegetative cover, compacting soil, exposing mineral soil to seed fall, and aiding the migration of seeds through movement of vehicles and drilling equipment from site to site. Noxious weeds can indirectly impact native vegetation by out-competing native plants for scarce nutrient, light, and water resources, thereby displacing the native species. Sites with the greatest potential for noxious weed invasion, erosion, or difficulty in restoring to pre-disturbance vegetation are generally sites with pre-existing weed problems or drier sites, such as those designated as barren land. Noxious weeds introduced into a forest environment would be very difficult to control because of access restrictions when weeds spread into deep drainages and timbered hills where chemical control would be difficult. Control of noxious weeds is addressed under current BLM stipulations or state law. The increase in the number and potential for spread of noxious weeds with disturbance is an important consideration even at the current level of exploration and development. This concern is related to other indirect impacts, such as lack of successful reclamation and erosion.

Species of concern include federally listed T&E, and candidate species; Montana species of concern; BLM species of concern, USFS species of concern, and Montana Natural Heritage Program (MNHP) species of concern. For the state, this document addresses only those listed as category S1, which are species of extreme rarity or species for which some factor of its biology makes it especially vulnerable to extinction. The *Vegetation Appendix*, Table VEG-6 describes and lists all special-status species.

As discussed in the *Species of Concern* section of Chapter 3 in this EIS, there is one federally listed threatened plant species. In accordance with the ESA, this species and its habitat must be protected from possible impact by oil and gas and CBM development on federal land, but not on state or private land. Additionally, 69 species are classified as "species of special concern" by the Montana BLM, USFS, and MNHP. By policy, BLM management cannot impact these species in a way that may cause further declines in the species' population status. This section will address federally listed plant species protected under the ESA.

Species of Concern: Federally Protected

Ute Ladies'-Tresses Orchid

This species is only known to occur in the southwestern part of the state. No development is planned for that part of the state, therefore impacts are not expected to known populations of this orchid from CBM exploration or development.

TABLE 4-15
ACRES OF LAND AND LENGTH OF ROADS AND UTILITY CORRIDORS DIRECTLY IMPACTED BY CBM CONSTRUCTION

	Alternative			
	B	**C**	**D**	**E**
Area disturbed per well[1]	3.25 acres	4.14 acres	3.25 acres	4.14 acres
Length of roads per well	0.237 miles	0.365 miles	0.237 miles	0.365 miles
Length of utility corridor per well	0.734 miles	1.13 miles	0.734 miles	1.13 miles
Number of wells	18,300	18,300	18,300	18,300
Total area directly disturbed	59,475 acres	75,762 acres	59,475 acres	75,762 acres
Length of CBM roads per square mile[2]	2.9 to 8.8 miles	3.9 to 11.9 miles	2.9 to 8.8 miles	3.9 to 11.9 miles
Total length of CBM roads	6,680 miles	9,018 miles	6,680 miles	9,018 miles
Length of pipeline and utility corridors per square mile[2]	9.04 to 27.12 miles	12.2 to 36.61 miles	9.04 to 27.12 miles	12.2 to 36.61 miles
Total length of pipeline and utility corridors	20,679 miles	27,917 miles	20,679 miles	27,917 miles

[1]The land area disturbed and the length of roads and corridors would be 35 percent greater for Alternative C than for Alternatives B and D because transportation corridors and the use of existing disturbed lands would not be required for roads and utilities under Alternatives B and D.

[2]Length of roads, pipelines, and utility corridors per square mile covers the range of 8 to 24 wells per square mile of land overlying 1 to 3 coal seams, respectively. At an average of 8 wells per square mile, 2,287 square miles would be impacted by intensive CBM development. At 24 wells per square mile, 762 square miles would be impacted by intensive CBM development. Additional wildlife habitat surrounding well fields would be indirectly impacted by human activities and presence.

When disturbance removes vegetative cover from soil, it is open to erosion from wind and water. Erosion from roads and drilling sites can indirectly affect vegetation from high runoff velocities scouring plants from the site or by sediment burying the plants. The extent of this potential impact would be determined by the effectiveness of erosion-control measures and the stormwater management plans. Types of plant community impacts would be in the same proportions as discussed above but on a much greater scale than for Alternative A.

Existing hydrology and riparian vegetation would not be affected by build-up of salts with this alternative because of the use of injection and holding tanks for production water. The potential for spreading noxious weeds is substantially greater than under Alternative A because 20 times as much land would be disturbed.

Species of Concern-Federally Listed Species

Direct impacts to federally protected species are prohibited by law and are the same as under Alternative A.

The potential for direct and indirect impacts on other species of concern would be much greater under this alternative because of the much larger amount of habitat that will be disturbed or lost with the increased level of vegetation disturbance associated with the greater number of well pads, roads, pipelines, and utility lines. More roadways provide greater access and more potential for disturbance, poaching, or harassing of protected species.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. If there were no CBM development on Tribal Lands, then there is expected to be minimal, impacts on vegetation for the reservation. If there is CBM development on the reservation, then the acres of disturbed habitat could be inferred to the reservation using the same approach used in this section.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Mitigation would be the same as described for Alternative A, but applied to a larger area.

Conclusions

The impacts of CBM development under Alternative B would be substantially greater than under Alternative A because 20 times as many wells would be developed and 20 times as much area would be disturbed.

Reclamation after well abandonment on 44,000 acres may revegetate well sites and roads, but not necessarily restore the sites to previous vegetation or habitats, resulting in native habitat loss.

Cumulative impacts would be the same as described for Alternative A except that Montana CBM development impacts would be greater.

Alternative C

A total of approximately 75,762 acres would be directly impacted. Approximately 34,345 acres of grassland vegetation, 15,657 acres of shrubland, 10,859 acres of forest land, and 3,030 acres of barren land could be potentially impacted, if wells were distributed in proportion to the amount of acres in each habitat type. Direct impacts to riparian areas are similar to Alternative A. In addition, although no wells will be authorized in riparian areas under any alternative, the discharge of untreated water from exploration and production onto the surface could affect riparian vegetation, perhaps as much as 3,535 acres. This is the estimated average total acreage of habitat with riparian vegetation that is underlain by bituminous coal bed (BLM and state).

Indirect impacts would include the impacts noted earlier of noxious weed invasion, erosion, and changes in wildlife and livestock distribution. In addition, indirect impacts would include increased SAR and salinity levels, which would result in riparian community changes and increased erosion potential for wetland and riparian communities.

Alternative C has the greatest potential for erosion because of the increased disturbance area with no restrictions on corridors for pipelines, utilities and roadways and no requirements for directional drilling or multiple completions in a single well. The extent of erosion would be determined by the effectiveness of erosion-control measures and the stormwater management plans. This alternative will potentially increase the area of disturbance over Alternatives B or D by approximately 42,000 acres (Table 4-15). This acreage increase will increase the potential for erosion.

With discharge of the CBM water to surface drainages and streams, erosion could occur, which could damage or destroy instream and streambank riparian vegetation (Regele and Stark 2000). The erosion could result in increased sediment loads that, along with the potential high salinity and sodicity, could degrade the stream and impact riparian vegetation. Impacts of discharging CBM waters would likely be greatest in intermittent and smaller perennial drainages during low-flow periods. Releases during low-flow periods of late summer and fall would have the greatest potential to impact riparian vegetation. This is also the time when this vegetation is naturally stressed because of low water. The potential for impacts on riparian vegetation exists along drainages and streams throughout the CBM development area.

CBM groundwater discharge has an SAR capable of killing vegetation (Regele and Stark 2000). Plant growth is affected in sodic soils due to decreased soil permeability, increased pH (which lowers nutrient availability), and accumulation of certain elements (sodium, boron, and molybdenum) at a level toxic to plants. Because of the typically low flows of the CBM wells (approximately 5 to 10 gallons per minute), it is likely that these SAR impacts would be localized in the vicinity of the discharge, unless flow were collected from a large number of wells.

Species of concern have a higher potential for direct and indirect impacts compared to Alternative B because of more surface disturbance.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Mitigation measures would be same as described for Alternative A.

Conclusion

Reclamation of vegetation after well abandonment may revegetate well sites and roads, but not necessarily restore the sites to previous vegetation or habitats, resulting in native habitat loss.

Localized increases in salinity and SAR values may be the most important aspect of this alternative. Salinity can have long-term effects on vegetation, including death of riparian vegetation and concentrations of salt in riparian soils. Soil impacts may last long after a given project site has been abandoned. Increased SAR values may prevent nonhydrophytic reclamation vegetation from succeeding. Increased roads result in more land being disturbed, more wildlife and livestock forage will being removed, and more area for noxious weed invasion being present.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, and/or by changing streambed hydrology and increased SAR and salinity values in water and soil.

Cumulative impacts are the same as discussed under Alternative A and B plus some additional losses as a result of CBM development in Montana under this alternative.

Alternative D

Impacts

Impacts on habitat types under this alternative would be the same as Alternative B except for the potential for riparian impacts. Although no wells will be authorized in riparian areas on BLM land under any alternative, the discharge of water from exploration and production onto the surface could create riparian areas that will be abandoned and could affect the hydrology of current riparian areas, perhaps as much as 2,776 acres.

Under this alternative, indirect impacts could include the impacts noted earlier of noxious weed invasion, erosion, and changes in wildlife and livestock distribution. In addition, indirect impacts would likely include increased water being added to riparian systems, which could affect riparian vegetation. Reservoirs that are used in this alternative for holding treated water could produce problems when they are abandoned. Riparian vegetation that developed during the operation dies after abandonment and the bed of the drying reservoir tends to become infested with noxious weeds (Lahti 2001).

Erosion potential may increase under this alternative because there are no reclamation requirements for roadbeds. This is offset somewhat by the stipulation that no slopes greater than 30 percent can be used for CBM construction.

Discharge of water from exploration and production onto the surface could affect the hydrology of as much as 2,776 acres of current riparian vegetation. Changes in hydrology could have both advantageous and undesirable effects on Ute ladies'-tresses through erosion and changed surface and ground water levels.

Other species of concern could be impacted as described for Alternative B and by discharge of CBM water.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Under this alternative, mitigation would be the same as Alternative A, except water would be treated prior to surface release.

Conclusions

There is no requirement for road abandonment so long-term impacts caused by removal of vegetation for roadways is not known, but would occur. Stipulations concerning slope of land for potential CBM sites are

likely to protect such slopes from failure and mass wasting problems. A secondary effect is that such areas will remain in their existing habitat and plant communities. Reclaimed areas may revegetate adequately, but this will not restore the sites to previous native vegetation or habitats. There is potential for habitat loss because of the lack of requirements for roadbed reclamation or for abandoned reservoirs. Areas that are not reclaimed would represent a permanent loss of native vegetation and be subject to noxious weed infestations.

Release of production water, even when treated, under this alternative can potentially impact habitats preferred by the Ute ladies'-tresses orchid on state or private lands by changing streambed hydrology.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through user-created roads, or by changing streambed hydrology and increased SAR and salinity values in water and soil.

Cumulative impacts would be the same as Alternatives A and B.

Alternative E (Preferred Alternative)

Impacts

The same types of impacts to vegetation and species of concern described for Alternative C would occur under Alternative E because no additional specific mitigation measures will be required and because transportation corridors will not be required. This Alternative would require a Water Management Plan for every well exploration APD on a site-specific basis for management of production water. There would be no discharge of produced water, either treated or untreated, into the watershed under this alternative unless the operator can demonstrate in the Water Management Plan how discharge could occur without damaging the watershed in accordance with water quality laws. Water quality laws will not protect riparian vegetation from inundation and other changes in the water level as a result of production.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Mitigation would be the same as for Alternative A with the addition of preparation of a Water Management Plan.

Conclusions

Residual impacts would be the same as described for Alternative C. All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered after well abandonment and by increased access through increased road densities, which may cause greater disturbance and noxious weed infestations.

The cumulative impacts from Alternative E would be the same as described for Alternatives A and C.

Visual Resource Management

Assumptions

Based on the Visual Resource Management (VRM) class, BLM stipulations would require special design, including location, painting, and camouflage, to blend with the natural surroundings and meet visual quality objectives for the area. A standard component typically includes painting facilities to camouflage them, and a standard color may be specified.

The TLMD has the ability through site-specific mitigation measures to address visual concerns on state lands.

Impacts From Management Common to All Alternatives

Visual resources would be impacted to varying degrees by oil and gas exploration and production activities. Exploration would involve minor visual impacts from clearing operations for access to exploratory sites. The majority of this impact would be expected to result from access road construction, site construction, drill rig operations, and on-site generator use. Short-term visual impacts would occur where construction and drilling equipment is visually evident to observers. Long-term impacts would occur from construction of roads and pads, installation of facilities and equipment, vegetation removal, and change in vegetation communities. These would produce changes in landscape line, form, color, and texture.

Impacts would occur locally on a case-by-case basis as the native vegetation is disturbed and small structures are erected. Landscape line, form, color, and texture would all be expected to change. The view to travelers throughout much of the Powder River area is a high plain with low-lying scrub-shrub vegetation and periodic rock outcrops. In the Castle Rock Project, there is rough terrain, high hills and buttes, and timber present. Much of the area is very scenic and quite a contrast to the landscape of open prairie you might find in other areas of the Powder River Basin. Visual impacts may include building roads in rough terrain or cutting timber. Introducing man-made structures into this landscape, although small and painted for camouflage, changes the overall nature of the visual resource.

Three thousand acres of surface mining expansion under permit consideration may be approved this year. This mining activity may affect some visual resources in those areas for the next 20 to 30 years. The construction of the Tongue River Railroad would impact the visual resources along the river. The decrease in air quality (see the Air Quality and Climate section) from all of the activities, for example, dust and compressor emissions would reduce overall visibility.

Impacts From Management Specific to Each Alternative

Alternative A

CBM production well activities would have visual impacts. CBM wells, typically covered in a box, or "housing" for protection from weather, are isolated structures approximately 4 feet high by 4 feet wide by 4 feet long. The wells are scattered across a wide area, and are connected to field compressors. The compressors are larger, and create more of a visual impact-although in a much smaller area because these structures are more widely distributed. Compressors range in size from field compressors at 8x12x8 (width, length, height; in feet) to sales compressors at 12x18x10. Visual impacts also would arise from construction activities related to developing access to the sites. Exploration well activities may have short-term visual impacts if the exploration wells are not converted to production wells. These short-term impacts (approximately 2 months) would be from the visual effects of the drill rig, portable generator, and access road.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there is expected to be minimal, if any, impacts on visual resources for the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Because Alternative A is an amendment to the existing RMP, the mitigation measures would be the same as described in that document.

Conclusions

As determined in the existing RMP, mitigation measures offset the impacts.

Alternative B

Visual impacts would occur from the development of CBM wells in this alternative for lands in VRM Classes III and IV. VRM Class I and II lands would not be developed and the No Surface Occupancy stipulation applies. The Controlled Surface Use stipulation would be applied to Class III and IV lands providing for special design, painting, camouflage, to help the aboveground equipment blend in with the natural surroundings to meet visual quality objectives for the area. A Visual Resource Inventory would be accomplished to determine the VRM class and the visual quality objectives for the area of development. Impacts from utilities would be minimal as power lines are buried and other utilities are concentrated within roadway corridors.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

A mitigation plan based on the objectives identified in the Visual Resource Inventory and VRM Class would be developed on a case-by-case basis. Typical measures include designing the compressor station to blend into the background, landscaping options, and painting to camouflage the aboveground equipment. Powerlines and pipelines would be placed underground and well heads camouflaged with landscaping or vegetation.

Conclusions

Implementation of the mitigation plan and visual impact reducing elements of the alternative would lessen the majority of visual impacts but would not eliminate them. Residual visual impacts would include the impact of the expanded road network when viewed from a distance or from higher elevations.

Cumulative impacts would include the visual impact of additional roads when combined with existing roads and new roads being constructed for other uses.

Alternative C

For Alternative C, visual impacts would occur from the development of CBM wells for lands in VRM Classes II, III, and IV. VRM Class I lands would not be developed and the No Surface Occupancy stipulation would apply. The Controlled Surface Use stipulation would be applied to Class II, III, and IV lands. A visual resource inventory would be accomplished to determine the VRM class and the visual quality objectives for the area of development.

Power lines would be aboveground in this alternative and roads would be allowed to be placed according to operator plans. This would result in power lines where none now exist, as well as a wider expanse of roads.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The results of the visual resource inventory would be incorporated into the project plan for VRM Classes II, III, and IV. Identified visual quality objectives would be evaluated and where feasible incorporated into the plans.

Conclusions

Residual visual impacts would include the impact of the expanded road network when viewed from a distance or from higher elevations. There also would be a network of power lines visible from many places.

Cumulative impacts would be the same as described for Alternative B.

Alternative D

Visual impacts would be the same as described for Alternative B.

Mitigation

Mitigation would be the same at described for Alternative B.

Conclusions

Residual and cumulative impacts are the same as described for Alternative B.

Alternative E (Preferred Alternative)

Visual impacts would occur from the development of CBM wells for lands in VRM Classes II, III, and IV. VRM Class I lands would not be developed and the No Surface Occupancy stipulation would apply. The Controlled Surface Use stipulation would be applied to Class II, III, and IV lands providing options for lessening the visual impact through design and landscape features. A Visual Resource Inventory would be accomplished to determine the VRM class and the visual quality objectives for the area of development.

This alternative does allow for installation of pipelines, power lines and roads where there are none now. But, it also requires that the operator minimize or mitigate impacts from these activities in the Project Plan and state how the surface owner was consulted for input on the location of roads, pipeline and utility line routes. It also allows, at the surface owners discretion, the closing and rehabilitation of roads or the option of leaving them open, after well abandonment.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

A mitigation plan based on the results of the Visual Resource Inventory Visual Quality Objectives would be developed on a case-by-case basis. This plan would include measures to design the compressor stations and well heads to blend into the background through the use of landscape or painting options, burying pipelines and powerlines when necessary, and locating wells in locations that would mask the visual impact.

Conclusions

Use of the mitigation plan as part of the Project Plan would lessen many of the visual impacts but would not eliminate them. New roads and powerlines would be a residual visual impact from this alternative.

There would be cumulative visual impacts from the combination of new and existing roads and utilities.

Wilderness Study Areas

Assumptions

Wilderness Study Area (WSA) policy prohibits leasing of WSA lands for resource extraction subject to rights associated with valid claims and leases existing at the time of designation.

Impacts From Management Common to All Alternatives

BLM leasing restrictions are designed to protect WSAs from considerable impact. The WSA policy prohibits leasing of these lands for resource extraction. It is expected that WSAs will not be impacted through conventional oil and gas development under current management.

Mitigation

The laws and regulations established for WSAs were established to minimize and mitigate impacts to WSAs; these include prohibiting leasing of WSA designated lands for resource extraction.

Impacts From Management Specific to Each Alternative

Alternative A

State and fee lands would be impacted by CBM production activity. There would be no production activities in BLM planning areas under this alternative and therefore no impacts from CBM activities.

Conclusion

Impacts from this alternative would be similar to management common to all alternatives. Since stipulations for WSAs prevent leasing of these lands for resource extraction, there are expected to be no major impacts to WSAs.

There are no cumulative impacts from CBM development.

Alternative B

Alternative B would allow development while emphasizing the protection of natural and cultural resources. Under this alternative development would result in increased access to remote areas. The impacts from this alternative would be similar to those described under *Impacts From Management Common to All Alternatives*.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative C

Alternative C would emphasize CBM exploration and development with minimal restrictions. The impacts from this alternative would be similar to management common to all alternatives.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative D

Alternative D would encourage CBM development while maintaining existing land uses and protecting down stream water consumers. The impacts from this alternative would be similar to management common to all alternatives.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative E (Preferred Alternative)

Alternative E, the Preferred Alternative, would allow CBM development subject to existing planning restrictions and balances CBM development and the protection of the natural environment. The impacts from this alternative would be similar to those described under *Impacts From Management Common to All Alternatives*.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives.

Conclusion

There are no cumulative impacts from CBM development.

Wildlife

Assumptions

CBM exploration, production, and abandonment on BLM lands is subject to the stipulations summarized in Table 4-16, which are intended to offer some protection to wildlife as a result of development on BLM-administered minerals. These stipulations are recommended for, but do not necessarily apply to, CBM-related activities on non-BLM lands. Therefore, the stipulations would avoid some of the potential impacts on BLM lands, but may or may not avoid impacts on non-BLM lands. The success of these stipulations in avoiding covered impacts would require collection of site-specific information regarding the resources to be protected in relation to exploration, production, and abandonment plans, followed by strict adherence to the terms of the stipulations. For the purposes of this analysis it is assumed that the stipulations offer some protection to these wildlife species on BLM-administered lands.

The DNRC TLMD may apply the following stipulations on a case-by-case basis to school trust lands leased for oil and gas exploration, development, and production. The noxious weed stipulation is placed on all oil and gas leases issued by TLMD. Some of the stipulations indirectly relate to wildlife, while others are more specific. The dates on the timing restriction stipulation vary depending on the wildlife species to which it applies.

- **Notification:** Lessee shall notify and obtain approval from the Department's Trust Land Management Division (TLMD) prior to constructing well pads, roads, power lines, and related facilities that may require surface disturbance on the tract. Lessee shall comply with any mitigation measures stipulated in TLMD's approval.
- **Weeds:** The lessee shall be responsible for controlling any noxious weeds introduced by Lessee's activity on state-owned land and shall prevent or eradicate the spread of those noxious weeds onto land adjoining the lease premises.
- **Sensitive Areas:** This lease includes areas that may be environmentally sensitive. Therefore, if the lessee intends to conduct any activities on the lease premises, the lessee shall submit to TLMD one copy of an Operating Plan or Amendment to an existing Operating Plan, describing in detail the proposed activities. No activities shall occur on the tract until the Operating Plan or Amendments have been approved in writing by the Director of the Department. TLMD shall review the Operating Plan or Amendment and notify the lessee if the Plan or Amendment is approved or disapproved.

  After an opportunity for an informal hearing with the lessee, surface activity may be denied or restricted on all or portions of any tract if the Director determines in writing that the proposed surface activity will be detrimental to trust resources and therefore not in the best interests of the trust.
- **Wildlife Restrictions:**
  - To protect wildlife during periods important to their survival, surface occupancy or other activity shall be restricted from March 15 through July 15 of each year unless otherwise authorized in writing by the TLMD.
  - Potential wildlife conflicts have been identified for this tract. The TLMD will contact the Montana Department of Fish, Wildlife, and Parks office in the area for advice on alleviating any possible conflicts caused by lessee's proposed activities. Additional mitigation measures may be required.
  - Potential wildlife conflicts have been identified for this tract. The TLMD will contact the U.S. Fish and Wildlife Service office in the area for advice on alleviating any possible conflicts caused by lessee's proposed activities. Additional mitigation measures may be required.
  - Wildlife species of concern have been identified on or near this tract. A survey in areas of proposed activity may be required prior to disturbance. Identified species will be avoided, unless otherwise authorized by the TLMD. Additional mitigation measures may also be required.

TABLE 4-16
EXISTING WILDLIFE-RELATED STIPULATIONS COVERING CBM EXPLORATION AND DEVELOPMENT ON BLM LANDS

Resource	No Surface Use	No Surface Occupancy	No Surface Use or Occupancy
Riparian areas		X	
100-year floodplains of major rivers, streams, and water bodies		X	
Water bodies and streams		X	
Crucial big game winter range*	December 1 - March 31		
Elk calving areas*	April 1 - June 15		
Powder River Breaks bighorn sheep range		Within designated bighorn sheep range	
Grouse leks			Within ¼ mile of lek
Grouse nesting zones*	Within 2 miles of leks from March 1 - June 15		
Raptor nests*	Within ½ mile from March 1 to August 1, within ½ mile of raptor nest sites which have been active within the past 2 years.		Within ¼ mile of nest
Bald eagle nests and nesting habitat	Within ½ mile from March to August 1, within ½ mile of raptor nest sites which have been active within the past 2 years.		Within ½ mile of nests active in the last 7 years and within riparian area nesting habitat
Peregrine falcon			Within 1 mile of nests
Ferruginous hawk			Within ½ mile of nests active within 2 years
Piping plover			Within ¼ mile of wetlands identified as piping plover habitat
Interior least tern			Within ¼ mile of wetlands identified as Interior Least Tern habitat
Prairie dog colonies > 80 acres	Controlled surface use		

Note: These stipulations are attached to leases and can affect exploration and construction

*Stipulation does not apply to operation and maintenance of production facilities.

Please refer to Table MIN-5, *Minerals Appendix*, for a listing of resource mitigation.

- **Miscellaneous Restrictions:**
  - Plant species of concern have been identified on or near this tract. A vegetation survey in areas of proposed activity will be required prior to disturbance. Identified rare plant species will be avoided, unless otherwise authorized by the TLMD.
  - A critical weed problem exists on this tract. Additional mitigation measures will be required to prevent further spread of noxious weeds. The department may require such measures as power washing of vehicles, car pooling, timing restrictions for seismic, etc. to facilitate this prevention.
  - This tract contains biological weed-control sites which must be avoided unless otherwise authorized by TLMD.
- Other:
  - Any activity within 1/8 mile of the river or lake/reservoir on or adjacent to this tract must be approved in writing by the TLMD prior to commencement. No surface occupancy will be allowed within the bed of the river, abandoned channels, the bed of the lake/reservoir, or on islands and accretions associated with the river or lake/reservoir.
  - No activity shall be allowed within 100 feet of any perennial or seasonal stream, pond, lake, prairie pothole, wetland, spring, reservoir, well, aqueduct, irrigation ditch, canal, or related facilities without prior approval of the TLMD.
  - Wooded areas on this tract will be avoided unless otherwise authorized by the TLMD.

In addition to these stipulations, motorized vehicle use for recreationists on state trust lands is restricted by current policy to federal, state, and dedicated county roads or other roads regularly maintained by the county, or to other roads that have been designated open by DNRC. Off road use is prohibited. Increased posting efforts, i.e., Walk-In Only signs, may be implemented by the TLMD to prevent unauthorized use of two-track trails and roads by recreationists to alleviate increased pressure on wildlife.

Exploration for and development of CBM wells would cause a wide range of both direct and indirect impacts on wildlife. The extent and duration of effects on wildlife would depend on the animal species, the type and quantity of vegetation removed, the nature and period of disturbance, and the success of stipulations in avoiding some impacts. The impacts described below assume that the site-specific natural resource information and the stipulations discussed above are successfully used to avoid certain impacts on BLM and state lands.

As previously described, the No Action Alternative includes exploration for and development of a relatively small number of CBM wells (compared to the other alternatives) and the associated roads, pads, power lines, pipelines, utility corridors, facilities, and human activities and presence. Many of the direct and indirect impacts of CBM development on wildlife described for Alternative A would occur regardless of the number of CBM wells developed. These direct and indirect impacts are discussed below under the No Action Alternative and referenced as appropriate in the discussion of the impacts of Alternatives B, C, D, and E. Additional ecosystem-level impacts associated with the substantially larger number of CBM wells that would be developed under Alternatives B, C, D, and E are discussed under those alternatives.

Impacts From Management Common to All Alternatives

The responses of wildlife to facilities and activities associated with oil and gas development are complex but well documented (Wisdom et al. 2000; USDI and USDA 2000; Trombulak and Frissell 2000). Tolerance of various types of environmental disturbances varies among species and among individuals of the same species. The potential for impact is related to the timing and nature of the disturbance, severity of winter, location in the state, habitats and species present, physiological status of the animal, hunting pressure, and predictability of the disturbance. The scale of oil and gas development, number of associated roads and other facilities, and implementation of measures to avoid or reduce impacts also influence the probability and severity of impacts on wildlife.

Direct and indirect impacts of road construction and use on wildlife and wildlife habitat have been well documented for oil and gas projects and other natural resource developments. Impacts include a wide range of biological effects, such as habitat loss, displacement, noise, human disturbance, and stress. The types of impacts expected to result from oil and gas development would be similar to those described in detail under Alternative A for CBM development. The extent of the impacts would vary depending on the level of development.

A detailed discussion of impacts and mitigation measures for wildlife is included in the remainder of this section and in the *Wildlife Appendix*. This discussion addresses the direct and indirect quantitative and qualitative impacts that would likely result from CBM development in the Powder River and Billings RMP areas. The impacts from conventional oil and gas development would be similar to those anticipated for CBM but at a scale associated with conventional oil and gas development as identified in the Miles City District's *Oil and Gas Final EIS*, (BLM 1992). Conventional oil and gas development produces less water than comparable CBM production facilities, although at a higher salinity.

Impacts From Management Specific to Each Alternative

Alternative A

CBM exploration and production includes development of roads, pads, power lines, pipelines, utility corridors, and facilities as well as human activities and regular human presence. Much of this activity would occur in the relatively undisturbed native short grass prairie of eastern Montana, resulting in both direct and indirect impacts on wildlife. Those impacts would be localized around CBM exploration and production sites and proportional to the level of activity at a particular location. The following discussion documents the types of impacts that would be expected from CBM-related actions. These impacts would occur on BLM, state, and private lands.

While the types of impacts described below would occur under all of the alternatives, the extent of the impact would be roughly proportional to the extent of CBM development under each alternative. The number of CBM exploratory and development wells under the No Action Alternative is 1/20th the number that would be developed under the other alternatives. Therefore, the extent to which these impacts would occur under the No Action Alternative is relatively minor compared to the other alternatives.

With a few exceptions, the same types of impacts to wildlife would occur under all of the alternatives. Therefore, they are described under Alternative A below. Differences in the type or extent of impacts between alternatives and are noted for Alternatives B, C, D, and E.

Direct habitat loss and direct and indirect impacts because of habitat disruption and wildlife disturbance caused by roads, pipelines, and utility corridors would cause the bulk of the impacts on wildlife. Numerous studies have documented the direct and indirect impacts on wildlife from road development, human presence in formerly remote areas, and facilities construction (Trombulak and Frissell 2000, Wisdom et al. 2000). The nature of these impacts and how they relate to exploration, development, and maintenance of CBM wells is discussed in the text that follows. In most instances, the impacts would occur during all CBM phases. Exceptions are noted as appropriate.

Direct impacts would include loss of habitat to accommodate project features. They would persist for the duration of CBM activities and, in the case of loss of habitat value, beyond that time. Some degree of habitat loss and degradation would continue following CBM abandonment because of ecological differences between reclaimed sites and native vegetation.

The amount and types of habitat that would be directly lost from exploration and development are described in the Vegetation section. The species that would be affected by direct habitat loss would depend on the location of CBM exploration and development and the types of habitat affected. Based on the average area expected to be disturbed by exploration and development of each CBM well, about 675 acres would be lost during exploration, 310 acres would be impacted by well development, and an additional 500 acres would be impacted during operation under Alternative A. Additional lands would be impacted by the approximately 16 vehicles involved in exploration as they move across the landscape creating two-track trails in the arid short grass prairie lands of central and southeastern Montana.

Direct impacts on wildlife would also include mortality as relatively less mobile small mammals, reptiles, and amphibians are killed during road and other site construction during development of CBM facilities. Smaller mammals, reptiles, and amphibians are most likely to be directly killed by vehicles and are especially vulnerable when crossing roadways (USDI and USDA 2001). Amphibians are especially vulnerable to roadkill on all types of roads because their life histories often involve migration between wetland and upland habitats and individuals are often inconspicuous and slow-moving. Inexperienced juveniles of many raptor species experience high rates of mortality from collisions with vehicles (Trombulak and Frissell 2000). Grouse are particularly susceptible to collision mortality during the spring because they often fly to and from leks near the ground. Also, higher CBM-related traffic volumes on existing paved roads would result in higher mortality rates for reptiles that seek out roads for thermal cooling and heating (Vestjens 1973). Direct mortality from vehicle

collisions would be expected to increase for all wildlife along both new and existing roads used for CBM exploration and well construction and maintenance (Groot et al. 1996). Collision mortality would be most injurious to small and declining populations with limited distribution. Direct impacts from collision and crushing would continue for the duration of the project along roads until they are successfully closed and reclaimed.

Additional direct impacts that may occur on private lands because BLM stipulations are recommended but not required. These impacts include greater potential loss of riparian vegetation and other floodplain habitats valuable for wildlife, abandonment of raptor nests because of direct habitat loss and disturbance, and habitat loss for a wide range of species that occupy prairie dog towns.

Most indirect impacts on wildlife would occur during all CBM phases on BLM, state, and private lands. The duration of effects would correspond with the duration of each phase and the intensity of activity during that phase. The relative magnitude of impacts would be directly related to the nature and relative extent of activities associated with each phase of CBM development. Some indirect effects would persist beyond abandonment because continued human use of some CBM and user-created roads that are not closed and reclaimed (USDI and USDA 2001).

Indirect impacts of road development and use as would occur during exploration, development, and production on wildlife and wildlife habitat have been well documented for a variety of natural resource extraction and development projects (Trombulak and Frissell 2000, USDI and USDA 2000, Wisdom et al. 2000). Indirect impacts of CBM exploration and development on certain species of wildlife that are more sensitive to development and human disturbance would occur over much larger areas than the direct impacts. The *Oil and Gas Development on the Southern UTE EIS* (USDI 2000) suggested that human presence associated with exploration and development of oil and gas wells disturbed wildlife at distances up to 1/2 mile, and that operation and maintenance activities caused disturbance within 1/4 mile of wells and roads. The disturbance results both from the presence of people and from the noise associated with exploration and development. There are numerous studies documenting wildlife avoidance of roads and facilities and wildlife disturbance at distances of 1,650 feet (Madsen 1985), 6,600 feet (Van der Zande et al. 1980), and as far as 2 miles or more for sage grouse (summarized in Connelly et al. 2000) and raptors (Fyfe and Olendorff 1976). Elk avoidance of roads has been documented in many studies throughout the West (Lyon 1979 and 1983, Perry and Overly 1976, Rost and Bailey 1979, Ward et al. 1973). Roads displace animals from otherwise useable habitat. Elk in Montana prefer spring feeding sites away from visible roads (Grover and Thompson 1986) and both elk and mule deer in Colorado prefer areas greater than 660 feet from roads during the winter (Rost and Bailey 1979). Lyon (1983) studied the effects of roads on elk distribution and habitat use. He reported that within blocks of available elk habitat, road densities of only 2 miles of primitive (undeveloped) road open to vehicle traffic per square mile resulted in elk displacement from over 50 percent of the available habitat in the areas with roads present. The avoidance was due to human disturbance and the resulting lack of security for the elk. This type of disturbance would be greatest in open country such as the EIS planning area where line-of-sight distances are relatively long and escape cover is often limited.

Table 4-17 displays the area of wildlife habitat that may be indirectly affected by CBM exploration and development under Alternative A using both 1/2- and 2-mile zones of disturbance and also lists the types of direct and indirect impacts on wildlife that would be expected to be associated with CBM exploration, development, and maintenance, and indicates the relative level of vulnerability of different representative types of wildlife to these impacts.

Displacement from habitat because of roads, CBM facilities, and human disturbance may result in any of a number of individual and population level impacts on wildlife (Trombulak and Frissell 2000, Wisdom et al. 2000). These include stress, disruption of normal foraging and reproductive habits, abandonment of unique habitat features, and increased energy expenditure. These factors contribute to reduced over winter survival for individuals, poor condition entering the breeding season, reduced reproductive success and recruitment, and eventually population declines. For sensitive species, displacement from important habitat features is effectively equal to loss of habitat and the individuals that occupied that habitat. Wildlife cannot generally just move to unoccupied habitat in response to disturbance and survive there because other suitable habitat is already occupied by other individuals of the same species or by other species using the available resources.

CBM-developed roads and two-track trails would provide public access into previously unroaded areas and will result in additional user-created roads and trails branching off from CBM roads (USDI and USDA 2001). This is most likely to occur on BLM and state lands where access is not easily controlled because of large land area and limited funding. Access

TABLE 4-17
VULNERABILITY OF WILDLIFE TO TYPES OF CBM IMPACTS, ALTERNATIVE A

(The relatively low impact probabilities in this table reflect the fact that the no action alternative includes a small number of CBM wells compared to the other alternatives)

				Species/Groups Affected[1]																			
	Number of Affected Acres			Big Game/Large Predators[2]		Sage and Sharp-tailed Grouse[2]		Raptors[2]		Waterfowl/ Shorebirds		Song Birds		Prairie Dog Colonies		Small Mammals		Reptiles and Amphibians		Bats		Small Predators	
Type of Impact	**Exploration**	**Development**	**Operation**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**
Direct Impacts																							
Habitat loss	675 acres	310 acres	500 acres	1	2	1	2	1	2	0	0	1	2	2	3	1	2	1	1	2	2	1	2
Vehicle collision / crushing				1	2	2	3	1	1	0	0	1	1	1	2	3	3	3	3	0	0	0	1
Greater public access (increased poaching, fire, and legal hunting)				1	3	1	2	1	2	1	1	0	0	1	2	0	1	0	1	0	1	2	3
Indirect Impacts																							
Disturbance and displacement from CBM-associated human presence and activities.[3]				3	3	3	3	3	3	2	2	2	2	1	1	2	2	1	1	0	1	1	2
1/2 mile perimeter disturbance area	44,696 to 105,560 acres	105,560 acres	44,696 to 105,560 acres																				
2 mile perimeter disturbance area	140,896 to 239,760 acres	239,760 acres	140,896 to 239,760 acres																				
Noise disturbance/displacement/stress				2	2	3	3	1	1	1	1	3	3	0	0	1	1	1	1	1	1	1	2
Above-ground power lines				0	0	0	3	0	3	0	2	0	2	1	2	0	1	0	0	0	0	0	0
Noxious weed habitat degradation				0	2	0	2	0	2	0	0	0	2	0	1	1	2	0	1	0	0	0	1
Presence of new CBM and user-created roads				0	3	0	3	0	2	0	1	0	2	0	2	0	2	0	2	0	0	1	2
Habitat fragmentation				0	1	0	2	0	1	0	0	0	1	0	1	0	1	0	1	0	0	1	2
Sediment runoff from roads and excess CBM water/water quality degradation				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	2	0	0
Altered surface hydrology (springs and small stream flows reduced)				0	1	0	2	0	0	0	1	0	1	0	0	0	1	0	2	0	2	0	1
Increased livestock use of range due to CBM water sources				0	2	0	3	0	2	0	2	0	3	0	0	0	2	0	2	0	0	0	1

Notes:

Vulnerability of wildlife to categories of impacts are based on the nature of impact, species involved, and relative number of wells.
0 = little or no vulnerability
1 = low vulnerability
2 = moderate vulnerability
3 = high vulnerability

[1] Relative vulnerability assumes collection of site-specific data needed to follow stipulations during exploration and development on BLM lands, and strict adherence to stipulations.
[2] Vulnerability would be slightly lower for certain habitat components on BLM lands during exploration, than on non-BLM lands.
[3] Assumes displacement/disturbance within 1/2 to 2 miles around well fields with fields averaging 200 wells per field and 8 to 24 wells per square mile; varies by species with some species such as sage

to most CBM roads on private lands would be restricted by the surface owner. The open rolling nature of the terrain in the project area combined with the proliferation of four-wheel-drive trucks and all-terrain vehicles will allow the creation of many user-created roads (USDI and USDA 2001). This will cause additional road-related direct and indirect impacts over large open areas because of the great sight distances in central and southeastern Montana. For example, large, low-density species such as raptors and ravens that nest along prominent landmarks such as cliffs in open country are easily disturbed during the nesting season (Fyfe and Olendorff 1976). Some CBM roads will continue to be used by the public, and especially hunters, throughout the entire production phase and beyond because road closures are difficult to implement in open short-grass prairie habitat given large land expanses and limited budgets. This continued use would hamper reclamation efforts on some CBM roads while others will remain open by choice. Some portion of CBM roads and user-created roads would likely become permanent, with all of the associated impacts on wildlife and habitat.

Human use of all types of roads is a source of stress for many species. Roads also may affect an animal's reproductive success (Gutzwiller 1991). Golden eagles prefer to nest away from human disturbances, including roads, and have reduced nesting success in nests located closer to roads than in nests farther from roads (Fernandez 1993). Chronic physiological stress on wildlife can result in increased sickness, a decrease in individual productivity (Knight and Cole 1991, Anderson and Keith 1980, Yarmoloy et al. 1988), and eventually result in population declines (Anderson and Keith 1980).

The increased access provided by both CBM and user-created trails and roads over the span of all CBM phases and beyond would result in additional legal harvest and illegal poaching of game animals (Cole et al. 1997), target shooting of animals such as prairie dogs and other similar species (Ingles 1965), and chasing and harassing of animals (Posewitz 1994, USDI and USDA 2001). Human-caused fires are likely to increase in areas that were not regularly accessed by the general public before CBM and user-created roads were present.

Overhead power lines constructed for production wells pose problems for a variety of wildlife species. Raptors and other species of birds occasionally collide with power lines, especially during periods of relatively poor visibility. Overhead power lines can benefit some raptors in open country by providing hunting perches. However, the additional perches also result in local population declines in prey species. For example, overhead power lines constructed in the vicinity of sharp-tailed grouse leks and wintering areas can substantially increase predation rates on the grouse. Electrocution of raptors can also be a serious problem with overhead power lines and related distribution facilities. Raptor and sage grouse collisions with power lines have also been noted throughout the west including eastern Montana.

Another wildlife disturbance factor associated with CBM exploration, development, and operation is noise. The highest noise levels and greatest impacts would be expected during exploration and development, with lower noise levels during production operations. Noise levels would be similar on BLM and other lands. Animals would react to noises, but it is especially troublesome for songbirds. Male neotropical migrant birds that breed in short grass prairie, sagebrush, and riparian communities use songs to establish and defend breeding territories and attract females. Noise interferes with this ability, and with the level of interference related to the volume and frequency of the noise (Luckenbach 1975, Luckenbach 1978, Memphis State University 1971, Weinstein 1978). Other noise-related problems for birds around CBM exploration and production wells and compressors include interference with the ability to recognize warning calls and calls by juveniles. The area of disturbance would vary by species and CBM activity. Producing wells would be relatively quiet once regular production is underway. Compressors would be louder with noise levels at 50 decibels at a distance of 1/4 mile.

Stipulations prohibit surface occupancy in riparian areas and on floodplains of major rivers. However, they do not prohibit crossing of streams or construction of roads through riparian areas. Roads constructed through riparian areas and other forest and shrub stands for CBM development and operation create edge effects and alter the physical environment (Trombulak and Frissell 2000). Roads create drier conditions in the vicinity of the road, thereby altering habitat for many species. In grassland and shrubland habitats, trails and roads create edge habitat for predators and reduce patch size of remaining habitat for area-sensitive species (USDI and USDA 2001, Ingelfinger 2001). Swihart and Slade (1984) found that prairie voles (*Microtus ochrogaster*), which occur in the EIS planning area, were reluctant to cross tire tracks running through an open field. Reluctance to cross narrow gravel roads has also been observed in white-footed mice (*Peromyscus leucopus*), which also occur in the EIS planning area, and many other rodent species (Mader 1984, Merriam et al. 1989, Oxley et al. 1974). Consequently, roads can function as barriers to

population dispersal and movement of species of small mammals that occur in the EIS planning area.

Many amphibian's annual life cycles require migration between habitats with different ecological properties. These species' populations depend on dispersal connections and landscape links (Gibbs 1998). Simple linear structures such as roads of all types can act as physical and psychological barriers for amphibian movement (Mader 1984, Gibbs 1998). Furthermore, motorized off-highway travel may disrupt reptile and amphibian habitat to the point where it becomes unusable (Busack and Bury 1974). Pronghorns and mountain lions have also demonstrated reluctance to crossing roads (Bruns 1977, Van Dyke et al. 1986).

Noxious weeds and exotic plants rapidly colonize disturbed sites, prevent native species from being re-established following ground disturbance, spread into undisturbed areas reducing habitat value on additional lands, and provide very poor quality wildlife habitat or forage. Furthermore, use of chemicals to control noxious weeds usually also kills non-target beneficial native plants, contributing to further habitat loss.

Roads are sources of fine sediment that can enter wetlands and intermittent and perennial drainages, especially following thunderstorms. Effects include increased turbidity (Reid and Dunne 1984), smothering wetland vegetation, and degradation of habitat for amphibians and other aquatic life (Newcombe and Jensen 1996).

There are no apparent differences between indirect impacts on wildlife on BLM, state, and private lands.

Species of Concern

Species of concern include federally listed T&E and candidate species; Montana species of concern; BLM species of concern, USFS species of concern, and MNHP species of concern. For the State of Montana species of concern, this document addresses only those listed as category S1, which are species of extreme rarity or species for which some factor of its biology makes it especially vulnerable to extinction. Chapter 3 of the EIS describes and lists all special-status species.

As discussed in the *Species of Concern* section of Chapter 3 in this EIS, there are 9 federally listed threatened, endangered, and proposed species; and 3 federal candidate species. In accordance with the ESA, listed wildlife must be protected from possible impact by oil and gas and CBM development on all lands. ESA protected plants are not protected on private lands. Additionally, there are many species classified as "species of special concern" by the Montana BLM and MNHP. By policy, BLM management cannot impact these species in a way that may cause further declines in the species' population status. These include 68 plant, 16 mammal, 6 herptile, and 22 bird species, and are listed by the state, BLM, and USFS. This section will address federally listed wildlife species protected under the ESA. General recommendations for other species of concern wildlife species can be found within the general Wildlife impact sections. Federally listed species are discussed individually because of the need for species-specific mitigation measures to avoid extensive impacts. Conclusions are summarized after all of the species are discussed.

Federally Listed Species

Bald Eagle

Bald eagles are sensitive to human presence. Disturbance to foraging, resting, roosting, or migrating eagles is possible through surface use in other areas not addressed by stipulations. Based on the assumptions listed in the introduction to the *Wildlife* section, protection of nests and nesting habitat should prevent eagles from abandoning traditional nesting sites in the project area, but periodic or complete abandonment of non-nesting habitat may occur depending on the level of human use and noise. Above-ground transmission facilities could result in the death of some bald eagles because of electrocution. Power lines also pose strike hazards for bald eagles, especially near perennial rivers and water bodies that support fish and waterfowl. Removal of large trees in wintering areas, particularly at established roost sites, would also displace bald eagles by removing perch and roost sites.

Mountain Plover

Mountain plover are most susceptible to disturbance during the nesting season, which can run from mid-April through early July. Construction activity and operations and maintenance could disturb the nesting/courting birds during this period. Noise and the presence of humans and equipment would be the main causes of disturbance. The absence of stipulations to protect mountain plover nesting areas (prairie dog towns smaller than 80 acres) would result in impacts on this species if exploration or development occurs in or near occupied nesting habitat. Prairie dog towns often are located on flat, topographically low areas, which are also preferred by CBM developers.

Interior Least Tern

As with mountain plover, this species is susceptible to disturbance during the nesting period.

Gray Wolf

Roads and the presence of humans would increase the threat from shooting, either on purpose or accidental (when mistaken for a coyote). The density of roads in occupied wolf areas could force wolves from occupied areas and could increase stress on wolves and result in the loss of some individuals.

Canada Lynx

Canada lynx would be expected mainly in western and south-central Montana, where high-elevation, dense, old-growth forests are most likely to be found. Although possible, exploration and development of CBM are not expected to occur in these habitats. Therefore, there would be no impacts to Canada lynx.

Black-Footed Ferret

Black-footed ferrets are exclusively found associated with their main prey species: prairie dogs. Prairie dogs are found throughout the project area. Any activity affecting prairie dog colonies has the potential to impact the ferret. Prairie dog colonies are frequently located on level to slightly sloping ground, which are also prime locations for CBM exploration and development.

Two BLM leasing stipulations address black-footed ferret concerns. The first states that exploration in prairie dog colonies within potential black-footed ferret reintroduction areas comply with the Draft Guidelines for Oil and Gas Activities in Prairie Dog Ecosystems Managed for Black-footed Ferret Recovery (FWS 1990, BLM 1992). If these guidelines are accepted, they specify that conditions of approval depend on the type and duration of the proposed activity, proximity to occupied ferret habitat, and other site-specific conditions. Exceptions or waivers of this stipulation may be granted if the Montana Black-Footed Ferret Coordination Committee determines that the proposed activity would have no disagreeable impacts on ferret reintroduction or recovery. The status of the Fort Belknap population allows them to be treated as a proposed species, which may require a conference with FWS if impacts are expected in the vicinity of the reservation.

The second stipulation requires that all prairie dog colonies or complexes greater than 80 acres in size be surveyed for black-footed ferret absence or presence prior to ground disturbance. The results of the survey determines if restrictions or denial of use are appropriate for the site.

Permits issued by MBOGC do not have the same stated requirements for protection of dog towns of certain sizes; however, the ESA's protection of listed wildlife does apply to state and private land. Operators are prohibited from causing harm to the ferret. As appropriate, state leases will include a survey stipulation or contact MFWP stipulation for species of concern.

Implementation of stipulations in potential and occupied habitat would avoid impacts to the ferret on BLM land.

Grizzly Bear

Threats to grizzly bears mainly result from human-bear interactions, which occasionally end in the death of the grizzly bear. If exploration moves into sparsely settled areas or previously unroaded areas within grizzly bear range, the possibility of bear-human interaction increases.

Federal Candidate Species

One candidate species may potentially found in the project area: the black-tailed prairie dog. Although not subject to the substantive or procedural provisions of the ESA, FWS encourages no action be taken that could impact candidate species and contribute to the need to list the species. The state also has a policy that the state should take no action that could contribute to these species being listed.

Black-Tailed Prairie Dog

As discussed under black-footed ferret above, BLM has stipulations governing activities that could impact black-tailed prairie dog towns larger than 80 acres and if ferrets are found to be present. However, these protections do not apply if the ferret is not present. The MFWP through a working group composed of state, federal, and private individuals is developing a Prairie Dog Conservation Plan to address how to avoid continuing impacts, which are resulting in population declines. Prairie dogs develop colonies on flat ground, which is also preferred by CBM developers. There are no special protective measures being implemented by the state or BLM at this time, although an evaluation including associated impacts to other listed species, in order to identify measures to avoid impacts is required. Construction of CBM exploration and production wells on all land ownerships is expected to impact black-tailed prairie dog towns.

BLM, USFS, and Montana Species of Concern

Under all alternatives, the variety of life forms and the large number of species of concern, the lack of

specificity of project locations, and the wide variation in habitat used by these species preclude the ability to identify specific impacts to each individual species of concern. Exploration and development of CBM wells would result in a variety of direct and indirect impacts to species of concern. Specific impacts would depend on the species, the amount and type of habitat removed, and the nature and period of disturbance. Leasing stipulations as discussed above and in the *Wildlife* section would offset or offer some protection to federally listed species. However, there are no stipulations for most species of concern.

Alternative A presents a discussion of impacts to all wildlife species, of which species of concern are a subset. That discussion is not repeated here and the reader should refer to the *Wildlife* section for an understanding of impacts to wildlife species of concern. Some of these species are particularly vulnerable because of their scarcity or narrow habitat niche.

Guidelines recently developed by Connelly et al. (2000) to manage sage grouse populations and their habitat indicate that the stipulations stated above that are intended to avoid impacts on sage grouse leks, and nesting areas during exploration are not adequate to do so. Sage grouse are extremely sensitive to human disturbance and habitat alteration and breeding populations have declined dramatically throughout much of their range (Connelly and Braun 1997) including southcentral and southeastern Montana (Eustace 2001). MFWP has been monitoring certain sage grouse leks in southcentral Montana since the early 1980s. There has been an approximate 50 percent reduction in the number of these active leks since the monitoring began. Eustace attributes this decline to habitat loss and human disturbance and stated that he believes similar declines have occurred in other portions of Montana. Connelly et al. (2000) indicate that energy-related facilities should be located at least 2 miles from sage grouse leks. They further note that sage grouse populations display four types of migratory patterns: 1) distinct winter, breeding, and summer areas; 2) distinct summer areas and integrated winter and breeding areas; 3) distinct winter areas and integrated breeding and summer areas; and 4) non-migratory populations. Avoiding impacts on sage grouse requires protecting the integrity of all seasonal ranges. Average distances between leks and nests vary from 0.7 to 3.9 miles (Autenreith 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994, Lyon 2000), and movements between seasonal ranges may exceed 45 miles (Dalke et al. 1963, Connelly et al. 1988). Furthermore, sage grouse have high fidelity to all seasonal ranges (Keister and Willis 1986, Fischer et al. 1993). Females return to the same area to nest each year (Fischer et al. 1993) and may nest within 660 feet of their previous year's nest (Gates 1983, Lyon 2000). Therefore, while important, protecting a 1/4-mile radius area around leks as specified in the stipulations, is inadequate to avoid impacts on displaying and nesting birds and does nothing to protect much of the breeding area or any wintering areas. This stipulation is not adequate to avoid impacts on sage grouse from CBM activities. Sage grouse would be impacted by CBM activities that occur within 2 miles of sage grouse leks or within winter range.

Overhead power lines constructed for production wells pose several problems for sage grouse. Sage grouse occasionally collide with power lines, especially during periods of relatively poor visibility. Overhead power lines provide hunting perches for raptors. Predation rates on sage grouse increase dramatically when these lines are located in the vicinity of sage grouse leks and wintering areas, resulting in population declines (Connelly et al. 2000, Milodrgovich, G. 2001).

As previously discussed, pumping at CBM wells during development and operation may also alter near-surface hydrology by dewatering local aquifers or lowering shallow groundwater levels. Precarious effects on wildlife and habitat would include drying of sub-irrigated wet meadows, drying of springs, and reduced flow and duration in intermittent and small perennial drainages. Sage grouse could be severely impacted, as broods spend much of July and August in more mesic sites as sagebrush habitats desiccate (Gill 1965, Savage 1969, Connelly and Markham 1983, Fischer et al. 1998). Reduced availability of mesic sites would reduce sage grouse brood survival and unfavorably affect populations (Connelly et al. 2000).

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there is expected to be minimal impacts on wildlife on the reservation. Exceptions to these minimal impacts would include disruption of migratory pathways of some wildlife, impacts due to vehicular traffic, hunting of wildlife, and noise and other impacts to wildlife near borders of the reservation. The limited CBM development forecast under this alternative is not likely to lead to any but minimal impacts.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

Agency-applied mitigation measures related to natural resources are presented in Table MIN-5 of the *Minerals Appendix*. Agency-applied measures will be implemented and enforced during all CBM phases. Agency-applied mitigation measures are intended to compensate after-the-fact for some impacts that are not avoided through stipulations. Residual impacts are those that remain after implementation of mitigation measures.

BLM would include and enforce appropriate measures during the site-specific plan approval stage. Measures to further avoid or reduce impacts in addition to those included at the plan approval stage may be recommended. The state would apply additional mitigation measures on a case-by-case basis through the use of field rules. However, no specific additional mitigation measures have been identified for inclusion by BLM or the state at this time and no mitigation measures besides those in Table MIN-5 were considered in the analysis.

Species of Concern Mitigation Measures

Bald Eagle

Before construction begins, a wildlife biologist would survey the construction zone within a 0.5-mile width for bald eagles and bald eagle nests and identify any locations that are found. No surface occupancy or use within 0.5 miles of known nests or riparian nesting habitat would minimize impacts to nesting bald eagles.

Mountain Plover

Surveys would be made for all prairie dog towns within the roadway corridor and pad sites. If prairie dog colonies or several of the other indicators are found, FWS survey protocol for mountain plover would be followed. See the *Wildlife Appendix* for Mountain Plover Survey Guidelines. This includes surveying from May 1 through June 15 for presence or absence on potential sites. Construction would be avoided in these areas during this time period to assure that potential nesting mountain plovers are not prevented from setting up territories as a result of the presence of equipment and humans.

Interior Least Tern

Potential habitat near drilling and construction sites would be identified and appropriate surveys would be conducted for this species. Surface occupancy and use is prohibited within 1/4 mile of wetlands used by nesting interior least tern during exploration. This stipulation would minimize impacts to interior least tern. Occupied wetlands and water levels would be protected in all phases of drilling and construction and no discharge into occupied wetlands would be permitted.

Gray Wolf

Prior to construction on state lands and counties bordering Yellowstone National Park (Gallatin and Park counties), surveys would include specific searches for this animal, occupied dens, or scat. The corridor would be surveyed in the spring, before construction by a wildlife biologist for scat. If scat is found, the site would be surrounded by a buffer zone recommended through consultation with an FWS biologist. If wolves or other wolf indicators are found, FWS would be consulted and proper protocols followed.

Canada Lynx

Any construction areas or drilling pads located in high elevation, old growth forested areas, especially areas with populations of hares or rabbits, would be surveyed prior to construction for scat and individuals following established protocols. If found, the site would be avoided and surrounded by a buffer zone recommended by FWS biologists.

Black-Footed Ferret

No mitigation measures are proposed for this species.

Grizzly Bear

Garbage and other human refuse would be removed from drilling and construction sites on a daily basis in potential bear habitat to avoid attracting bears. Surveys for scat and other sign of grizzly bears in remote, sparsely roaded areas would be conducted prior to construction. If found, protocol would be established after consultation with FWS biologists.

Black-Tailed Prairie Dog

No mitigation measures are proposed for this species.

Conclusions

Agency-applied mitigation measures would reduce erosion potential and facilitate reclamation of disturbed lands during abandonment. If a state or private CBM project triggers a federally related action, the FWS would need to be consulted for federally protected species, by the Federal agency.

Stipulations would avoid some impacts for certain species. However, they would not be 100 percent effective in achieving their intent because of limits on available biological information and because of non-CBM human activities that would be facilitated by new CBM roads. Many of the impacts discussed would not be avoided. Natural resource mitigation measures (Table MIN-5, *Minerals Appendix*) generally focus on vegetation reclamation and related efforts to reduce erosion and water pollution. Measures intended to reduce surface disturbance in sensitive habitats are to be implemented "to the extent practicable." Therefore, it is likely that some sensitive habitats would be directly impacted by CBM development. The intent of reclamation is to re-establish a vegetative cover on disturbed areas rather than to restore native plant communities, as they existed prior to disturbance. Plant species diversity would be lower on reclaimed sites that before disturbance, reducing overall wildlife habitat values for the foreseeable future. Mitigation measures would not be effective at compensating for the indirect impacts on wildlife.

Some wildlife species of concern and their preferred habitat may be disturbed or lost during construction. Individual animals may be lost through collisions with vehicles and indirect impacts as described previously for general wildlife. Indirect impacts to species of concern also could result in displacement or abandonment of habitat or to increased poaching pressure. Species of concern on all lands do not have the same level of protection as ESA-protected species. Therefore, some direct and indirect impacts on individuals or even populations within metapopulations would be expected. This alternative would have the least impact on all species of concern because of the limited number of well developments and associated disturbances.

If habitat degradation is kept at a minimum, mitigation measures are followed for all listed species of wildlife, and appropriate surveys are conducted prior to construction to ensure that these species are not found within or near well sites and other project facilities and corridors and, if found, are buffered by no construction zones and work restrictions recommended by FWS biologists, federally listed wildlife species would be affected but are not likely to be critically affected, directly, by this alternative. For the life of the permit and afterward if road reclamation is not required, these species would be detrimentally affected because of increased road density and associated human activity.

There could be some displacement of bald eagles in non-nesting habitat. Black-tailed prairie dogs may be impacted by this alternative if dog towns are less than 80 acres and if no black-footed ferrets are present.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access because of more roads, increased noise levels, and conflicts with CBM infrastructure and increased human pressure or by changing streambed hydrology and increased SAR and salinity values in water and soil.

The cumulative impacts on wildlife resulting from the effects of Alternative A include the direct loss of wildlife habitat, fragmentation, and wildlife mortality from collisions. Noise and human presence would disturb sensitive wildlife species over very large areas, causing local population declines for some species. This would be particularly problematic for sensitive species such as raptors, sage grouse, and other birds dependent on sagebrush habitats.

Impacts from Wyoming CBM development on wildlife and wildlife habitat would be similar to those described under Alternative A, but at a far larger scale. More than 7.5 times as many CBM wells may be developed in the Powder River basin of Wyoming than the 18,300 considered under Alternatives B, C, and D. The magnitude of direct and indirect Wyoming CBM impacts on wildlife and wildlife habitat would be about 7.5 times greater than described for Alternatives B, C, and D (described in the following sections). Large areas of riparian habitat would likely be impacted by erosion because of substantially higher flows and by higher SAR levels that are toxic to plants. Groundwater drawdown would likely dry up many springs and reduce flows or dry up intermittent streams throughout the Powder River basin of Wyoming and well into Montana. This would result in the direct loss of habitat and degrade habitat values on lands around springs and intermittent streams because natural water sources would be eliminated.

CBM development in Wyoming would have cumulative effects for many species of concern in Montana, especially under two categories: groundwater and surface water. There would be an increased flow and SAR values in the Powder, Little Powder, and Tongue rivers in Montana (See

Hydrology section for specific changes). The increase in water volume at certain times has the potential to cover sand bars and other open areas. There would be potential cumulative impacts for bald eagles and interior least tern that are present in these rivers as well because flow fluctuations and increases in SAR values would affect the food chain these species rely on and because it may affect their nesting habitat. In addition, the impact to groundwater resources from groundwater drawdown within coal seam aquifers that reach from Wyoming north into Montana could draw groundwater down an estimated 5 feet. This groundwater impact could extend as far as 14 miles into the southern border of Montana that is adjacent to the CBM development area in Wyoming. Indirect cumulative impacts along the southern border of Montana because of groundwater drawdown may result in springs drying up that all wildlife species depend upon, including listed species. Cumulative impacts from CBM development in Wyoming would have an impact, particularly those species that spend all or part of their life in or near the Powder, Little Powder, or Tongue rivers.

Alternative B

Generally, the same types of impacts on wildlife described for Alternative A would occur under Alternative B. However, Alternative B includes development or the drilling of 18,300 CBM wells. This is about 20 times as many wells; miles of roads, pipelines, and utility corridors, and facilities and 20 times more human activity than for Alternative A. CBM development under Alternative B would have widespread ecosystem-level impacts on wildlife and wildlife habitat as discussed at length for Alternative A.

Virtually every wildlife species that occurs within CBM development areas would be impacted, with sensitive species suffering the greatest impacts. For example, wintering and nesting sage grouse and nesting golden eagles would not be adequately protected by stipulations and would be expected to suffer large-scale impacts. It is likely that, at this scale of development, some species would become locally rare or vacate large areas. All of the wildlife groups listed in Table 4-17 would have a very high probability of being impacted throughout the CBM development area under Alternative B.

Table 4-15 in the *Vegetation* section notes the number of acres of direct impact (habitat loss) and the number of miles of roads, pipelines and utility corridors that would result from CBM development under Alternatives B, C, D, and E. Development under Alternative B would result in the direct loss of about 59,500 acres of wildlife habitat to well pads, roads (6,680 miles), and pipeline and utility corridors (20,679 miles). Direct and indirect impacts on wildlife from this scale of development would be both widespread and substantial.

The discussion of impacts for Alternative A indicated that elk, sage grouse, raptors, and other species are particularly sensitive to human disturbance associated with CBM development and related roads. Not all wildlife species are as sensitive to roads and disturbance as these species. However, those that are the most sensitive often include species that are declining in numbers and distribution because of this sensitivity, such as sage grouse and many raptors. Table 4-18 provides estimates of the area of habitat within which species sensitive to disturbance and roads may be affected both within and around the perimeter of CBM well fields. Potentially affected areas are estimated for both 1/2-mile and 2-mile perimeters around well fields and related activity (Fyfe and Olendorff 1976, Lyon 1983, Connelly et al. 2000). The table assumes that well field development would include 8, 16, or 24 wells per square mile and that each well field would include 200 wells. CBM well development is projected to occur over a 20-year period with an average well life of 20 years. Therefore, the information presented in Table 4-17 represents the maximum area of disturbance for sensitive wildlife species in year 20 when all wells would be developed and none would have been closed. Approximately 44 percent of the wells and associated disturbance would be in place in year 5, 72 percent in year 10, and 87 percent in year 15. By year 20, indirect impacts of CBM development would affect more sensitive species of wildlife on between 880,000 and 4.7 million acres, with an effect similar to direct habitat loss (see Table 4-17).

Sagebrush obligate song birds, which are suffering range-wide population declines, are also sensitive to disturbance and habitat fragmentation. They avoid pipeline and road corridors even when the roads are unpaved and receive little use (Ingelfinger 2001). His research in Wyoming natural gas fields found that the density of sagebrush obligates including Brewer's sparrow (*Spizella breweri*), sage sparrow (*Amphispiza belli*), and sage thrasher (*Oreoscoptes montanus*) were reduced by 50 percent within 100 meters of lightly traveled unpaved roads compared to densities in undisturbed sagebrush communities. Sage sparrow density along a natural gas pipeline route with no traffic was 64 percent lower within 100 meters of the route compared to densities in nearby undisturbed sagebrush. Ingelfinger attributed these declines to noise (along the roads), habitat fragmentation, edge

TABLE 4-18
AREA OF INDIRECT WILDLIFE DISTURBANCE AND DISPLACEMENT[1] WITHIN AND AROUND CBM WELL FIELDS FOR MORE SENSITIVE WILDLIFE SPECIES FOR ALTERNATIVES B, C, D, AND E
ASSUMES 200 WELLS PER WELL FIELD, 8, 16, OR 24 WELLS PER SQUARE MILE, AND 91.5 WELL FIELDS[2]

		Indirectly Affected Within 1/2 Mile		Indirectly Affected Within 2 Miles	
Number of Wells Per Square Mile	Acres Per Well Field	Additional Area Affected Around Perimeter of Each Well Field	Total Affected Area Within 91.5 Well Fields and Within 1/2 Mile of Well Field Perimeters[3]	Additional Area Affected Around Perimeter of Each Well Field	Total Affected Area Within 91.5 Well Fields and Within 2 Miles of Well Field Perimeters[3]
		Acres	Acres	Acres	Acres
8	16,000	7,040	2,108,160	35,840	4,743,360
16	8,000	5,120	1,200,480	28,160	3,308,640
24	5,312	4,352	884,256	25,152	2,787,456

[1]See text for discussion of individual and population level consequences of displacement.

[2]A larger average number of wells per field would reduce the affected area. For example, fields averaging 1,000 wells per field and 8 wells per square mile would impact 1,738,061 acres instead of 2,108,160 acres.

[3]Affected area around well fields assumes there is no overlap between affected areas of adjacent well fields. Overlap would reduce affected perimeter area.

avoidance, and possibly inter-specific competition with horned larks, that forage along roads. At full development there would be 6,680 miles of new roads. Assuming no overlap, 100 meters on each side of these roads would include over 530,000 acres and additional effective habitat loss would occur along pipelines. These lands are included in the information presented in Table 4-18.

Some additional direct and indirect impacts not already described for Alternative A would be expected to occur under Alternative B because of the much greater scale of CBM development. Prairie dog colonies tend to be located on relatively flat ground, and often in valleys; sites that are also favored by CBM developers. Prairie dog towns also support much higher densities of birds and mammals and greater avian species richness than on adjacent prairie (Agnew et al. 1986). Various studies have reported 163 vertebrate species on black-tailed prairie dog colonies in Montana including several species of concern such as burrowing owl and mountain plover (Reading et al. 1989, Tyler 1968, Clark et al 1982, Agnew 1986). Prairie dog colonies larger than 80 acres are protected from surface occupancy if blackfooted ferrets are found on BLM lands only. Smaller colonies receive no special protection on any lands. Road, well pad, pipeline, and utility line placement across and on prairie dog towns would result in direct mortality and impact large numbers of species through habitat loss and displacement to unsuitable habitat, which would result in the loss of displaced individuals.

Pumping at CBM wells during development and operation may also alter near-surface hydrology by dewatering local aquifers or lowering shallow groundwater levels as discussed in the *Hydrology* section of this chapter. This would occur where several wells are concentrated in a relatively small area. Effects on wildlife and habitat would include drying of sub-irrigated wet meadows, drying of springs, and reduced flow and duration in intermittent and small perennial drainages. Reduced surface water would result in more xeric vegetation and would impact all types of wildlife, but would be especially important for amphibians and certain bird species that depend on mesic plant communities. Sage grouse could be especially hard hit because broods spend much of July and August in more mesic sites as sagebrush habitats desiccate (Gill 1965, Savage 1969, Connelly and Markham 1983, Fischer et al. 1998). Reduced availability of mesic sites would reduce sage grouse brood survival and unfavorably affect populations (Connelly et al. 2000).

There would be no differences between the direct and indirect impacts on BLM, state, and private lands.

Federally Listed Species

Direct impacts to federally protected species are prohibited by law and would be the same as under Alternative A.

The potential for indirect impact would be much greater under this alternative because of the much larger amount of habitat that would be disturbed or lost with the increased level of vegetation disturbance associated with the greater number of well pads, roads, and utility lines. Increased roadways for more wells would result in greater human access, with the potential for more poaching, indirect disturbance, or harassing of protected species.

The same agency-applied mitigation measures described for Alternative A would apply to Alternative B. The effect of these mitigation measures on impacts would also be the same as under Alternative A.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. As before, regulations mentioned above related to wildlife would be under the jurisdiction of Tribal Laws and not state or federal laws. Exceptions to these impacts would include disruption of migratory pathways of some wildlife, impacts resulting from vehicular traffic, hunting of wildlife, and noise and other impacts to wildlife near borders of the reservation. Full scale development forecast under this alternative would increase the risk of these kinds of impact to wildlife on the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Same impacts as Alternative A for wildlife and species of concern; however, about 20 times greater in area and scope due to greater CBM well development and associated impacts of construction such as roads.

Cumulative impacts would be the same as described for Alternative A except that the impacts from Montana CBM development would be substantially greater.

Alternative C

The same types of impacts on wildlife described for Alternatives A and B would occur under Alternative C. However, Alternative C would have direct impacts on more acres of wildlife habitat than Alternative B. Table 4-15 in the *Vegetation* section notes the number of acres of direct impact (habitat loss) and the number of miles of roads and pipeline and utility corridors that would result from CBM development under Alternative C. Development under Alternative C would result in the direct loss of about 75,762 acres of wildlife habitat to well pads, roads (9,018 miles versus 6,680 miles for Alternative B), and pipeline and utility corridors (27,917 miles versus 20,679 miles for Alternative B). More land would be directly impacted because roads would not be required to follow existing corridors and there would be no requirement to place pipelines and utilities in corridors. Direct and indirect impacts on wildlife from this scale of development would be both widespread and substantial.

Table 4-18 indicates the minimum area on which sensitive species of wildlife would be disturbed by CBM development under Alternative C. Indirect disturbance and effective habitat loss for sensitive species would be the same as under Alternative B and would indirectly affect sensitive wildlife on between 880,000 and 4.7 million acres. Effects of disturbance were described under Alternative A.

CBM development produces excess surface water that has not been available in the past. It is unlikely that this water would go unused. Information in the *Water Resources Technical Report* (ALL 2001b) indicates that virtually all of the water produced during CBM extraction would be suitable for livestock or wildlife use. Cattle typically move up to 0.6 mile from water to graze in steep terrain, but will move up to 2 miles in relatively flat areas (Stoddart et al. 1975). CBM development areas that are greater than 0.6 to 2 miles from natural or developed perennial water sources, depending on terrain, are either not used or used lightly by livestock on a seasonal basis. Increased stock water availability from CBM-produced water would permit private land owners and state and BLM grazing permittees to adjust the distribution and management of their herds to use more of the forage within 0.6 to 2 miles of CBM wells. Each CBM production well field that is located in an area without perennial water sources could make up to several thousand acres available to more intensive cattle grazing. Utilization would be most intensive in the immediate vicinity of the water discharge location wells. Increased livestock grazing reduces forage otherwise available for wildlife and degrades habitat value for many species of wildlife (Saab et al. 1995). The additional CBM water would also be available for wildlife use.

The release of untreated CBM water to surface drainages and streams could result in serious erosion, damaging or destroying instream and streambank riparian vegetation that constitutes valuable wildlife habitat (Regele and Stark 2000). The erosion can result in increased sediment loads, which along with the potential high salinity and sodicity, can degrade the stream and impact riparian vegetation. Impacts of discharging sodic CBM waters would likely be greatest in intermittent and smaller perennial drainages during low-flow periods. Releases during low-flow periods of late summer and fall would have the greatest potential to impact riparian habitat and sensitive wildlife species such as amphibians. This is also the time when this vegetation is naturally stressed because of low water and amphibians are confined to remaining water or are burrowed into shallow mud. The potential for impacts on riparian habitat and amphibians exists along drainages and streams throughout the CBM development area.

Because of the typically low flows of the CBM wells (approximately 5 to 10 gallons per minute), it is likely that these impacts would be localized in the vicinity of the discharge, unless flow were collected from a large number of wells, which may occur. There are no apparent differences between the direct and indirect impacts on BLM, state, and private lands.

Species of Concern

Direct impacts to federally protected species are prohibited by law and are the same as under Alternative A.

The potential for indirect impacts or modification to habitat would be greater under this alternative than for Alternative B (Table 4-18) because of the greater amount of habitat that would be disturbed or lost with the increased level of vegetation disturbance associated with the greater number of well pads, roads, pipelines, and utility lines. Reclamation of disturbed areas would not necessarily restore sites to previous habitat configurations or specific habitat needs of listed species. This alternative will have the greatest acreage of disturbance from roadways, pipelines, and utilities of any alternative. Powerline strike and electrocution hazards are highest with this alternative. This alternative may affect SAR levels in rivers that will affect BLM and state species of concern and bald eagle foraging, interior least tern foraging success, and nesting habitat. Production water disposal could also develop riparian areas that would be lost after abandonment. If listed species come to rely on these

areas of developed habitat, this would lead to future declines when the water source for them no longer exists.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Alternative D

The same types of direct and indirect impacts on wildlife described for the Alternatives A and B and in Tables 4-17 and 4-18 would occur under Alternative D. Areas affected by direct and indirect impacts would be similar to those reported for Alternative B with the additions noted below. The impacts of the beneficial use of water for livestock grazing described for Alternative C would also occur under Alternative D. Unlike Alternative C, CBM water discharged under Alternative D would be treated before release. Additional treated water provided to intermittent and small perennial streams may result in both impacts and benefits, depending mostly on the volume of discharge water relative to the natural flow, the steepness of the terrain, and the erosiveness of the soil. Relatively high volumes of water discharged into smaller drainages could erode the channel, destroying riparian vegetation either directly or as a result of channel down-cutting, which would reduce water availability to plants. Intermittent water sources that become perennial because of CBM discharge would attract grazing livestock for longer periods of the year, resulting in degraded range conditions and reduced forage and cover for wildlife. Increased flows may also result in improved and more extensive riparian vegetation in intermittent drainages where seasonal water stress limits the current extent or condition of the vegetation and in more widespread water availability for wildlife. However, this benefit would be offset if more livestock grazing occurs in the vicinity and downstream of the discharge points. Lack of a requirement to reclaim roads and abandoned reservoirs would increase the potential for noxious weed occurrence and resulting habitat degradation.

There are no apparent differences between the direct and indirect impacts on BLM, state, and private lands.

The same agency-applied mitigation measures described for Alternative A would apply to Alternative D. The effect of these mitigation measures on impacts would also be the same as under Alternative A.

Species of Concern

Direct impacts to federally protected species are prohibited by law and are the same as under Alternative A. The potential for indirect impacts or modification to habitat would be greater under this alternative than Alternatives A or B, but less than Alternative C. As with those alternatives, reclamation of disturbed areas will not necessarily restore sites to previous habitat configurations or specific habitat needs of listed species. There will be increased roadways with this alternative over either Alternatives A or B. As with Alternative C, production water disposal, which would be treated under this alternative, could develop riparian areas that would be lost following abandonment.

Mitigation is the same as for Alternative A, but on a larger scale.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Residual impacts on wildlife would be similar to those described for Alternative B.

Under all alternatives, the variety of life forms and the large number of species of concern, the lack of specificity of project locations, and the wide variation in habitat used by these species preclude the ability to identify specific impacts to each individual species of concern. Exploration and development of CBM wells would result in a variety of direct and indirect impacts to species of concern. Specific impacts would depend on the species, the amount and type of habitat removed, and the nature and period of disturbance. Leasing stipulations as discussed above and in the *Wildlife* section would offset or avoid some impacts to federally listed species. However, there are no stipulations for most species of concern.

Cumulative impacts would be similar to those described for Alternative B.

Alternative E (Preferred Alternative)

Impacts on wildlife under Alternative E would be similar to those described in Alternative C although potentially less severe for many species of concern. Project Plans would be developed and approved using the programmatic guidance outlined in the Wildlife Monitoring Protection Plan (*Monitoring Appendix*). They would include baseline inventory in areas where wildlife inventory has not been completed. Operators would be required to submit plans which demonstrate how their project design minimizes or mitigates impacts to surface resources and meets objectives for wildlife. The Wildlife Monitoring Protection Plan would be a cooperative approach which incorporates adaptive environmental management principles and establishes a framework which encourages industry, landowners, and agencies to work together constructively to incorporate conservation measures into CBM development. All CBM development would follow the programmatic guidance to address wildlife concerns, and each individual Project Plan would include a site-specific Monitoring and Protection Plan which includes mitigation specific to species or local habitats. Over the life of the CBM project, Wildlife Monitoring Protection Plans would offer some assurances that management would be adapted to address specific situations.

Mitigation measures would be the same as listed in Alternative A.

Species of Concern

Impacts would be the same as Alternative A, but this alternative would have more impact on all species of concern because of the increase in number of wells and their associated disturbances.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative E.

Conclusions

Residual impacts would be generally the same as those noted for Alternative A. However, they would occur on a far greater scale, as noted above. Discharge of treated water to intermittent and small perennial streams would result in both impacts and benefits to riparian vegetation and amphibians, depending mostly on the volume of discharge water relative to the natural flow.

Habitat disturbance and poaching would be greater with this alternative than with either Alternatives A or B because of the greater potential area of disturbance.

All species of concern that are not federally protected would be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, or by changing streambed hydrology and increased SAR and salinity values in water and soil.

Aquatic Resources

Assumptions

The BLM has identified stipulations that would avoid or minimize impacts on biological resources and hydrological features resulting from CBM exploration, production, and abandonment activities on BLM lands (BLM 1992). These stipulations are attached in the *Minerals Appendix*. Stipulations related to aquatic resources include a prohibition on the surface occupancy or use of water bodies and streams, 100-year floodplains of major rivers, and riparian areas. In addition, surface occupancy and use is prohibited within 1/4 mile of designated reservoirs with fisheries to protect the fisheries and recreational values of reservoirs. Surface occupancy also is prohibited on slopes exceeding 30 percent to prevent excessive soil erosion, slope failure, and mass wasting, all of which would contribute increased sediment to drainages that may affect aquatic resources (BLM 1992). These stipulations may avoid some of the impacts on BLM lands, but they do not apply to CBM-related activities on non-BLM lands and therefore would not avoid impacts on non-BLM lands. The only management objective that applies to BLM lands and lands subject to state regulations is the required placement of untreated waters from exploration activities in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed applies to BLM and state lands.

CBM exploration, production, and abandonment activities would impact aquatic resources in a number of ways. The likelihood of these impacts occurring depends on the exact nature, location, and timing of CBM activities; the proximity of CBM activities to water bodies and the presence of sensitive species and/or sensitive life stages in these water bodies; and the nature of stipulations and mitigation measures that would be implemented to minimize, avoid, or mitigate the potential occurrence of impacts. A number of these additional mitigation measures that would be applied on a case-by-case basis, as needed, are described in Table MIN-5 of the *Minerals Appendix*. Examples of mitigation measures associated with aquatic resources, some of which are directed at special status species, include considerations of the location and timing of stream crossings as they relate to spawning periods and habitat, minimization or avoidance of in-channel activities to reduce the potential for habitat loss, the development of Spill Prevention Control and Countermeasures Plans to deal with accidental spills, control of storm water pollutant run-off, and various measures to prevent eroded materials from entering drainages. The success of these actions requires a site-specific understanding of the resources to be protected and adherence to stipulations and mitigation measures during CBM activities. The assumptions stated in *Water Resources* section of this chapter also form a portion of the framework for analyzing potential impacts from CBM activities on aquatic resources.

The discussion of impacts in the following text for the No Action Alternative first describes the types of impacts that would result from CBM activities in the absence of stipulations. It then assesses the likelihood of such impacts occurring based on the nature and magnitude of CBM activities, the proximity of those activities to aquatic resources, and the rigor of stipulations that would be implemented on lands managed by BLM and on lands subject to state regulations. Conclusions address the residual impacts that would remain following the implementation of mitigation measures. Conclusions also address the cumulative impacts that would result from the residual impacts of CBM development combined with the potential effects of other projects in the area.

Many of the same types of direct and indirect impacts on aquatic resources would occur regardless of the number of CBM wells developed, although the magnitude of impact would vary. Many of the same types of stipulations and mitigation measures also would be implemented. Therefore, the detailed discussions of types of impacts first presented for the No Action Alternative are referenced, as appropriate, in subsequent discussions of impacts for Alternatives B, C, D, and E. The potentially greater magnitude and geographic extent of impacts on aquatic resources because of the substantially greater number of CBM wells that would be developed under Alternatives B, C, D, and E are discussed under those alternatives.

Impacts from Management Common to All Alternatives

Types of impacts on aquatic resources, including fish, aquatic invertebrates, and their habitat, potentially resulting from CBM development activities would be similar to those described for oil and gas exploration and development activities (MBOGC 1989). These include direct removal of habitat, habitat degradation from sedimentation, altered spawning and seasonal migration because of stream obstructions, direct loss of fish from accidental spills or pipeline ruptures releasing toxic substances, increased legal harvests of fish because of increased human access, and reduced stream flows because of removing water for drilling activities. These potential types of impacts are common to all alternatives and are described further under Alternative A (the No Action Alternative). An

additional impact on aquatic resources that would only occur under Alternatives A, C, D, and E is degraded stream water quality and/or increased flows because of discharging production water. This impact also is described under the No Action Alternative. However, no impacts would result from conventional oil and gas activities because of protection of reservoirs on 1,844 acres.

Impacts from Management Specific to Each Alternative

Alternative A

Numerous dewatering problems that affect aquatic resources have been identified for drainages in the Billings RMP and Powder River RMP areas that would continue under the No Action Alternative. In the Billings RMP area, these include periodic dewatering of portions of the Yellowstone River and downstream sections of the Clarks Fork and Bighorn rivers, and chronic dewatering of the Boulder River, the upstream section of the Clarks Fork, portions of the Musselshell River, and Careless Creek. In the Powder River RMP area, dewatering problems include periodic dewatering of the downstream section of the Tongue River and chronic dewatering of the Powder River. Dewatering indicates a reduction in streamflow, usually during the irrigation season (July through September), beyond the point where stream habitat is adequate for fish. Periodic dewatering indicates a crucial problem in drought or water-short years, and chronic dewatering indicates a critical problem in virtually all years (Montana NRIS 2001).

The two most common forms of pollution in the Billings RMP and Powder River RMP area drainages are elevated sediment and salinity concentrations, primarily from non-point sources related to agricultural practices (MBOGC 1989). Levels of dissolved solids in drainages tend to increase proceeding downstream because of contributions from irrigation return flows, increased base flows that have been in contact with soil and rocks for long periods of time, and pollution from human activities. Water quality in intermittent and ephemeral drainages often is of poor quality because of the sudden and highly variable nature of discharge (snowmelt, intense rainstorms) that would result in elevated turbidity, dissolved solids, and suspended sediment levels in these and in downstream perennial drainages (MBOGC 1989). These water quality conditions would likely continue under the No Action Alternative.

Fish populations and habitat in perennial and intermittent streams in the Billings RMP and Powder River RMP areas are impacted by drought, high temperatures, prolonged cold, heavy icing, and flooding (BLM 1995). Pond habitat and fisheries in the RMP areas also would be affected by dry, low-water years when excessive water temperatures and reduced dissolved oxygen levels during summer would kill fish, and by extended periods of ice and snow and subsequent oxygen depletion during winter that would kill fish (BLM 1995). Water quality and habitat for fish in the Park, Gallatin, and Blaine counties' drainages that were discussed in Chapter 3 generally tend to be good to excellent, primarily because of the proximity to headwaters and/or the often undeveloped or remote nature of the surrounding areas. All of these resource conditions would probably continue under the No Action Alternative.

Previous studies have summarized the ways in which aquatic resources, including fish, aquatic invertebrates, and their habitat, would potentially be impacted, either directly or indirectly, by CBM activities (BLM 1992, USDI 2000, Regele and Stark 2000). Many of these impacts are the same as described for oil and gas exploration and development activities (MBOGC 1989). They include the following effects:

- Loss of aquatic and riparian habitat at stream crossings and near well sites
- Habitat degradation and loss from increased sediment delivery and sedimentation
- Altered spawning and seasonal migrations of fish because of stream obstructions
- Direct loss of fish and aquatic invertebrates from accidental spills, leakage, and runoff of toxic substances into drainages
- Increased legal and possibly illegal harvests of fish because of increased human presence
- Degraded water quality and increased stream flows from discharging saline production water into nearby drainages

Crossing streams and placing facilities such as culverts, bridges, and cattle guards during the construction or upgrading of access roads to well sites would result in the localized loss of aquatic and riparian habitat. Depending on stream location and hydrology, drainages may provide year-round (perennial) or seasonal (intermittent or ephemeral) habitat for a variety of fish species and their life stages, including spawning, incubating, rearing, holding, and over-wintering. Drainages also provide habitat for aquatic macro- and micro-invertebrates that are typically important fish foods, such as aquatic insects,

zooplankton, clams, snails, and worms, as well as habitat for aquatic plants, including periphyton, phytoplankton, and vascular macrophytes. Instream activities also would alter habitat characteristics such as water depth, velocity, and habitat types that are important to native and introduced fish species as well as benthic invertebrates.

The loss of riparian habitat would be especially important in smaller drainages because of its many influences on the quality of aquatic habitat. Murphy and Meehan (1991) reported that riparian habitat would form a protective canopy that provides overhead cover for fish and moderates the extreme effects of air temperatures during summer (helps to cool streams) and winter (helps to insulate streams). Riparian habitat also helps reduce soil erosion and filters sediment before it enters streams, stabilizes streambanks, and allows for the formation of undercut banks that provide cover for fish. In addition, riparian habitat contributes litter (nutrients and food for invertebrates) and woody debris (instream cover) to drainages, and it provides habitat for insects that fall to the water's surface and are consumed by fish (Murphy and Meehan 1991). The loss of these riparian functions would result in impacts on aquatic resources.

Soil disturbance, erosion, and runoff during CBM activities would result in increased sediment delivery to streams and the degradation or loss of aquatic habitat. Examples of such activities include the construction, upgrading, use, maintenance, and retirement of access roads; the installation of culverts, bridges, and cattle guards at stream crossings; other instream activities such as fording streams; site preparation, well drilling, and related onsite facilities; and the construction and placement of pipelines for gas delivery. The potential for erosion and runoff would be greatest where wet or moist soils on steep slopes with little or no vegetative cover have been compacted by heavy equipment (BLM 1992).

Increased sediment delivery to drainages would affect aquatic resources through the sedimentation of habitat and increased levels of turbidity and suspended sediment in the water column. Increased sedimentation would cause a reduction or elimination of stream bottom habitat used by aquatic insects such as caddisflies, mayflies, and stoneflies; a subsequent reduction in aquatic insect abundance and diversity; a reduction in the permeability among interstitial spaces within spawning gravels that inhibits the flow of well-oxygenated water and the removal of metabolic wastes; a subsequent reduction in spawning success, hatching success, and fish production; and a reduction in the interchange of surface and subsurface waters in the hyporheic (mixing) zone beneath the stream channel (Nelson et al. 1991, USDI 2000). Substantially increased sedimentation would eliminate or reduce the depths of pools that provide important year-round cover for juvenile, sub-adult, and adult fish, and would cause the premature siltation of beaver ponds, which often provide year-round habitat for trout (MBOGC 1989). If severe enough, increased sediment loads would cause the erosion and migration of stream channels (Chamberlin et al. 1991), and the degradation of aquatic and riparian habitat.

Elevated turbidity and suspended sediment levels caused by increased sediment delivery would have sublethal and acute effects on fish. Nelson et al. (1991) reported that suspended sediment concentrations of 1,200 mg/l cause mortalities in under yearling salmonids, while suspended sediment concentrations as low as 100 mg/l up to 1,000 mg/l are sometimes associated with a general reduction in fish activity, impaired feeding, reduced growth, downstream displacement, and decreased resistance to other environmental stressors. MBOGC (1989) reported fish and fish food production would be affected by the abrasive effects of very fine sediment on fish embryos and fry and on immature aquatic insects. In addition, very turbid waters would exhibit increased temperatures because of the water's capacity to retain more heat. This would affect those fish and invertebrate species with the most restrictive cold-water or cool-water thermal requirements.

The most severe aquatic impacts resulting from increased sediment delivery would be to trout, whitefish, and grayling. These species have relatively narrow habitat requirements, including the need for clean, cold, well-oxygenated water and/or gravels for spawning, egg incubation, rearing, and adult success (Bjornn and Reiser 1991). The MBOGC (1989) generally concluded that in Montana, increased sediment delivery would have a greater impact on aquatic resources in high-gradient mountain streams than in low-gradient prairie streams. Mountain streams typically support the very sensitive and highly valued species of salmonids, which are generally much less tolerant of increased sediment and turbidity levels than are the warm water fish species found in the lower-gradient prairie streams and rivers in Montana. The MBOGC (1989) also noted that the potential for impacts from sediment delivery to drainages may be greatest in mountainous terrain because roads and pipelines are typically constructed close to streams where slopes are less steep.

Fish spawning migrations and localized movements would be affected by the improper placement, misalignment, or construction of culverts and bridges. Improperly designed facilities would block fish

passage directly or constrain fish movements by creating hydraulic barriers caused by excessive water velocities or insufficient water depths. Furniss et al. (1991) reported that unless properly designed, stream crossings would be considered dams that are designed to fail, with subsequent impacts on fish passage and the sedimentation of habitat. Four aspects of culvert design, including diameter, length, slope, and vertical drop to the water's surface, can potentially affect fish passage, especially of smaller fish. The MBOGC (1989) reported that perched culverts or small-diameter culverts with high water velocities effectively block trout spawning migrations. Bell (1986) stated that improperly designed culverts may preclude the passage of small fish and possibly discourage larger fish from attempting passage.

Accidental spills, leakage, and runoff or leaching of petroleum products, drilling fluids stored in reserve pits, and other potentially toxic substances such as saline production water (discussed further below) would contaminate surface water drainages and have acute and chronic effects on fish and their foods (BLM 1992; USDI 2000). The effects of such contamination are influenced by the toxicity of the contaminant including its persistence and fate, volume of spill, distance from surface water and likelihood of contaminant entry, the volume and diluting ability of the receiving water, and sensitivity of organisms exposed to the contaminant. Direct effects include mortalities of aquatic organisms, while indirect effects may be exhibited through chemically induced changes in densities and community structures of aquatic organisms (Norris et al. 1991). Examples include alteration of environmental characteristics such as cover, food, or some other variable important to the well-being of fishes. Effects would be comparatively greater during low-flow than high-flow periods and in smaller rather than larger water bodies. The MBOGC (1989) concluded that the potential for impacts from accidental spills may be greatest in headwater mountain streams with relatively low flows because soils in such areas are often porous and runoff to streams is direct and rapid.

Increased human access because of new roads and increased human activity associated with CBM exploration and production may result in increased legal and illegal harvest of fish from nearby drainages (MBOGC 1989). Besides angling mortalities of game species, legal fishing activities may result in the trampling of eggs and recently emerged fry from wading in streams, and walking on or next to streambanks may cause increased bank erosion and habitat sedimentation.

A CBM activity that would result in stream flow depletion is the pumping and removal of groundwater during CBM production that is closely connected to surface water supplies. The potential for stream flow depletion from this activity depends on geological conditions in the vicinity of the well site and the degree of interconnectedness between surface water and groundwater hydrology and hydraulics. Removal of substantive amounts of groundwater in closely interconnected systems would affect aquatic habitat, particularly in smaller, shallower drainages during low-flow periods and during the summer and winter periods of extreme water temperatures. Examples of resultant habitat modifications that would impact fish and invertebrates include reduced water depths; slower water velocities; fewer and/or shallower pools and riffles; increased water temperatures during summer; exposed stream channel bottom and stream banks; reduced habitat for spawning, rearing, holding, and refugia; reduced riparian habitat quantity, quality, and function; and reduced fish and invertebrate production.

Several examples illustrate the effects, or absence of effects, of groundwater withdrawals on surface water hydrology and aquatic resources. *Southern Ute DEIS* (USDI 2000) noted the potential for slightly altered drainage patterns in surface waters because of CBM production water withdrawals from groundwater aquifers on the Southern Ute Indian Reservation in New Mexico and Colorado. That analysis estimated that between 1,600 and 2,500 acre-feet of water may be lost from instream flows, and concluded that this was not anticipated to impact fish habitat. This is equivalent to a 2.2 to 3.5 cfs reduction in instream flows spread evenly over a year. Under other circumstances and depending on the size of the drainage potentially affected, a flow reduction of about 3 cfs would have substantive effects on very small perennial and intermittent drainages, but negligible effects on very large perennial drainages. Studies also were conducted for the Deer Creek Coal bed Methane Project, which is in the Tongue River watershed in the northwestern part of the Powder River Basin (BLM 2000a). Hydrologic analysis of the Deer Creek Project indicated that because of the sealing effect of the overlying aquitards, water levels in shallow aquifer zones and in shallow wells in the project area would not be impacted by water level drawdowns caused by CBM well operations (BLM 2000a). The Deer Creek analysis concluded that flows and aquatic habitat in project area drainages should not be depleted or aquatic habitat degraded. Similar findings were presented for studies of the Castle Rock Project, which concluded that cumulative impacts on the surface water resources of the exploration area, which include the Powder River and Pumpkin Creek, are expected to

be minimal to nonexistent in the short term (BLM 2000b).

Aquatic resources would be affected by the discharge to surface waters of groundwaters that are withdrawn during CBM production activities. The discharge of saline groundwaters would degrade surface water quality and increase flows, impacting aquatic habitat and biota. The effects of production water discharge would be most evident in smaller drainages during low-flow times of the year, particularly in those drainages with low levels of TDS. The specific ionic constituents comprising TDS are also important determinants of a water body's toxicity to aquatic organisms. For purposes of comparison, fresh water usually has a salinity of less than 500 mg/l while sea water has an average salinity of 35,000 mg/l. The surface discharge and runoff of production water also would cause erosion of soils and even higher concentrations of solids. For the proposed Deer Creek Project in the Tongue River watershed, TDS values of water produced from CBM wells are expected to range from 2,500 to 3,500 mg/l (BLM 2000a). Examples of TDS concentrations in groundwater found in coal aquifers of the Powder River Basin were presented previously in the *Hydrological Resources* section of this document, and ranged from 401 to 2,646 mg/l.

Based on the stipulations and assumptions described earlier, relatively few impacts on aquatic resources would be expected from exploration activities on BLM-administered lands under Alternative A. However, short-term impacts on aquatic resources resulting from CBM exploration activities on BLM-administered lands would include increased sediment delivery to nearby drainages during runoff events. Fish passage would also be impeded if culverts or bridges are used to cross drainages and are inappropriately placed. In addition, there is the potential for the accidental spill or leakage and entry of petroleum products into drainages associated with vehicles using the access roads and present at exploration sites. Increased access and human presence during exploration activities also may result in some increased harvest of game fish. There would be no anticipated change in streamflow volumes or salinity caused by exploration activities since these activities would not discharge production waters into surface drainages. Any untreated waters from exploration would be placed in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed.

As noted in the earlier discussion of wildlife resources, nearly all of the stipulations for CBM activities on BLM lands do not apply to CBM activities on non-BLM lands (i.e., lands subject to state regulations). Therefore, the absence of stipulations that prohibit the occupancy or use of water bodies, floodplains, and riparian areas on lands subject to state regulations increases the likelihood that exploration activities within or immediately adjacent to these habitats would have a greater potential for impacting aquatic resources than on BLM-managed lands. These impacts would be in addition to those described in the preceding text for exploration activities on BLM lands. However, the magnitude of these impacts would probably still be minor because of the somewhat limited nature of exploration activities. There would continue to be the potential for increased sediment delivery, possible impedance of fish movements in streams, potential for accidental spills of petroleum products, and possibly increased fish harvest. However, there would be no effect on stream flow volume or salinity. In addition, as noted for exploration activities on BLM lands, there would be requirements for placing untreated exploration water in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed.

The State of Montana has stressed the importance of protecting high-value recreational fish populations that occur in drainages in the CBM-emphasis area. It is expected that the state would not allow exploration activities to be conducted in a manner that would impact these highly valued fisheries. They include trout fisheries and populations of other important species of game fish, particularly in those drainages in each county that have been judged by the State of Montana to support a resource of national renown and to have outstanding, high, or substantial fisheries resource values.

Under the No Action Alternative, CBM production would only occur on the CX Ranch, where there are no specific stipulations for CBM production activities. Because of this, potential impacts from the development of 250 producing CBM wells on the CX Ranch would generally include the same impacts that were described for exploration activities on lands subject to state regulations, although they would extend over a longer period of time.

The TDS concentration in CBM-produced water from the CX Ranch is about 1,400 mg/l, while Regele and Stark (2000) reported the average TDS concentration for the Tongue River is 284 mg/l. The resultant TDS concentration from discharging 3 cfs of production water (1,400 mg/l TDS) to the Tongue River with a flow of 39 cfs (284 mg/l TDS) would be 364 mg/l TDS. This represents an 80 mg/l increase in TDS over background levels, but it is still well below the TDS guideline of 1,000 mg/l associated with possible effects on fish. This would not be the case when there is very low or sometimes no background flow in the

Tongue River, as is the case during critical drought periods. Under the very worst-case conditions, the only flow in the river would theoretically consist of CBM produced water with a TDS concentration of approximately 1,400 mg/l that has been discharged to the river. While this TDS value would exceed the 1,000 mg/l TDS concentration associated with possible effects on aquatic organisms, it would be the only source of water in the drainage and probably provide at least some refuge for aquatic organisms until background flows return.

This same type of analysis can be done by evaluating the toxicity of produced water and the dilution effect of Tongue River water using bioassays and predictive modeling. However, the results of bioassays differ substantially from and show far fewer effects on aquatic organisms than suggested by predictive modeling. The Mount et al. (1997) model would predict that the produced water from the CX Ranch wells would be lethal to 100 percent of fathead minnows. Once the water is discharged to the Tongue River, the dilution would be such that there would be no increase in toxicity to fish in the river. The model would indicate that if there was no or very little dilution of this discharge by either flowing or standing river water, it would be toxic to fish and aquatic invertebrates.

Results of actual whole effluent toxicity (WET) testing using fathead minnows and a cladoceran (water flea), *Ceriodaphnia dubia*, showed far fewer or no mortalities than predictive modeling. A representative sample of effluent from Fidelity Exploration & Production Company coal bed natural gas wells that discharges to the Tongue River and of Tongue River receiving water collected immediately upstream of the effluent outfall were used in WET testing. Acute toxicity tests (96 hours for fathead minnows and 48 hours for *Ceriodaphnia*) were conducted at Energy Laboratories, Inc. (2001) in Billings Montana, from March 22 through March 26, 2001, in accordance with Region VIII EPA guidelines. Six dilutions were used during WET testing with percent effluent in each dilution at 0 percent (pure receiving water control), 12.5 percent, 25 percent, 50 percent, 75 percent, and 100 percent (pure effluent). The effluent passed the 50 percent mortality test for both species tested, indicating there would be no mortalities at equal parts of effluent (or less) and receiving river water. At effluent levels of 75 and 100 percent, fathead minnow survival after 96 hours was 85 percent and 60 percent, respectively. *Ceriodaphnia* survival after 48 hours at effluent levels of 75 and 100 percent was 95 and 80 percent, respectively (Energy Laboratories, Inc. 2001). These test results generally indicate some mortalities of fish and insects could occur when the volume of effluent constitutes more than 50 percent of the flow in a drainage.

The abandonment of exploratory and producing wells would have few, if any, direct or indirect impacts on aquatic resources. Activities that impact aquatic habitat and biota during CBM exploration and production phases would cease with CBM abandonment. Any associated long-term effects on aquatic resources from these discontinued activities, such as sediment delivery from roads, would gradually subside as disturbed areas are reclaimed.

Special Status Species

The federally endangered pallid sturgeon, two federal candidate species (Montana Arctic grayling, Warm Springs Zaitzevian riffle beetle), and two fish species (sicklefin chub, sturgeon chub) not warranted for federal listing but of significant concern to the U.S. Fish and Wildlife Service are present in portions of the project area. Also present in portions of the project area are eight BLM-sensitive and/or state fish species of special concern, including blue sucker, northern redbelly dace, finescale dace, paddlefish, pearl dace, shorthead sculpin, shortnose gar, westslope cutthroat trout, and Yellowstone cutthroat trout. Distribution of these species was described in Chapter 3 discussions of the affected environment for aquatic resources. Because of their scarcity or narrow habitat niche, these special status species may be somewhat more vulnerable to potential project effects than were described above for all aquatic resources. However, the potential for affecting any of the federally listed, candidate, significant concern, BLM-sensitive, or state species of concern would generally be similar to that described in the preceding text for other aquatic species, and would either be low or absent. For example, all water from exploration activities would be captured in tanks and not discharged to rivers. In addition, conditions of MPDES Permits would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. Some impacts could potentially occur, however, during extreme low or no flow conditions. Release of adequate quality water from production may improve habitat that has been degraded through water withdrawals. The range and type of other potential effects discussed above for aquatic resources also apply to special status species since they are a subset of aquatic resources. Special status species could be minimally affected through construction of stream crossings, erosion generated by construction

activities, and effects of other activities discussed above for aquatic resources.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. However, regulations mentioned above related to aquatic resources would be under the jurisdiction of Tribal Laws and not state or federal laws. If there were no CBM development on Tribal Lands, then there is expected to be minimal impacts on aquatic resources on the reservation. CBM development in Wyoming could impact surface waters on the reservation and could have an effect on aquatic life.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

BLM would develop, include, and enforce appropriate mitigation measures for aquatic resources, including special status species, during the site-specific, plan-approval stage. Measures to further avoid or reduce impacts in addition to those included at the plan-approval stage may be recommended. The state would apply additional mitigation measures on a case-by-case basis through the use of field rules. However, there are no specific mitigation measures identified at this time and they were not considered in the analysis.

Conclusions

Relatively few residual impacts on aquatic resources, including the special status species, would be expected from exploration activities on BLM-managed lands. Some minor, short-term impacts on aquatic resources on BLM lands may result from increased sediment delivery, possible impedance of fish movements in streams, potential for accidental spills of petroleum products, and possibly increased fish harvest. Residual impacts on aquatic resources from exploration activities on lands subject to state regulations would be similar to these impacts, although possibly slightly greater in magnitude because of the lack of stipulations prohibiting surface occupancy or use of water bodies, floodplains, riparian areas, and steep slopes. Expected impacts on aquatic resources on state-regulated lands would still be relatively minor because of the limited nature of exploration activities and their dispersed pattern over a large geographic area. Residual impacts from developing 250 CBM wells on the CX Ranch would include the same potentially minor kinds of impacts that were described for exploration activities on lands subject to state regulations, although they would extend over a longer period of time. The effects of discharging saline production water from these wells to the upper Tongue River drainage basin would cause river flow to increase from about 39 cfs to 42 cfs and river TDS concentration to increase from 284 mg/l to 364 mg/l. These increases would not be expected to impact aquatic habitat or organisms in the Tongue River. In addition, the conditions of the MPDES Permit would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. Discharges of CBM produced water during extreme drought conditions of no background flow (worst-case conditions) would probably provide some refuge for aquatic organisms, even though TDS concentration would be approximately 1,400 mg/l. There also could be some mortalities of aquatic organisms, as indicated by results of WET testing, under these extreme conditions. The abandonment of CBM wells would have few, if any, direct or indirect residual impacts on aquatic resources. Long-term effects on aquatic resources associated with discontinued activities, such as sediment delivery from roads, would subside as disturbed areas are reclaimed. Agency mitigation measures implemented during abandonment would reduce erosion potential, prevent water pollution, facilitate reclamation of disturbed lands, and further reduce the potential for long-term impacts on aquatic resources, including special status species.

This assessment considers the potential cumulative impacts on aquatic resources resulting from the effects of the No Action Alternative together with the effects from five coal mines, two minerals/metals mines, five existing power plants, four oil and gas refineries, and two manufacturing facilities that are present within the project area. The greatest potential for impacts on aquatic resources from these other projects is probably from coal mines, both through the direct loss of habitat and the degradation of water quality. Surface water quality near coal mines is impacted by increased sediment load because of increased erosion during mining. This is mitigated by the use of sediment settling ponds and the vegetation of overburden and topsoil storage areas. The discharge of groundwater pumped from mine pits also may affect surface water quality and quantity, depending on the quality of groundwater within the mine vicinity and the quantity of groundwater discharged. Aquatic resources associated with nearby springs and surface streams within the area would be impacted by the lowering of water tables. In some instances, mining activities impact aquatic resources by diverting streams or

drainage areas that are within the area to be mined. Original topography, including stream channels and drainage areas, are restored during mine reclamation activities. Some of these same types of impacts also may occur at minerals/metals mines, but would be less likely to occur at the power plant, oil and gas refinery, and manufacturing sites.

Other possible impacts on aquatic habitat and biota from these projects include sediment delivery from access roads located near drainages, loss of riparian habitat and function along streams, and reduction in water-based recreational activities such as fishing with the loss of aquatic habitat. The nature of effects on aquatic resources from these activities would be similar to those described for potential impacts under the No Action Alternative for CBM development. Most of these impacts would be limited in area given the generally localized nature of these other projects, and their effects are typically mitigated by following standard construction and operating procedures and BMPs and by implementing reclamation activities during or following project construction, operation, and/or abandonment. For these reasons, the effects from these other projects would not be expected to result in substantive cumulative impacts on aquatic resources potentially affected by CBM development.

Regele and Stark (2000) discussed some of the possible biological issues associated with CBM gas development in Montana, including the effects of pumping and discharging saline production water from CBM wells into surface drainages. They reported that much of the groundwater being produced from more than 3,000 CBM-producing wells in the Wyoming portion of the Powder River Basin is being discharged into rivers that flow directly into southeastern Montana. These include the Powder and Little Powder rivers and their tributaries. Some potential short-term and long-term CBM developmental effects identified by Regele and Stark (2000) include decreased surface water availability in some areas because of groundwater pumping; increased surface water flows in areas receiving CBM discharges in other areas; and water quality effects of CBM development discharges on waters and biota receiving the CBM discharges. However, Wyoming EISs and EAs found no decrease in surface water because of aquitards between production coals and surface waters.

The *Hydrology* impact analysis presented in this chapter evaluated the potential cumulative effects of full-scale CBM development and discharge of produced water to the Powder River Basin in Wyoming. That analysis recognized the substantial flow increases and associated hydrologic and water quality impacts that would occur in the Powder, Little Powder, and Tongue rivers in Montana as a result of those discharges. Impacts on aquatic habitat and biota from that magnitude of discharge also would be substantial. The *Hydrology* analysis noted, however, that the Wyoming DEQ and Montana DEQ have pledged to maintain water quality in these three rivers, and that surface water discharge permits limiting the quantity of CBM-produced waters that would be discharged would mitigate impacts from Wyoming CBM on Montana Rivers. This action also would mitigate the potential for cumulative impacts on aquatic resources from the effects of Wyoming CBM on Montana Rivers.

Alternative B

Most but not all of the same types of impacts on aquatic resources described for CBM activities under Alternative A (No Action Alternative) would occur under Alternative B. These impacts and some of their effects include the direct removal of aquatic and riparian habitat at stream crossings and near well sites, habitat degradation and loss from sedimentation, altered spawning and seasonal migration because of stream obstructions, direct loss of fish and aquatic invertebrates from accidental spills or pipeline ruptures releasing toxic substances and increased harvests of fish because of increased human access. The magnitude and geographic extent of these impacts would potentially be greater under Alternative B than Alternative A because of the activities associated with the development of an estimated 2,000 CBM exploration wells and 16,500 CBM production wells.

Impacts described under the No Action Alternative that are associated with the discharge of production water to drainages and resultant increases in stream flows and elevated levels of TDS and constituent contaminants would not occur under Alternative B. There would be a potential for the accidental spill, release, or seepage of production waters temporarily stored in holding ponds or tanks prior to their injection. However, as noted in the Water Resources impact analysis, berms around these facilities would be designed to contain and prevent the accidental runoff to nearby drainages of stored production waters, which should minimize the potential for impacting aquatic habitat and resources.

The *Hydrology* impact analysis indicates, based on the estimated groundwater depletions, those watersheds that may experience the greatest CBM development activity. The most active watersheds are projected to be the Little Bighorn and Lower Bighorn, Upper Tongue and Lower Tongue, Little Powder and Middle Powder, Mizpah, and Rosebud, where an estimated 14 to 50 percent of the groundwater resource within a

watershed would be depleted after 20 years. Even though few impacts on aquatic resources are projected under Alternative B, data on fish species present, fisheries management policies, and fisheries resource values would be used to identify those watersheds and drainages that are probably most sensitive to the effects of CBM development and should be monitored closely during CBM activities. Based on these fisheries criteria, drainages probably most sensitive to the effects of CBM development are the Lower Bighorn, Upper Tongue, and Little Bighorn. The Lower Bighorn and Upper Tongue are managed as trout fisheries and have high fisheries resource values, while the Little Bighorn is managed for warm/cool water fish species and trout, and has a moderate fisheries resource value. The Lower Tongue, Little Powder, and Rosebud are probably less sensitive from a fisheries perspective, being managed as non-trout or undesignated fisheries, but they have high to substantial fisheries resource values. The Mizpah is probably the least sensitive of these drainages, being managed as a non-salmonid (warm water) fishery with a moderate to limited fisheries resource value.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative B would generally be similar to those described in the preceding text for aquatic resources under this alternative. Many of these effects also would be similar to those described under Alternative A. However, they would be greater in magnitude and extent because of more exploration and production wells, and would primarily result from construction-related activities. No production water would be discharged to drainages under Alternative B and there would be no resultant potential for affecting special status species. The overall likelihood of affecting special status species would probably be low or absent, depending on species distribution. However, as noted for Alternative A, these species may be somewhat more vulnerable than the more commonly-occurring aquatic species because of their limited distribution, low abundance, and/or narrow habitat requirements.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. If there were no CBM development on Tribal Lands, then there is expected to be minimal impacts on aquatic resources on the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative.

Mitigation

The same agency mitigation measures described for Alternative A would apply to aquatic resources, including special status species, under Alternative B. The effect of these mitigation measures on impacts also would be the same as described for Alternative A. In addition, management features included in Alternative B would mitigate numerous potential impacts that otherwise might result from CBM development.

Conclusions

The types of residual impacts that would persist for Alternative B are the same as described for Alternative A, with the following two exceptions. Impacts would occur on a far greater scale under Alternative B than Alternative A. Also, no CBM-produced water would be discharged under Alternative B and there would be no potential for resultant residual impacts on aquatic resources including special status species, from that particular activity.

Cumulative impacts would be the same as described for Alternative A. In addition, the 1-mile-wide buffer around active coal mines under Alternative B would reduce the potential for cumulative groundwater drawdown impacts to result from coal mine projects.

Alternative C

Impacts on aquatic resources associated with Alternative C would include all of those CBM-related impacts described for Alternatives A or B, but they would be greater in magnitude. The intensity and geographic extent of CBM exploration, production, and abandonment under Alternative C would be the same as described for Alternative B. However, Alternative C emphasizes CBM exploration and development with minimal restrictions, and it would disturb many more acres than Alternative B. Alternative C also contains far fewer management prescriptions designed to avoid, minimize, or mitigate the impacts of CBM development activities on aquatic resources than Alternative B. Alternative C contains some restrictions that would reduce the potential for sediment delivery and resultant impacts, such as positioning roads, pipelines, and utility corridors where there are existing disturbances, and rehabilitating and closing new CBM-related roads following well

abandonment. However, unlike Alternative B, CBM exploration and production water would be discharged, untreated, onto the ground's surface where it would subsequently enter surface water drainages. There would be no requirement for injecting CBM production water into the ground. Discharged CBM water would be available for beneficial uses by industry and landowners.

The effects of increased TDS concentrations would probably be greater on the more sensitive species of salmonids in headwater mountain streams than on native fish species in prairie streams that have evolved in an environment of naturally higher TDS levels. In addition, sensitive species of salmonids and non-native warm water fish that have not evolved in highly saline water but that now reside in prairie streams also would be at risk. These species may be particularly vulnerable because TDS levels are generally already high in prairie streams, thereby increasing the potential for TDS-related impacts from CBM production.

Regele and Stark (2000) discussed impacts on aquatic resources resulting from CBM effects on drainage hydrology and water quality that would probably have the greatest likelihood of occurring under Alternative C. Impacts from reduced surface water availability include the reduction or loss of springs and flowing reaches of stream channels that provide habitat for native flora and fauna in southeastern Montana. Regele and Stark (2000) cited studies by the MFWP that recognized the importance of perennial and intermittent prairie streams in the life history of native fishes, by providing spawning and rearing habitat for mainstem fish species. The effects of increased flows from CBM discharges would include channel erosion, soils and vegetation loss, increased sediment load and sedimentation, and degraded water quality; these effects would directly and indirectly impact fish, amphibians, aquatic invertebrates, and algae. Also, if great enough, increased TDS and salinity levels in streams receiving CBM discharges would affect fish and aquatic invertebrates, especially those species not well adapted to high TDS levels, such as salmonids found in higher-elevation streams. Regele and Stark (2000) cited studies that showed TDS concentrations should not be increased above 1,200 micromhos if a water's "excellent biological health characteristics are to be preserved." The potential development of saline seeps down-gradient of CBM holding ponds also would affect aquatic resources present in streams receiving these saline discharges. Regele and Stark (2000) cited the MFWP, which concluded that because of the limited fisheries habitat available in the arid environment of southeastern Montana, great care must be taken where there is a potential to degrade aquatic resources.

The *Hydrology* impact analysis in this chapter estimated that 0.67 billion cubic feet of CBM water would be discharged to the Montana portion of Powder River Basin drainages each year. This is equivalent to an additional, total year-round basin flow of 21 cfs and assumes a 70 percent conveyance loss prior to discharges reaching drainages. The *Hydrology* impact analysis showed that resultant flow increases over base flows would average less than 1 percent in most of the Powder River Basin drainages. The largest percent base flow changes would occur in the Little Powder and Rosebud drainages, which are managed as non-trout, undesignated fisheries and have high or substantial fisheries resource values. Rosebud Creek has been proposed to be classified as a cold water fishery by the Northern Cheyenne Tribe. It supports northern pike and rainbow trout (FWS 1980). This additional volume of water would not be expected to impact larger drainages, but it would impact smaller perennial, intermittent, and ephemeral drainages, especially if peak discharges of CBM water to smaller drainages greatly exceed this annual average. Water quality would be impacted much more than water quantity from CBM discharges because of the considerably higher TDS and constituent contaminant concentrations typically found in CBM-produced water than in surface drainages. The *Wildlife* impact analysis in this chapter notes that the potential for impacting water quality by discharging CBM production water with high salinity and sodicity would be greatest in smaller perennial and intermittent drainages during low-flow periods of the year. The effects of high TDS and constituent contaminant concentrations on aquatic organisms were discussed under Alternative A.

Surface discharges of CBM-produced water would be subject to Montana DEQ MPDES Permit requirements and limitations for discharge into identified watersheds. The volume of CBM production water potentially discharged to the Powder River Basin drainages in Montana that were listed in the *Hydrology* impact analysis has a greater potential for causing sediment, flow, and water quality-related impacts on aquatic resources than the effects of Alternatives A or B. However, these effects would be within the range of acceptable limitations stipulated under the various MPDES Permits that would have to be issued under Alternative C. For this alternative to be viable, conditions of the MPDES Permits must be able to provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges.

Special Status Species

The types of impacts and potential project effects on federally listed, candidate, significant concern, BLM-sensitive, and state species of concern under Alternative C would generally be similar to those described in the preceding text for aquatic resources under this alternative. Special status species would potentially be affected by changes in the quantity and quality of receiving waters from discharges of CBM-production water, construction of stream crossings, erosion generated by construction activities, and effects of other activities discussed above for aquatic resources. Since production water will not be held in tanks or improved in quality, that which reaches the Tongue, Little Powder, and Powder Rivers would likely have increased SAR values that could affect the quantity and quality of receiving waters, especially during low or no flow conditions, as well as food sources for special status species. One special status species possibly present in downstream reaches of several of these drainages and found in the Yellowstone River within the Powder River RMA that is potentially at risk is the federally-listed, endangered pallid sturgeon. Other special status species occupying similar habitat types in these particular waters also may be at risk. There also is the potential for affecting the two federal candidate species (Montana Arctic grayling and the Warm Springs zaitzevian riffle beetle) because of the nature of CBM exploration and development activities that would occur under Alternative C. However, the likelihood of risk is probably low because grayling are generally found at relatively high, cold headwater locations in the Gallatin River and the Clarks Fork within the project area, and the riffle beetle is found in a single warm spring near the City of Bozeman. Minimizing or avoiding activities in these specific areas to the extent possible would minimize the potential for affecting these candidate species.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The same agency mitigation measures described for aquatic resources, including special status species, under Alternative A would apply to Alternative C. The effect of these mitigation measures on impacts also would be the same as described for Alternative A. In addition, several management features included in Alternative C would mitigate some of the potential impacts that otherwise might result from CBM development.

Conclusions

The types of residual impacts that would persist for Alternative C are the same as described for Alternative A, but they would occur on a far greater scale. In addition, a large volume of CBM-produced water would be discharged under Alternative C and there would be a potential for resultant residual impacts on aquatic habitat and organisms, including special status species, from that particular activity. One of the most noteworthy potential effects of this alternative on special status aquatic species would be possible risks to the endangered pallid sturgeon.

Cumulative impacts would be the same as described for Alternative A. Unlike Alternative B, there would be no buffers around active coal mines or Indian reservations to minimize the potential for inter-related effects.

Alternative D

Impacts on aquatic resources associated with Alternative D would include all of those CBM-related impacts described for Alternatives A and/or B, but they would be greater in magnitude. The intensity and geographic extent of CBM exploration, production, and abandonment under Alternative D would be the same as described for Alternative B. However, Alternative D encourages CBM development while maintaining existing land uses and protecting downstream water consumers. Alternative D, like Alternative B, contains a number of management prescriptions designed to avoid, minimize, or mitigate the impacts of CBM development activities on aquatic resources. However, unlike Alternative B, CBM-produced water (depending on water quality) would be treated, prior to its discharge or storage in holding facilities, so that the effluent meets standards established by the Montana DEQ for downstream uses. Beneficial uses of produced water would be allowed and treatment would vary based on industrial, municipal, and agricultural uses. Treated, produced water would be discharged to drainages by pipeline or constructed watercourses to avoid the potential for erosion and sediment-related impacts on aquatic resources. The treatment of produced water prior to its discharge to surface drainages through constructed facilities would greatly reduce the potential for

elevated TDS, salinity, and sodicity levels described for Alternative C.

The *Hydrology* impact analysis estimated that 2.24 billion cubic feet of CBM water would enter the Montana portion of Powder River Basin drainages each year. This is equivalent to an additional, total year-round basin flow of 71 cfs and assumes no conveyance losses because of the use of pipelines or constructed water courses to convey discharges. The *Hydrology* impact analysis showed that resultant flow increases over base flows would average 1 percent in Powder River Basin drainages. The greatest increase in base flows (approximately by a factor of 4) would occur in the Little Powder and Rosebud drainages, which would impact aquatic habitat and organisms through the same mechanisms described under Alternative A. This volume of water would not be expected to impact larger drainages, but it would impact other smaller perennial, intermittent, and ephemeral drainages, especially if peak discharges of CBM water to smaller drainages greatly exceed this annual average. Otherwise, water quality of these streams would not be impacted by discharged water since it would have been treated. As noted for Alternatives A, B, and C, conditions of the MPDES permits issued under Alternative D must be able to provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative D would generally be similar to those described in the preceding text for aquatic resources under this alternative. Many of these effects also would be similar to those described under Alternatives A and B, except they could be greater in magnitude because of the discharge of treated production water to drainages under Alternative D. Special status species potentially most vulnerable to project-related effects would include those in smaller perennial and intermittent drainages within the Powder River Basin. The overall likelihood of affecting special status species would probably be low or absent, depending on species distribution. However, as noted for the other alternatives, special status species may be somewhat more vulnerable than the more commonly-occurring aquatic species because of their limited distribution, low abundance, and/or narrow habitat requirements.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Mitigation

The same agency mitigation measures described for Alternative A would apply to aquatic resources, including special status species, under Alternative D. The effect of these mitigation measures on impacts also would be the same as described for Alternative A. In addition, management features included in Alternative D would mitigate numerous potential impacts that otherwise might result from CBM development.

Conclusions

The types of residual impacts that would persist for Alternative D are the same as described for Alternative A, with the following two exceptions. Impacts would occur on a far greater scale under Alternative D than Alternative A. Also, CBM production water discharged under Alternative D would be treated and there would be no potential for residual water quality impacts on aquatic resources, including special status species, from that particular activity.

Cumulative impacts would be the same as described for Alternative A. In addition, the 1-mile-wide buffer around active coal mines under Alternative D would reduce the potential for cumulative impacts to result from coal mine projects.

Alternative E (Preferred Alternative)

Impacts on aquatic resources associated with Alternative E (the Preferred Alternative) would generally be comparable to the CBM-related impacts described for Alternative B, which emphasizes the protection of natural and cultural resources. The objective of Alternative E is to manage CBM development in an environmentally sound manner. To meet this scope, Alternative E contains requirements designed to protect hydrologic resources by combining management options of CBM-produced water so that no degradation of water quality would be allowed in any watershed. CBM operators would be required to develop a Water Management Plan as part of their

overall Project Plan that describes how impacts on surface resources would be minimized or mitigated, and how a discharge (if proposed by the operator) could occur without damaging the watershed-in accordance with a required and approved NPDES Permit and water quality laws. The lack of transportation corridor requirements under Alternative E would result in greater surface disturbances and possibly increased sediment delivery to nearby drainages compared to Alternative B. However, because of the overall beneficial effect of protective measures, relatively few impacts on aquatic resources would be expected under Alternative E. Aquatic resources in the same watersheds and drainages identified under Alternative B as being most sensitive to CBM development also should be monitored closely during CBM activities under Alternative E.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative E (the Preferred Alternative) would generally be similar to those described in the preceding text for aquatic resources under this alternative. Requirements designed to protect hydrologic resources by combining management options of CBM-produced water so that no degradation of water quality would be allowed in any watershed would benefit special status species. The lack of transportation corridor requirements under this alternative would result in comparatively greater surface disturbances than under Alternative B and possibly increased sediment delivery to nearby drainages. However, because of the overall beneficial effect of protective measures, relatively few impacts on special status species would be expected under Alternative E. The same watersheds and drainages identified under Alternative B as being most sensitive to CBM development also should be monitored closely during CBM activities under Alternative E.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E. To determine potential impacts to the Crow Reservation, monitoring wells would be installed during the exploration phase on all BLM-administered oil and gas estates that adjoin reservation boundaries in Montana. If monitoring indicates drawdown would occur on the reservation, mitigation such as the operator providing a hydrologic barrier, communitization agreement, or spacing that would protect Indian minerals from drainage, would be required.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this Alternative. The same monitoring and mitigation procedures would be used for the Northern Cheyenne Reservation.

Mitigation

The same agency mitigation measures described for Alternative A would apply to Alternative E. The effect of these mitigation measures on impacts also would be the same as described for Alternative A. In addition, management features contained in Alternative E, including the overall Project Plan and the Water Management Plan, would mitigate or minimize numerous potential impacts on aquatic resources, including special status species, that otherwise might result from CBM development.

Conclusions

The types of residual impacts that would persist for Alternative E are similar to those for Alternative B. These impacts would be essentially the same as described for Alternative A, except that impacts would occur on a far greater scale and there would be no potential for resultant residual impacts on aquatic resources, including special status species, associated with the disposal of CBM-production water.

Cumulative impacts would be the same as described for Alternative A. As with current management, there would be no buffer zone for CBM production around active coal mines.

Comparison Table for Alternatives Impacts

Table 4-19 summarizes, by alternative, the impacts resulting from the management objectives, which were described in Chapter 2.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Air Quality	• Alternative A represents minimal number of wells and associated equipment. Air impacts to wilderness areas, Tribal lands, and other PSD Class I areas would be below all applicable air quality standards.	• Alternative B would result in lower emissions than Alternative C.	• Alternative C would result in emissions of NO_X, CO, VOC, SO_2, methane, and PM-10. These emissions would not exceed any applicable air quality standards.	• Alternative D would result in lower emissions than Alternative C.	• Alternative E would result in lower emissions than Alternative C. • Impacts would be reduced following the mitigation measure described in the Air Quality and Climate section, *Alternative C* discussions.
Cultural Resources	• An estimated 17 cultural resource sites would be disturbed, with four of these sites being impacted from exploration activities in state planning areas; six being impacted from production activities at CX Ranch; and seven being impacted from exploration activities in BLM planning areas. • One to two of these sites could be found eligible for the National Register of Historic Places.	• An estimated 629 cultural resource sites would be disturbed, with 16 sites being from exploration activities in state planning areas, 335 from production activities in state planning areas, 10 from exploration activities in BLM planning areas, and 269 from production activities on BLM planning areas. • Of these sites, 119 to 170 could be found eligible for the National Register of Historic Places.	• Similar to Alternative B with the following exceptions: transportation corridors are not required thereby increasing the number of disturbed acres; power lines may be aboveground or buried, which would decrease the number of disturbed acres; and discharge of produced water may be directly to the ground, which would increase erosion.	• Same as Alternative B.	• The estimated number of cultural resources disturbed under Alternative E would be similar to those in Alternative B. • Impacts to important sites would be mitigated as described under the Cultural Resources section, *Impacts From Management Common to All Alternatives*.
Environmental Justice	• No adverse impacts with the exception of the undetermined Wyoming discharge influence. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.	• No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana river's would constitute a potential environmental justice issue if unresolved. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.	• Same as B except for adverse environmental effects would be expected from downstream water quality changes resulting in limitations to subsistence living styles. These limitations would fall disproportionately on minority or low-income populations from this alternative. Wyoming Discharge issues same as Alternative B.	• It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative. Wyoming Discharge issues same as Alternative B.	• Same as Alternative C. • Impacts would be mitigated as described under the Environmental Justice section, *Alternative A* and by implementation of the Project Plan requirements.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Geology and Minerals	• Federal: – Only minor loss of CBM during Testing operations. • State: – Irretrievable commitment of CBM resources from production on state planning areas. – Prevention of conventional oil and gas development, coal mining, and surface mineral mining because of surface facilities and producing wells on CBM sites. – CBM production dewatering at nearby coal seams, which can cause underground coal fires, methane seeps, and the liberation of methane to water wells. – The presence of shallow CBM production would prevent the performance of seismic prospecting for conventional oil and gas reservoirs. • Cumulative Impacts: – Reduction in Coal resources from current and planned surface mine operations. – Drawdown of groundwater from Wyoming CBM operations, up to 14 miles north into Montana. – Potential CBM drainage along Wyoming Montana State Line.	• Federal: – Same as for the State under Alternative A but increased in magnitude and complexity to reflect full-field development. – Potential mineral drainage between Federal mineral estates and state and private developments depending on site-specific conditions. • State: – Same as Alternative A but increased in magnitude to reflect full-field development. – Mineral drainage issues same as for Federal under this alternative. • Cumulative Impacts: Same as Alternative A.	• Federal: – Same as Alternative B. • State: – Same as Alternative B. • Cumulative Impacts: Same as Alternative A.	• Federal: – Same as Alternative B. • State: – Same as Alternative B. • Cumulative Impacts: – Same as Alternative A.	• Federal: – Same as Alternative B. • State: – Same as Alternative B. • Cumulative Impacts: – Same as Alternative A. • Impacts would be mitigated following the measures outlined in the Geology and Minerals section, *Impacts From Management Common to All Alternatives.*

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Hydrological Resources	• Federal: – No impacts to surface or groundwater resources. • State: – Minor increase in surface water flow and quality changes in the Tongue River. – Groundwater drawdown within the vicinity of the CX ranch project up to 14-miles. • Cumulative Impacts: – Wyoming's discharge of CBM production water would increase surface water flow in Montana rivers depending on the season between 8 to 70 times. – Wyoming's discharge of untreated CBM production water would alter surface water quality by increasing SAR levels to between 5 and 17 depending of the drainage system. – Drawdown of groundwater from Wyoming CBM operations, up to 14 miles north into Montana.	• Groundwater: – Groundwater drawdown in Powder River Basin watersheds from 14 to 50%, less in isolated developments across the state. Average represented as 14-miles from edge of field development. – No impacts to groundwater quality foreseen. • Surface Water – Surface water quality changes limited to accidental spills and ruptures due to injection control. – No substantial increase in surface water flow due to injection control. • Cumulative Impacts: – Wyoming impacts same as Alternative A. Full-scale Production will further drawdown Montana groundwater aquifers.	• Groundwater: – Same as Alternative B. – Potential impacts to groundwater quality from impoundment infiltration and surface discharge of untreated production water. • Surface Water – Surface water quality degradation from surface discharge of production water resulting in increased SAR values, increased TDS and other constituents. – Increased surface water flow causing riparian erosion, changes in water courses and increased sedimentation. • Cumulative Impacts: – Impacts to surface water and groundwater from Wyoming are similar to Alternative A. These coupled with Montana's full –scale production would increase aquifer drawdown and decrease surface water quality due to discharge.	• Groundwater: – Same as Alternative B. – Reduced likelihood of impacts to groundwater quality due to treatment requirement prior to discharge. • Surface Water – Surface water quality degradation reduced from treatment requirement prior to discharge. – Increased surface water flow causing riparian erosion, changes in water course and increased sedimentation. – Increased availability of surface water for irrigation and other downstream beneficial uses. • Cumulative Impacts: – Same as Alternative B, however added discharge volumes will further impact riparian areas.	• Groundwater: – Same as Alternative B. – Potential impacts to groundwater quality from impoundment infiltration and surface discharge of untreated production water. • Surface Water – Surface water quality degradation from surface discharge of production water resulting in increased SAR values, increased TDS and other constituents. – Increased surface water flow causing riparian erosion, changes in water courses and increased sedimentation. – Added management options could reduce surface water discharge and thereby, reduce surface water quality impacts. • Cumulative Impacts: – Same as Alternative C but dependent on WDEQ/MDEQ Water Quality Agreement and MDEQ non-degradation numerical standards. • The project plan will discuss how impacts would be mitigated. See also Mitigation subsections described under Hydrological Resources in Chapter 4.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

	Alternative A	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural	Alternative C Emphasize Coal Bed Methane	Alternative D Encourage Exploration and Development While Maintaining	Alternative E
Indian Trust Assets	• No measurable Indian trust impacts are expected from the CBM activities planned under this alternative in Montana. • Cumulative Impacts: – Reduction in Coal resources from the Absaloka Mine operation. – Surface water quality and quantity impacts from Wyoming CBM development. – Drawdown of groundwater from Wyoming CBM operations, up to 14 miles inward on the Crow Reservation. – Potential CBM drainage along southeastern corner of Crow Reservation from Wyoming operations.	• Federal: – Groundwater drawdown beyond the 2-mile buffer zone into Reservation Lands, somewhat delayed due to buffer zone. – No surface water quality impacts foreseen. – Potential CBM drainage, dependent on specific site conditions, delayed by buffer zone. • State: – Groundwater drawdown up to 14-miles inward from reservation boundaries. – Limited short-term surface water impacts from spills and ruptures adjacent to Reservations. – Potential CBM drainage, dependent on specific site conditions, no delay due to adjacent development. • Cumulative Impacts: – Same as Alternative A. – Reduction of CBM resources if developed by Tribes, coupled with land disturbances and compounded water impacts.	• Federal: – Groundwater drawdown up to 14-miles inward from reservation boundaries. – Surface water quality and quantity impacts. – Potential CBM drainage, same as Alternative B. • State: – Groundwater drawdown same as Alternative B. – Surface water quality and quantity impacts. – Potential CBM drainage, same as alternative B. • Cumulative Impacts: – Same as Alternative B.	• Federal: – Groundwater drawdown same as alternative B. – Surface water quality impacts reduced by source treatment, increased availability of surface waters for irrigation and other beneficial uses – Increased surface water flow resulting in increase riparian erosion. – Potential CBM drainage, same as Alternative B. • State: – Groundwater drawdown same as Alternative B. – Surface water quality impacts reduced. – Potential CBM drainage, same as alternative B. • Cumulative Impacts: – Same as Alternative B.	• Federal: – Effects from groundwater drawdown lessened due to hydrologic barrier. – Surface water quality impacts reduced by source treatment, increased availability of surface waters for irrigation and other beneficial uses – Increased surface water flow resulting in increase riparian erosion. • State: – Groundwater drawdown same as Alternative B. – Surface water quality impacts reduced. • Cumulative Impacts: – Same as Alternative B. • Measures to reduce or mitigate the impacts are found in the Indian Trust section under *Alternative B*. The Project Plan would also address how effects would be mitigated.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Lands and Realty	• Federal: – Minimal land area displaced by roads. • State: – Increased motorized access on the CX Ranch. – Increase motorized trespass.	• Federal: – Increase fire hazard and motorized access during 20-year lease. – Limit public access. – Disrupt active logging operations. • State: – Displace agricultural lands. – Disrupt irrigation system, increase cost of farm operation. – Reduced property values. – Displace community and residential growth. – Increase dust and noise impacts on residential. – Increase cost of county road maintenance. – Increase long-term motorized access. – invite illegal trespass activities. – Increase forest pests. – Disrupt active logging operations. – Increase motorized trespass.	• All impacts in Alternative B occur in Alternative C in addition to: – Impacts to adjacent mining operations and Tongue River railroad project. – The land use displacement from roads and utility lines during the 20-year lease is greatest in Alternative C.	• All impacts in Alternative B occur in Alternative D in addition to: – Federal: Permanent loss of land use from road network. – State: Production water sodicity and salinity impacts to crops, subsurface impacts to neighboring domestic wells.	• Same as Alternative C. • Impacts would be mitigated as described in the Lands and Realty section under Alternatives B and C. • Impacts from powerlines and not requiring transportation corridors would be the same as Alternative A. • Effects to access would be the same as Alternative D.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Livestock Grazing	• Exploration wells located within BLM-permitted rangelands would result in the temporary loss of 69 AUMs • State: – The exploration wells and production wells located at CX Ranch would result in a maximum construction loss of 272 AUMs on state and private rangelands. – Re-vegetating parts of the well pads during production would reduce the state-permitted losses to 194 AUMs.	• Exploration wells would result in the temporary loss of 413 AUMs (BLM 163, State 250), production wells would result in a maximum construction loss of 11,960 AUMs (BLM 4,770, State 7,190). • Re-vegetating parts of the well pads during production would reduce the losses to 6,904 AUMs (BLM 2,484, State 4,420). • If all Alternative requirements were utilized fully, the area of surface disturbances could be reduced by an additional 35 percent during construction and 40 percent during production.	• Impacts to livestock grazing would be similar to Alternative B. • Additionally, suitable CBM discharge water could be used for livestock watering; increased erosion would result in increased surface disturbance to livestock, which would lead to disrupted grazing patterns, undermined fencing, and reduced forage; an increase of noxious weeds and a decrease in forage material would occur if discharged produced water is too high in saline content; and possible health effects if livestock consume produced water that is unacceptable.	• Impacts would be similar to Alternative C with some exceptions: impacts from drilling and collocation of wells would be the same as Alternative B. • Transportation corridor and road impacts would be similar to Alternative B. • There would be a reduction to forage losses from increased land application of produced water; and there would be less soil and forage loss from erosion of soils.	• Impacts to livestock grazing would be similar to Alternative B. Additionally, suitable CBM discharge water could be used for livestock watering. • Transportation corridor impacts would be the same as Alternative D. • Forage losses would be the same as Alternative D. • Impacts would be mitigated following methods outlined in the Livestock Grazing section, *Impacts From Management Common to All Alternatives*.
Paleontological Resources	• It is unlikely that any of the 12,485 acres that would be disturbed during development would contain noteworthy paleontological resources. The 575-acre Bridger Fossil Area ACEC (only paleontological resource) would not be disturbed. • Other impacts would include vandalism and removal of fossils by amateur fossil collectors resulting from increased accessibility to remote areas.	• Same as Alternative A, except increased access would include increased vandalism and removal of fossils by amateur fossil hunters.	• Same as Alternative B.	• Same as Alternative B.	• Same as Alternative B. • Impacts would be mitigated as described under the *Impacts From Management Common to All Alternatives* subsection, under Paleontological Resources.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Recreation	• Loss of land for recreation purposes, and the disruption to recreation activities • Exploratory activities such as drilling and testing would temporarily displace game species locally	• Impacts would be similar to Alternative A with the addition of more opportunities for Increased access to remote areas	• Impacts would be similar to Alternative B with the exception that increased erosion could lead to a reduced amount of land available for recreation activities and could disrupt habitat for game species.	• Impacts would be similar to Alternative B.	• Impacts would be similar to Alternative B with the exception that no requirements for transportation corridors could increase access to remote areas. • Impacts would be mitigated as described under the *Impacts From Management Common to All Alternatives* subsection.
Socio-Economics	• No social impacts (only small changes in employment, population, demand for services, etc.). • Small impact on economic conditions as a result of new production wells.	• Social impacts would include new jobs and new population moving to the area. • Economic impacts include generation of new personal and government income. • Additional disposal costs associated with injection of production water. • Additional demands on public services.	• Social impacts same as Alternative B, with increase in impacts on lifestyles and values. • Economic impacts same as Alternative B, with increase in impacts to water resource users.	• Social impacts same as Alternative B, with small increase in impacts on lifestyles and values. • Economic impacts same as Alternative B, with small increase in impacts to water resource users.	• Social impacts same as Alternative B, with the exception that public burden to maintain roads may increase depending on landowner access decisions. • Economic impacts same as Alternative B, except that oil and gas income may be less depending on water treatment costs. • Impacts would be mitigated as described under the Alternative A, *Mitigation* subsection.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Soils	• There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities. • During exploration, 675 acres of state, private, and BLM lands will be disturbed, with 812 acres of state lands disturbed for production. • 500 acres would be disturbed longer term during production, with a majority of the land reclaimed after production is ceased.	• Soil disturbances could be reduced by 35 percent or higher over Alternative A. • During exploration, 1,850 acres of state, private, and BLM lands will be disturbed, with 35,100 acres of BLM and state lands disturbed for production. • 17,450 acres would be disturbed longer term during production, with a majority of the land reclaimed after production is ceased. • No impacts will be made to soils from CBM waters.	• Impacts would be similar to Alternative B, except that the surface disturbances would not be able to be decreased by up to 35 percent and surface discharge and irrigation of produced water would increase detrimental impacts to soils. • One favorable side effect would be that more water would be available for irrigation if acceptable agricultural land is available, but if acceptable qualities of water are not used, there could be an increased detrimental impact on additional soils.	• Impacts would be similar to Alternative B with the exception that produced water would be treated prior to discharge onto the surface and not injected, which would reduce the detrimental impacts caused by application of high-SAR water to soils.	• Impacts would be similar to Alternative B, however there maybe increased disturbance to surface acres do to increased use of impoundments depending on the discharge strategies used. • Impacts would be mitigated as described under the *Impacts From Management Common to All Alternatives* subsection.
Solid and Hazardous Wastes	• Typical solid waste refuse can be disposed of in local landfills. • Drilling mud and cuttings can be disposed of onsite with the landowner's permission, but most would be hauled offsite to a commercial disposal facility. • Impacts would also occur from the use of pesticides and herbicides during access and construction activities.	• Same as for Alternative A, but with larger quantities of waste.	• Same as for Alternative B.	• Same as for Alternative B.	• Same as For Alternative B. • Impacts would be mitigated following the methods discussed under the *Impacts From Management Common to All Alternatives* subsection.

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Vegetation	• As much as 970 acres of native habitat will be permanently impacted under this Alternative, more than half (580 acres) in grasslands. • Potential loss of plant diversity with reclamation. • On non-federal land, Ute ladies'-tresses may be impacted by disturbance.	• As much as 50,158 acres of native habitat could be impacted under this Alternative, more than half (26,962 acres) in grasslands. • Potential loss of plant diversity with reclamation. • On non-federal land, Ute ladies'-tresses may be impacted by disturbance.	• As much as 67,426 acres of native habitat could be impacted under this Alternative, more than half (34,345 acres) in grasslands. • If SAR values exceed 10 in water, riparian vegetation will be impacted, affecting as many as 3,535 acres of riparian habitat. • Potential loss of plant diversity with reclamation. • On non-federal land, Ute ladies'-tresses may be impacted by disturbance, SAR values, and water level changes, particularly inundation.	• As much as 50,158 acres of native habitat could be impacted under this Alternative, more than half (26,962 acres) in grasslands. • Hydrology changes may affect as much as 2,776 acres of riparian habitat. • Potential loss of plant diversity with reclamation. • On non-federal land, Ute ladies'-tresses may be impacted by disturbance and water level changes, particularly inundation..	• Impacts would be similar to those for Alternative C. • Impacts would be mitigated as described under the *Impacts From Management Common to All Alternatives* subsection. • The Project Plan would also address mitigation of effects.
Visual Resource Management	• Federal: – Impacts to VRM Class III and IV only. • Federal and State: – Dust emissions will reduce visibility. – Well pads, roads, and compressors will disrupt the visual landscape long-term. – Drill rigs, two-track trails, heavy road-making equipment, and generators will disrupt the visual landscape short-term.	• Type of impacts common to Alternative A will occur with Alternative B, though at a much greater scale. • View shed impacts from road network will last for 20 years and then reclaimed.	• Impacts common to Alternative B will occur with Alternative C, in addition to the following: • Above ground powerlines will greatly impact skyline and viewshed. • Visual impacts from roads and utility lines is greatest with this alternative until reclamation.	• Impacts common to Alternative B will occur with Alternative D, in addition to the following: • Production related roads will not be reclaimed and will become a permanent visual impact.	• Impacts would be similar to those for Alternative C, except the operator must specify mitigation measures in the Project Plan. • Impacts would be mitigated as described under the Alternative B, *Mitigation* subsection .

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Wilderness Study Areas	• BLM leasing restrictions are designed to protect WSAs from substantial impact by prohibiting leasing of these lands for resource extraction. • Because there would be no production activities in BLM planning areas under this alternative, there would be no impacts.	• Same as Alternative A.	• Same as Alternative A.	• Same as Alternative A.	• Same as Alternative A. • Laws and regulations established for WSAs prohibit leasing of WSAs designated lands for resource extraction.
Wildlife	• Direct and indirect impacts would occur at a level commensurate with the level of CBM development. • Direct impacts include habitat loss, death from vehicle collisions, and effects associated with greater human access into previously untraveled areas. • Indirect impacts on wildlife include disturbance and displacement, stress, power lines, noxious weed invasion, user-created roads, habitat fragmentation, water quality degradation from road runoff, and increased livestock grazing. • Indirect impacts on wildlife would occur on 33,840 to 84,000 acres. • Through mitigation, this Alternative should not directly impact any T&E listed wildlife species.	• Same as Alternative A but on a much larger scale. Twenty-five times as many wells, roads, and utility corridors as under Alternative A. • 6,680 miles of roads (2.9 to 8.8 miles per square mile). • 20,697 miles of utility corridors (9 to 27.1 miles per square mile). • Indirect impacts to wildlife on 884,000 to 4.7 million acres. • Additional types of impacts include loss of high value habitats such as prairie dog towns, sage grouse leks, and big game winter range. • Loss of springs and intermittent streams and associated wildlife habitat because of groundwater withdrawal.	• Same as Alternative B plus: – 9,018 miles of roads (3.9 to 11.9 miles per square mile). – 27,917 miles of utility corridors (12.2 to 36.6 miles per square mile). – Indirect impacts to wildlife on 884,000 to 4.7 million acres. – Discharge of untreated CBM water into drainages would impact riparian and wetland habitat and associated species because of poor water quality and erosion – Increased livestock grazing within 2 miles of CBM discharges that occur in areas without summer water	• Same as Alternative B plus: – Discharged treated CBM water would erode riparian and wetland habitat – Increased livestock grazing within 2 miles of CBM discharges that occur in areas without summer water – Through mitigation, this Alternative should not directly impact any T&E listed wildlife species. – Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, are greater than under Alternative A because of the increased number of CBM wells permits, but less than Alternative C.	• Same as Alternative C. • Measures to reduce or eliminate these effects are found in the DNRC TLMD lease stipulations, BLM standard lease stipulations and in the MBOGC field rules. These mitigations measures are described throughout the Wildlife section (See Table 4-16 and the *Species of Concern Mitigation Measures* subsection).

TABLE 4-19
COMPARISON SUMMARY OF IMPACTS

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Wildlife (cont'd)	• Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, are less with this Alternative because of the limited number of CBM wells permitted. • All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads.	• Through mitigation, this Alternative should not directly impact any T&E listed wildlife species. • Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, are greater than under Alternative A because of the increased number of CBM wells permits, but less than C or D because of restricting utilities and roadways to the same corridor. • All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment and by increased access through increased roads.	– Through mitigation, this Alternative should not directly impact any T&E listed wildlife species. – Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, are greater under this Alternative than any other because of the increased number of CBM wells permits. – Potential indirect impacts to T&E species from changes in riparian habitat due to increased SAR values and hydrology are likely to occur under this Alternative. Bald Eagles and Interior Least Terns may also be affected if SAR changes affect forage fish. – All species of concern not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, and/or by changing streambed hydrology and increased SAR and salinity values in water and soil. – More water would be available for wildlife.	– Potential indirect impacts to T&E species from hydrology changes caused by increased water levels may impact nesting Interior Least Terns. If hydrology changes from surface water runoff, cause riparian vegetation changes, other T&E species may be impacted as well, such as nesting Bald Eagles. – All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, and/or by changing streambed hydrology.	

TABLE 4-19
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Resource Topic	Alternative A No Action (Existing Management)	Alternative B Emphasize Soil, Water, Air, Vegetation, Wildlife and Cultural Resources	Alternative C Emphasize Coal Bed Methane Development	Alternative D Encourage Exploration and Development While Maintaining Existing Land Uses	Alternative E (Preferred)
Wildlife (Aquatic Resources)	• Minor short-term impacts on aquatic resources during CBM exploration and production may result from increased sediment delivery and its effects on aquatic habitat and organisms, possible impedance of fish movements, potential for accidental spills of petroleum products, and possibly increased fish harvest. • Relatively minor long-term increases in river flow and TDS concentration from production water discharge would not be expected to impact aquatic resources. • Conditions of MPDES Permits would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. • Impacts from CBM abandonment would be minor and subside over time.	• The same types of impacts described for Alternative A (No Action) would occur under Alternative B, except as noted in the following two bullets. • The scale of potential impacts associated with sediment delivery, fish movements, petroleum spills, and fish harvest would be much greater under Alternative B because of the development of over 18,000 CBM wells across a much larger geographic area. • No CBM production water would be discharged to surface drainages under Alternative B and there would be no potential for impacting aquatic resources from this particular activity. • Based on fish species present, fisheries management policies, fisheries resource values, and the projected intensity of CBM development, the drainages most sensitive to the effects of CBM development would be the Lower Bighorn, Upper Tongue, and Little Bighorn; then the Lower Tongue, Little Powder, and Rosebud; followed by the Mizpah. • The potential for affecting aquatic resources in sensitive drainages would be less under Alternative B than under Alternatives C or D.	• The same types of impacts described for Alternative A would occur under Alternative C, but they would occur on a far greater scale because of the development of over 18,000 CBM wells. • A total of 0.67 billion cubic feet of untreated CBM production water would be discharged to drainages each year. Resultant flow and TDS increases could potentially impact aquatic organisms, especially in smaller drainages during dry times of the year. • Conditions of MPDES Permits would provide legally enforceable assurances preventing the degradation of water quality, aquatic resources, and the beneficial uses of receiving waters. • The potential for affecting aquatic resources in the sensitive drainages would be greater under Alternative C than under Alternatives B or D.	• The same types of impacts described for Alternative A would occur under Alternative D, but they would occur on a far greater scale because of the development of over 18,000 CBM wells. • The annual discharge of 2.24 billion cubic feet of treated CBM production water through pipelines or constructed water courses and resultant flow increases could impact aquatic resources in smaller drainages during dry times of the year. • The treatment of CBM production water prior to its discharge would greatly reduce the potential for elevated TDS and salinity impacts on aquatic resources. • MPDES Permits would provide legal assurances that water quality, aquatic resources, and beneficial uses of receiving waters would be protected. • The potential for affecting aquatic resources in the sensitive drainages would be greater under Alternative D than under Alternative B but less than under Alternative C.	• Same as Alternative B.