Environment

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Task 3D Report for the Powder River Basin Coal Review Cumulative Environmental Effects

List of Acronyms

ACE	Anderson Consulting Engineers, Inc.
APLIC	Avian Power Line Interaction Committee
AUM	animal unit month
AVF	alluvial valley floor
BBO	billion barrels of oil
Bcf	billion cubic feet
BLM	Bureau of Land Management
BNSF	Burlington Northern and Santa Fe Railroad
dS/m	DeciSiemens per liter
DM&E	Dakota, Minnesota, and Eastern Railroad
EA	environmental assessment
EC	electrical conductivity
EIS	environmental impact statement
EOR	enhanced oil recovery
ESA	Endangered Species Act
FS	United States Forest Service
GIS	Geographic Information System
kV	kilovolt
LBA	lease by application
LQD	Land Quality Division
MBTA	Migratory Bird Treaty Act
mg/L	milligrams per liter
MMBO	million barrels of oil
mmgpy	million gallons per year
mmtpy	million tons per year
µmhos/cm	milliohms per centimeter
MW	megawatt
NARO	North Antelope/Rochelle
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PRB	Powder River Basin
RFD	reasonably foreseeable development
ROW	right-of-way

SAR	sodium adsorption ration
SMCRA	Surface Mining Control and Reclamation Act
SSURGO	Soil Survey Geographic Database
TBNG	Thunder Basin National Grassland
Tcf	trillion cubic feet
TDS	total dissolved solids
U.S.	United States
UP	Union Pacific
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VMT	vehicle miles traveled
WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department

Contents

1.0 Introduction 1-1

1.1 Study Background 1-1

1.2 Objectives 1-2

1.2.1 Phase I of the Study 1-2

1.2.2 Phase II of the Study 1-7

1.3 Agency Outreach, Coordination, and Review 1-7

2.0 Predicted Future Cumulative Impacts 2-1

2.1 Topography, Geology, Minerals, and Paleontological Resources 2.1-1

2.1.1 Study Area 2.1-1

2.1.2 Cumulative Impacts 2.1-1

2.2 Soils and Alluvial Valley Floors 2.2-1

2.2.1 Study Area 2.2-1

2.2.2 Cumulative Impacts 2.2-1

2.3 Vegetation Including Wetlands and Riparian Areas 2.3-1

2.3.1 Study Area 2.3-1

2.3.2 Cumulative Impacts 2.3-1

2.4 Wildlife, Fisheries, and Related Habitat Values 2.4-1

2.4.1 Study Area 2.4-1

2.4.2 Cumulative Impacts 2.4-1

2.5 Grazing 2.5-1

2.5.1 Study Area 2.5-1

2.5.2 Cumulative Impacts 2.5-1

2.6 Land Use and Recreation 2.6-1

2.6.1 Study Area 2.6-1

2.6.2 Cumulative Impacts 2.6-1

2.7 Transportation and Utilities 2.7-1

2.7.1 Study Area 2.7-1

2.7.2 Cumulative Impacts 2.7-1

3.0 References 3-1

List of Tables

Table 2.2-1 Soil Limitations and Characteristics in the Wyoming PRB Study Area 2.2-2

Table 2.4-1 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2020 – Lower Production Scenario 2.4-3

Table 2.4-2 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2020 – Upper Production Scenario 2.4-9

Table 2.4-3 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2030 – Lower Production Scenario 2.4-10

Table 2.4-4 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2030 – Lower Production Scenario 2.4-12

List of Figures

Figure 1-1 Wyoming Study Area and Subwatersheds 1-3

Figure 1-2 Federal Land Management 1-4

Figure 1-3 Surface Ownership 1-5

Figure 1-4 Federal Mineral Ownership 1-6

1.0 Introduction

The Powder River Basin (PRB) Coal Review is a regional technical study for assessing the existing conditions and projected future cumulative impacts associated with energy-related past, present, and reasonably foreseeable development (RFD) in the Wyoming PRB, and for specific resources, the Montana PRB. This study is being conducted by AECOM, Inc. dba AECOM Environment (AECOM) under the direction of the Bureau of Land Management (BLM) High Plains District Office and Wyoming State Office.

1.1 Study Background

The PRB of Wyoming is a major energy development area with diverse resource and environmental values. The first coal mine in the basin was developed near Glenrock, in Converse County, in 1883 (Foulke et al. 2002). While coal can be found in several areas of Wyoming, the extensive surface-accessible coal resource is what sets the PRB apart from other energy-producing areas of the state and country. The Wyoming portion of the PRB is the largest coal-producing region in the United States (U.S.); PRB coal is used to generate electricity within and outside of the region. The PRB also has produced large quantities of oil and natural gas resources. Over the last two decades, this region has experienced nationally significant development of natural gas from coal seams (coal bed natural gas [CBNG]).

Federal coal leasing is a high profile activity as over 90 percent of the PRB's coal is federally owned. The BLM is required to complete a National Environmental Policy Act (NEPA) analysis (environmental impact statement [EIS] or environmental assessment [EA]) for each coal lease-by-application (LBA) as part of the leasing process. In the coal leasing EAs and EISs that have been prepared since the Powder River Regional Coal Team decertified the region in early 1990 (thereby allowing the BLM to use the coal LBA process), cumulative impacts have been addressed in a separate section of the NEPA analyses to highlight the distinction between site-specific and cumulative impacts. With coal leasing continuing into the foreseeable future, and with impacts related to oil and gas development increasing since the late 1990s due to development of CBNG in the PRB, the BLM initiated studies and analyses to provide a consistent basis for evaluation of cumulative impacts in the coal leasing EISs. These studies and analyses included the PRB Coal Development Status Check (BLM 1996), Wyodak EIS (BLM 1999), PRB Oil and Gas EIS (BLM 2003), Montgomery Watson Harza (2003) study of PRB coal demand through 2020, and most recently, the PRB Coal Review.

Initiated in 2003, Phase I of the PRB Coal Review included the identification of current conditions (Task 1 reports); identification of RFD and future coal production scenarios for 2010, 2015, and 2020 (Task 2 report); and predicted future cumulative impacts (Task 3 reports) in the PRB. Phase II of the PRB Coal Review was initiated in January 2010 to update the Phase I analyses. Under Phase II, base year information has been updated through 2008, new RFD and future coal production scenarios have been developed, and projected cumulative impacts are being analyzed for 2020 and 2030.

The PRB Coal Review provides data, models, and projections to facilitate cumulative analyses for BLM's future land use planning efforts and for future project-specific impact assessments for project development in compliance with NEPA. It should be noted that the PRB Coal Review itself is not a NEPA document. It also is not a policy study, analysis of regulatory actions, or an analysis of the impacts of project-specific development.

For the purpose of this study, the Wyoming PRB study area (**Figure 1-1**) comprises all of Campbell County, all of Sheridan and Johnson counties less the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County. This includes all or portions of 18 subwatersheds (fourth order). It also includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the Thunder Basin National

Grassland (TBNG), which is administered by the United States Forest Service (FS) (**Figure 1-2**). State and privately owned lands also are included in the study area (**Figure 1-3**).

Private lands comprise most of the surface ownership in the study area (**Figure 1-3**); the majority of the mineral ownership is federal (**Figure 1-4**). Federal mineral ownership may include all minerals in some locations and only specific minerals (e.g., coal or oil and gas) in other locations. As a result, split estates (where the surface ownership is different than the mineral ownership) exist in a large portion of the study area.

This report summarizes Task 3D of the PRB Coal Review, which describes the potential future cumulative impacts associated with ongoing coal mine and CBNG development in the Wyoming PRB study area, as well as other energy-related development for the time periods of 2020 and 2030. The resources addressed in this report include:

- Topography, geology, minerals, and paleontological resources;
- Soils and alluvial valley floors (AVFs);
- Vegetation, including wetlands and riparian areas;
- Wildlife, fisheries, and related habitat values;
- Grazing;
- Land use and recreation; and
- Transportation and utilities.

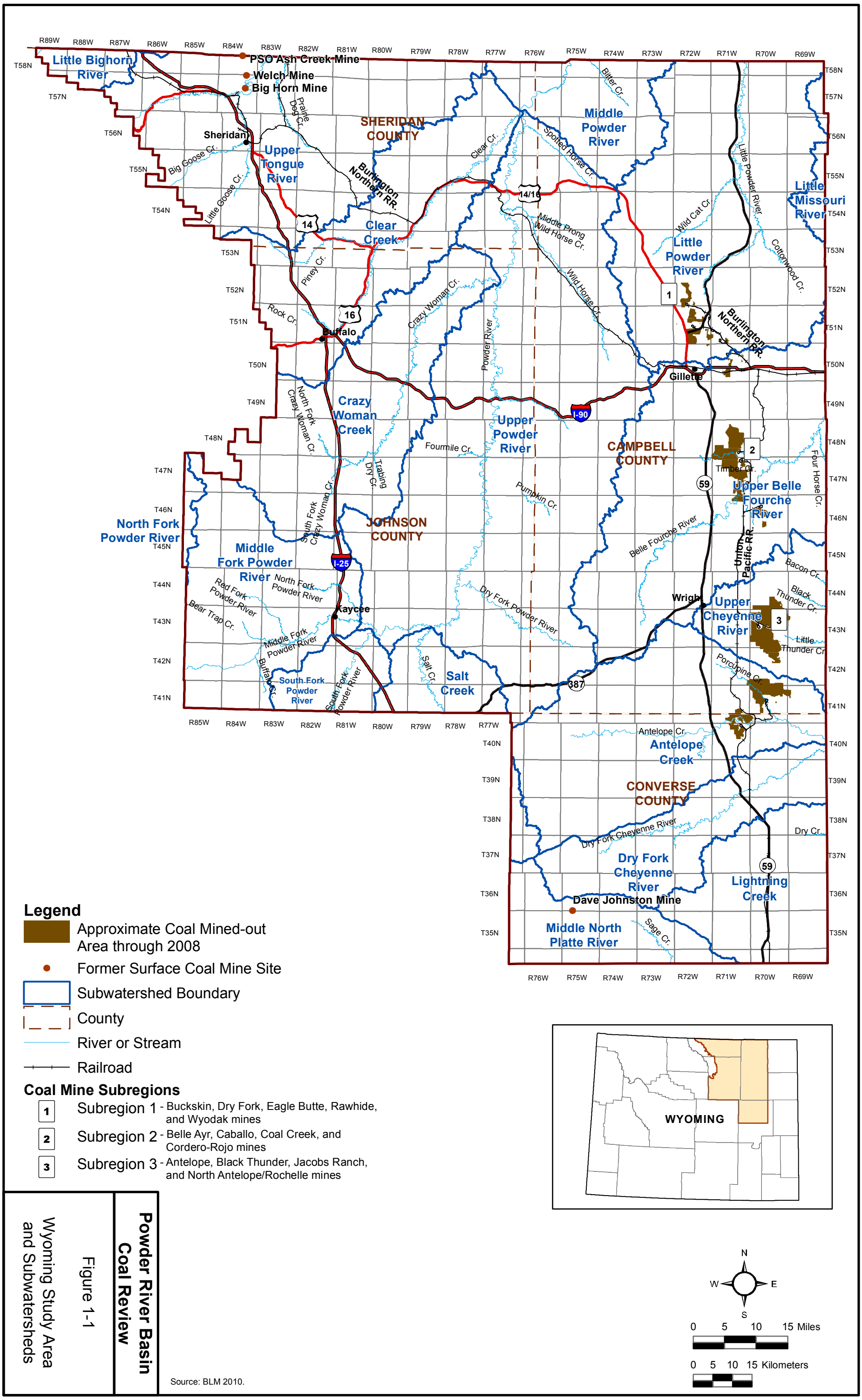
Based on the analysis presented in the Task 1D report (AECOM 2012) and the projected westward migration of conventional oil and gas and CBNG wells in future years (away from the coal mines) as described in the Task 2 report (AECOM 2011), potential future cumulative impacts to lands with wilderness characteristics, wild and scenic rivers, noise and visual resources, and hazardous materials and solid wastes in years 2020 and 2030 would be similar to or decline relative to base year 2008. Therefore, these resources are not analyzed further in this document. The potential future (Task 3) descriptions for air quality, socioeconomics, and water resources are presented in separate stand-alone reports. Cultural resources are addressed in the BLM Cultural Class I Regional Overview – Buffalo Field Office.

1.2 Objectives

1.2.1 Phase I of the Study

Phase I of the PRB Coal Review was developed as a regional technical study to determine the base year conditions and assess potential future cumulative effects of projected energy-related development activities in the PRB for 2010, 2015, and 2020. Specific to the other environmental resources component, the Task 1D report (ENSR 2005) summarized the current environmental conditions as of base year 2002 in the Wyoming PRB study area, inclusive of cumulative impacts associated with energy-related development.

The update of the Task 2 report (AECOM 2009a) defined the past and present development actions in the Wyoming and Montana PRB study area, as well as the projected RFD scenarios in the study area for years 2010, 2015, and 2020. The RFD scenarios presented in the Task 2 report provided the basis for the analysis of potential cumulative impacts (Task 3 reports). Specific to the other environmental resources component of the study, the update of the Task 3D report (AECOM 2009c) summarized the cumulative impacts for each resource in the Wyoming PRB study area for future years 2010, 2015, and 2020.



Source: BLM 2010.

Powder River Basin Coal Review

Figure 1-1

Wyoming Study Area and Subwatersheds

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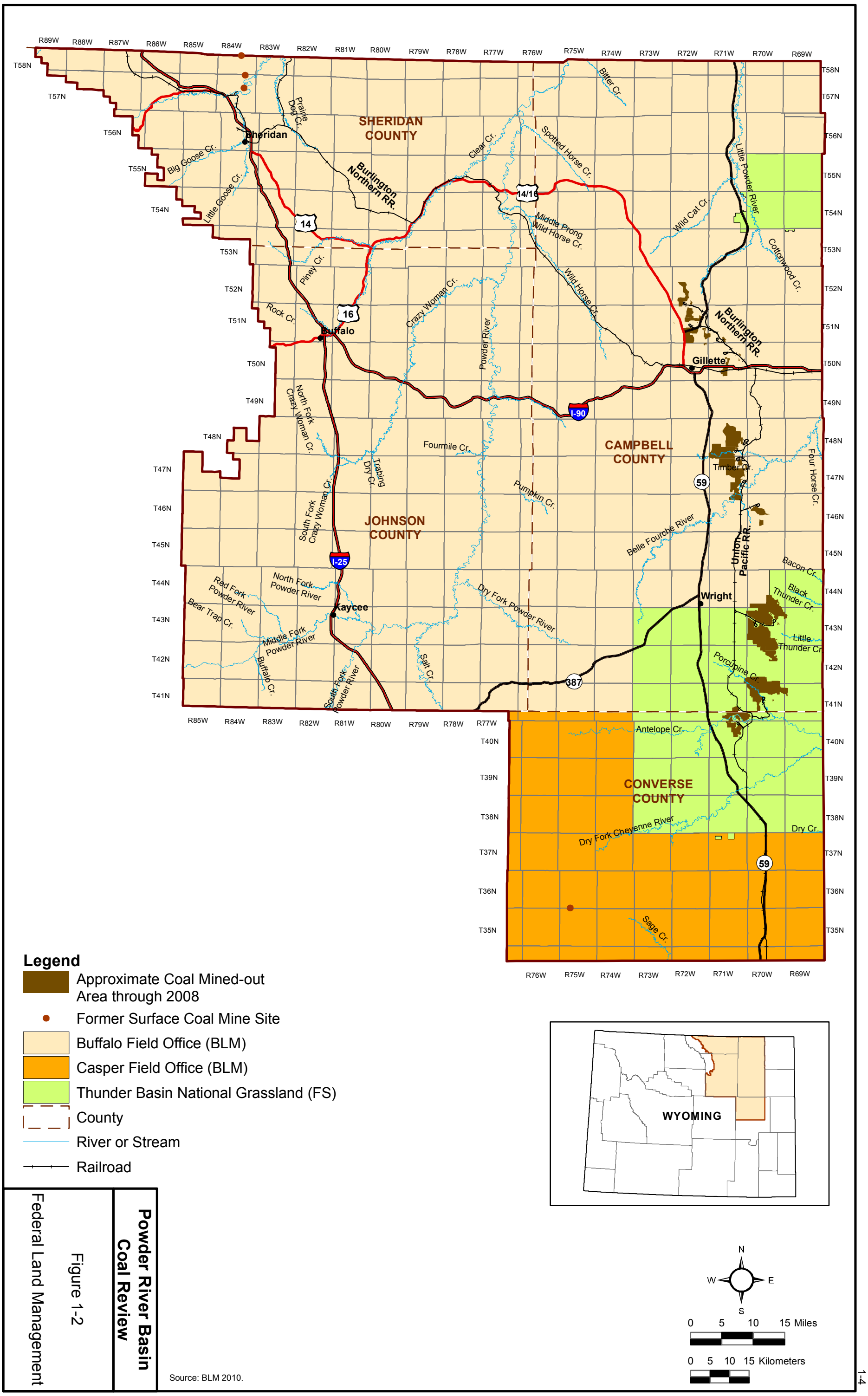

Source: BLM 2010.

Powder River Basin Coal Review

Figure 1-2

Federal Land Management

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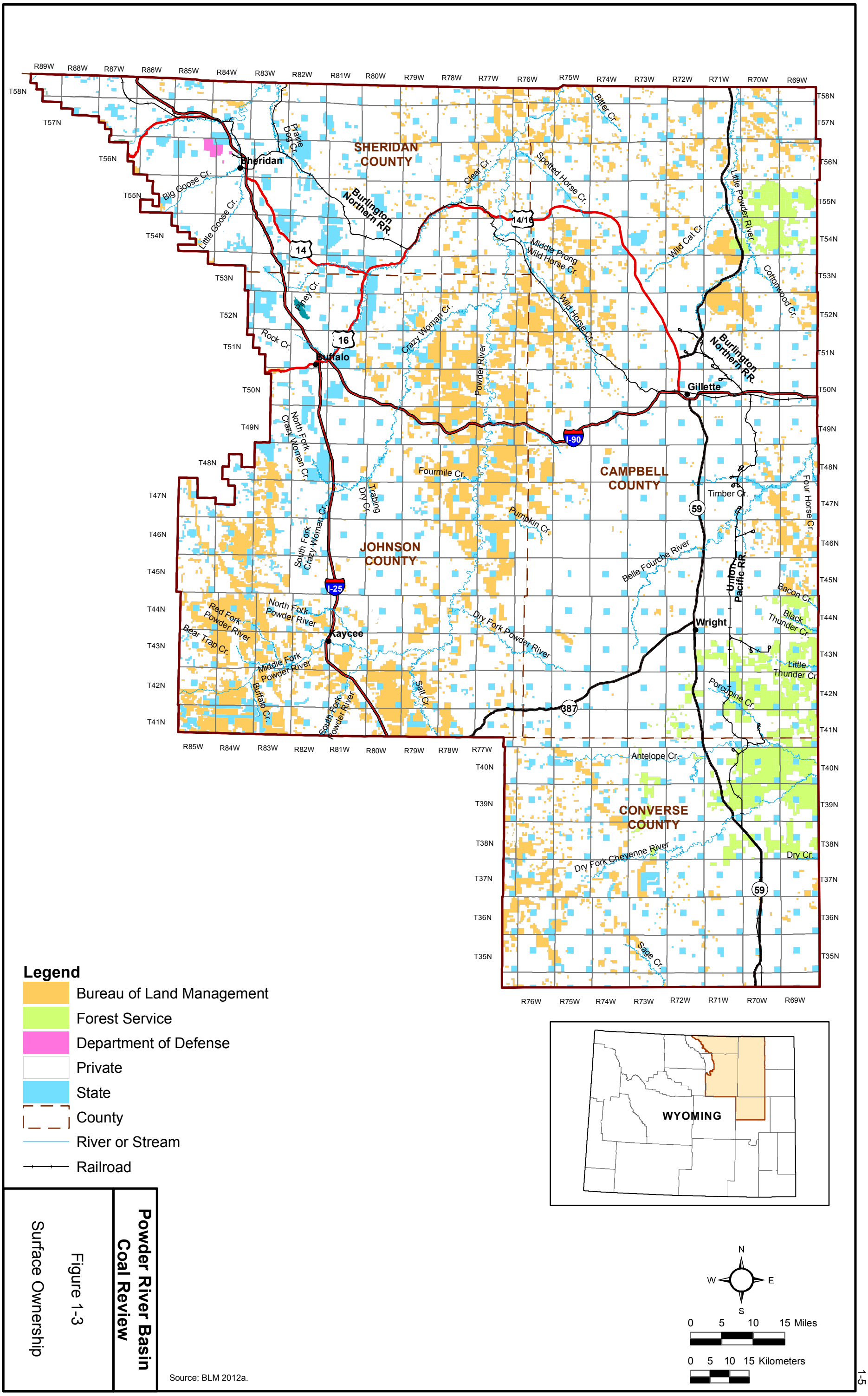

Source: BLM 2012a.

Powder River Basin Coal Review

Figure 1-3

Surface Ownership

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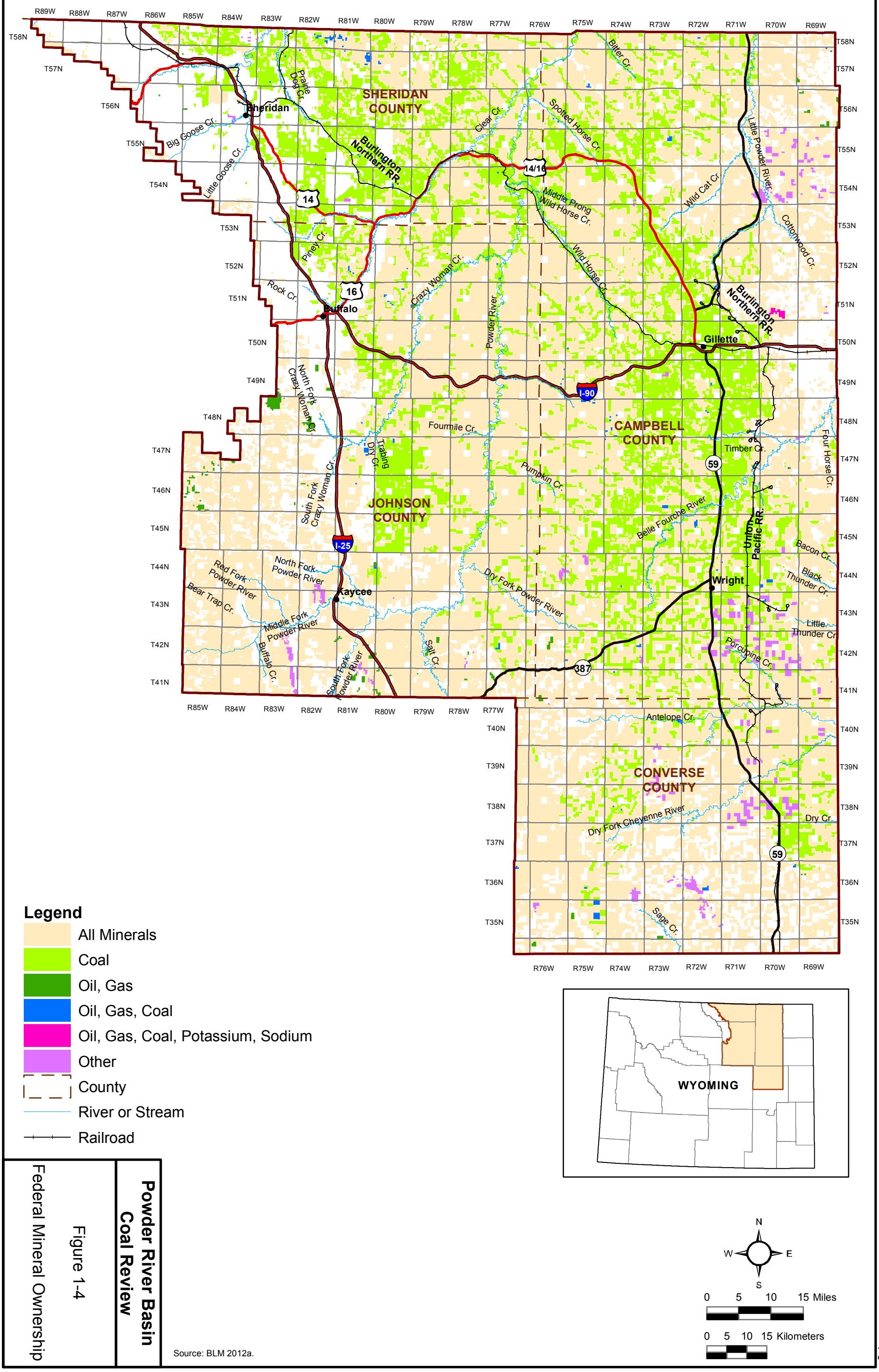

Source: BLM 2012a.

Powder River Basin Coal Review

Figure 1-4

Federal Mineral Ownership

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The study also included the evaluation of base year conditions (Task 1) and projected cumulative impacts (Task 3) for air quality, socioeconomics, and water resources. The results of these analyses were presented in separate stand-alone reports.

1.2.2 Phase II of the Study

Similar to Phase I, Phase II of the PRB Coal Review is a regional technical study to determine the base year (2008) conditions and assess potential future (2020 and 2030) cumulative effects of projected energy-related development activities in the PRB. Phase II of the study was initiated due to the ongoing energy-related development in the PRB, the elapsed time since initiation of Phase I of the study, and the BLM's need to maintain up-to-date development projections and related predicted future cumulative impact analyses for use in the agency LBA EISs and EAs. Under Phase II, the existing and projected future energy-related development activities have been updated (Task 2 [AECOM 2011]) based on updated information, with the air quality, water resources, socioeconomic, and environmental resources base year analyses (Task 1) and projected cumulative impact analyses (Task 3) correspondingly updated.

Specific to the other environmental resources component, the Task 1D report (AECOM 2012) has been updated to summarize existing conditions for the other environmental resources in the Wyoming PRB study area as of the end of base year 2008. The list of environmental resources analyzed (see Section 1.1) is the same as that analyzed during Phase I, with the exception of cultural resources. For Phase II, the cultural resources analysis has been conducted by the BLM Buffalo Field Office, the results of which are presented in the BLM Cultural Class I Regional Overview - Buffalo Field Office.

The energy-related development activities (including coal mining and CBNG development) in the Wyoming PRB for base year 2008, as identified in the Task 2 report (AECOM 2011), provide the basis for the analysis of base year 2008 conditions, inclusive of energy-related cumulative impacts, as documented in this Task 3D report. The Task 2 RFD scenarios provide the basis for the analysis of potential cumulative impacts for years 2020 and 2030, as documented in this Task 3D report.

1.3 Agency Outreach, Coordination, and Review

The BLM directed the preparation of the PRB Coal Review. In order to ensure the technical credibility of the data, projections, interpretations, and conclusions of the study and ensure the usefulness of the study for other agencies, the BLM initiated contact with other federal, state, and local agencies early in Phase I of the study. This same approach has been carried forward into Phase II of the study.

As part of this agency outreach and technical oversight, the BLM organized technical advisory groups for each of the key resources (air quality, water resources, and socioeconomics). These groups were composed of agency representatives and stakeholders with technical expertise in the applicable resources. Relative to the other environmental resources component, the BLM core technical advisory group consulted with key BLM Field Office and Wyoming State Office staff, as well as staff from other agencies (e.g., FS, Wyoming Department of Environmental Quality [WDEQ], U.S. Fish and Wildlife Service [USFWS], and Wyoming Game and Fish Department [WGFD]), as needed, to obtain data in support of the PRB Phase II analysis effort.

2.0 Predicted Future Cumulative Impacts

This chapter presents the existing and projected future cumulative environmental impacts in the Wyoming PRB study area, with the exception of water resources, air quality, and social and economic conditions, which are presented in standalone Task 3 reports, and cultural resources, which is addressed in the BLM Cultural Class I Regional Overview – Buffalo Field Office. Based on the analysis presented in the Task 1D Report for the PRB Coal Review (AECOM 2012) and the projected westward migration of conventional oil and gas and CBNG wells in future years (away from the coal mines) as described in the Task 2 Report for the PRB Coal Review (AECOM 2011), potential future cumulative impacts to lands with wilderness characteristics, wild and scenic rivers, noise and visual resources, and hazardous materials and solid wastes in years 2020 and 2030 would be similar to or decline relative to base year 2008. Therefore, these resources are not analyzed further in this document. The base year 2008 cumulative impacts and projected future cumulative impacts for 2020 and 2030 summarized in this chapter were based on the current environmental conditions in the Wyoming PRB, as presented in the Task 1D report, and the compilation of past and present actions and RFD activities in the Wyoming PRB, as presented in the Task 2 report.

Future disturbance and reclamation acreages for the RFD scenarios in this study were based on the data files compiled for, and summarized in, the Task 2 report with the following variables and uncertainties associated with using Geographic Information System (GIS) analysis for defining this information. The methodology and assumptions relative to oil and gas development (as summarized in Appendix D in the Task 2 report) provide a means of identifying the number of new wells to be developed and the number of existing wells to be plugged and abandoned within each of the subwatersheds for each of the target years for this study (i.e., 2020 and 2030). However, discrete locations for new and plugged and abandoned well sites for these future time periods are not available. For coal mines, the methodology and assumptions presented in Section 3.2 of the Task 2 report provide for calculation of future disturbance and reclamation acreages. Although the general area of potential future coal mine-related disturbance can be identified based on projected reserve locations, the actual disturbance footprint associated with future mining and the actual locations of future reclaimed areas for the target years are not known. As a result, the spatial relationship between projected future disturbance and reclamation areas for these industries and the resource-specific information in the GIS layers cannot be determined using existing information. For those resources that are site-specific (e.g., vegetation, soils, wildlife habitat), the Task 2 data files do provide for quantification of future disturbance and reclamation acreages on a subwatershed basis and, with other information (e.g., projected locations of future coal reserves), a means of qualitatively analyzing future resource-specific impacts in the absence of known spatial relationships. The disturbance acreages for the RFD scenarios (based on the Task 2 data files) are presented in Appendices A and C of the Task 2 report. Minor discrepancies in the total acreages, as presented in the Task 2 appendices and in this report, are the result of rounding.

2.1 Topography, Geology, Minerals, and Paleontological Resources

2.1.1 Study Area

The study area for topography, geology, minerals, and paleontological resources generally includes all or portions of Campbell, Johnson, Sheridan, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). Private lands comprise most of the surface ownership in the study area (**Figure 1-3**); the majority of the mineral ownership is federal (**Figure 1-4**). Federal mineral ownership may include all minerals in some locations and only specific minerals (e.g., coal or oil and gas) in other locations. As a result, split estates (where the surface ownership is different than the mineral ownership) exist in a large portion of the study area. The State of Wyoming also owns a portion of the surface area in the study area (**Figure 1-3**), and generally owns the minerals (**Figure 1-4**) where it owns the surface.

2.1.2 Cumulative Impacts

As described in the Task 2 Report for the PRB Coal Review (AECOM 2011), a total of approximately 261,150 acres (3 percent) have been disturbed by development activities in the study area (as of end of 2008). Of the 261,150 acres of total cumulative disturbance, approximately 91,228 acres of disturbance (35 percent) were associated with coal mine development.

Of the 261,150 acres of total cumulative disturbance, approximately 102,855 acres (39 percent) have been reclaimed. The remaining 158,296 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 91,228 total cumulative acres of disturbance directly associated with coal mine development, approximately 29,648 acres (32 percent) have been reclaimed (as of end of 2008). Of the remaining 61,580 acres of disturbance, approximately 26,656 acres currently are not available for reclamation, as they are occupied by long-term mine facilities required during continuing operations. These areas would be reclaimed near the end of each mine's life. Reclamation of the remaining 34,924 acres, which represent areas of active mining and areas where coal has been recovered but reclamation has not been completed, would proceed concurrently with coal mining.

The effects to topography, geology, minerals, and paleontological resources from development activities within the study area under the two production scenarios (lower and upper production scenarios) for the years 2020 and 2030 are presented below.

2.1.2.1 Year 2020 – Lower Production Scenario

<u>Topography</u>

Potential impacts to topography as a result of RFD activities in the study area would be similar to those described in the Task 1D Report for the PRB Coal Review (AECOM 2012). Under this scenario, it is projected that an additional 71,039 acres would be disturbed, resulting in approximately 332,189 acres of total cumulative disturbance to topography. Of the 332,189 acres of disturbance (4.2 percent of the study area), it is projected that 130,601 acres (39 percent) would be altered as a result of coal mining activities.

Of the 332,189 acres of total cumulative disturbance, approximately 177,763 acres (54 percent) would be reclaimed by 2020. The remaining 154,425 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 130,601 acres of total cumulative disturbance associated with coal mine development, it is projected that approximately 59,245 acres (45 percent) would be reclaimed by 2020. Of the remaining 71,355 acres of coal mining-related disturbance, it is projected that approximately 27,931 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed

near the end of each mine's life. Reclamation of the remaining 43,425 acres of disturbance would proceed concurrently with mining operations.

The disturbance associated with the majority of the past and RFD activities would result in the general leveling of the surface to accommodate facilities (e.g., well pads, power plants, etc.) and roads. Recontouring during reclamation to match approximate original contour as required by regulation would minimize the long-term impact to topography. Coal mining would have a greater impact on topography than other types of development through changes in slope, lowering the general land surface, and changing the physical nature of the surficial materials and overburden, even after reclamation.

Geology

Under this scenario, there would be approximately 332,189 acres of total cumulative disturbance in the study area by 2020 as a result of development-related activities. Approximately 130,601 acres of the cumulative disturbance would be directly related to coal mining activities. In the coal mine areas, the overburden and coal would be removed and the overburden replaced, resulting in a permanent change in the geology of the area and a permanent reduction of coal resources. The remainder of the projected disturbance generally would result in only surficial surface disturbance.

No cumulative impacts have been identified in association with geologic hazards.

Mineral Resources

Coal Resources. Under this scenario, coal production in 2020 would be approximately 456 million tons per year (mmtpy). This would be an increase of 12 mmtpy over base year (2008) production levels. Ongoing production would result in the permanent reduction of coal resources available for future development in the study area.

Although prices of fluid minerals have fluctuated over the past 20 years, coal prices have been relatively stable in comparison. Conventional oil and gas and CBNG are more sensitive to supply and demand fluctuations. As a result, the commodities are mutually exclusive with regard to one affecting the other. Ultimately, aggregate energy prices are related; however, development of conventional oil and gas, CBNG, and related facilities (pipelines and compressor stations) would not be affected by coal leasing and production.

Conventional Oil and Gas Resources. By year 2020, annual oil production in the study area is projected to be approximately 4.8 million barrels of oil (MMBO). The resulting cumulative oil production (1974 through 2020) from the study area would be 1.39 billion barrels of oil (BBO). Annual production of associated and conventional natural gas in 2020 is projected to be 17.1 billion cubic feet (Bcf), resulting in a cumulative production (1974 through 2020) of 2.5 trillion cubic feet (Tcf). (See Appendix D of the Task 2 report for information on the methodology and assumptions used for oil and gas projections in this study.) Ongoing production would result in the permanent reduction of these resources in the study area.

As discussed under Coal Resources, no conflicts between coal mine development and conventional oil and gas development are anticipated.

CBNG Resources. By year 2020, annual CBNG production in the study area is projected to be approximately 160 Bcf, 387 Bcf lower than the base year (2008) production levels. The resulting cumulative CBNG production (1974 through 2020) from the study area would be 5.7 Tcf. (See Appendix D of the Task 2 report for information on the methodology and assumptions used for oil and gas projections in this study.) Ongoing production would result in the permanent reduction of CBNG resources available for future development in the study area. Most of the early CBNG development in the study area occurred in shallower areas close to the coal outcrop and coal mining areas in the eastern portion of the Wyoming PRB. As a result, much of the CBNG may be depleted in these areas by 2020.

There may be isolated areas where development of coal and CBNG would be in conflict; however, the effect on these resources would be negligible.

Other Mineral Resources. Based on information in the Task 2 report, aggregate (sand, gravel, and scoria), bentonite, uranium, and leonardite production are anticipated to continue in the study area. By year 2020, annual production rates in the study area are projected to be approximately 4.5 million tons for sand and gravel, approximately 15.9 million pounds for uranium, and approximately 41,500 tons for leonardite. Although production levels for bentonite cannot be determined based on current information, production is anticipated to continue to meet demands. Ongoing production would result in the permanent reduction of these resources available for future development in the study area.

The development of other mineral resources with regard to coal production would be similar to the interaction with oil, natural gas, and CBNG as described under Coal Resources. Coal production levels are not likely to affect the development of other mineral resources in the study area. Sand and gravel resources are more likely to be affected to a greater degree by conventional oil and gas and CBNG development, due to the large quantity of these resources required for use in the construction of well field-related access roads and pads.

Paleontological Resources

Under this scenario, it is projected that development-related impacts to the Wasatch and Fort Union formations (which comprise 57 and 35 percent of the surface, respectively, in the study area) would result from the approximately 332,189 total cumulative acres of disturbance. Of the 332,189 acres, it is projected that 130,601 acres (39 percent) would be associated with coal mining activities.

As discussed in the Task 1D report, the Wasatch and Fort Union formations are classified as having moderate or unknown potential for the occurrence of significant or important paleontological resource based on the BLM's potential fossil yield classification system. As a result, development-related activities in the study area could adversely affect scientifically significant fossils, if present in or adjacent to disturbance areas. Both surface and subsurface fossils could be damaged or destroyed during development-related ground-disturbing activities. Potential subsurface disturbance of paleontological resources (e.g., during drilling operations) would not be visible or verifiable.

Of the energy-related development activities in the Wyoming PRB study area, coal mining and CBNG and conventional oil and gas development have the greatest potential to impact paleontological resources. These activities have the potential to impact paleontological resources as a result of direct disturbance to the Wasatch and Fort Union formations. As only portions of the study area have been evaluated for the occurrence of paleontological resources, and discrete locations for RFD activities cannot be determined at this time, no accurate estimate can be made as to the number of paleontological sites that potentially may be affected by energy-related development activities.

RFD activities involving federally-owned surface and/or minerals would be subject to federal guidelines and regulations protecting paleontological resources. Protection measures, permit conditions of approval, and/or mitigation measures would be determined on a project-specific basis at the time of permitting to minimize potential impacts to paleontological resources as a result of RFD activities. Specifically, the BLM's policy for paleontological resources is to manage them for their scientific, educational, and recreational values, and to mitigate adverse impacts to them. Data on the occurrence or potential for the occurrence of fossils is essential to land managers for compliance with the policy. For paleontological resources, the land-use planning process includes:

- Identifying areas and geological units (i.e., formations and members containing paleontological resources);
- Evaluating the potential for areas to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils;

- Developing management recommendations (including mitigation measures in specific locations) to promote the scientific, educational, and recreational uses of fossils on public lands and mitigate resource conflicts; and
- Developing strategies to regularly monitor public lands where important paleontological localities have been identified.

If no federal ownership (land or mineral) is involved, federal permits would not be required. In this case, protection measures for paleontological resources might not be mandated by the landowners or monitored as closely. Unprotected paleontological resources potentially could be disturbed, damaged, destroyed, or removed from the site, losing much or all of their scientific information.

2.1.2.2 Year 2020 – Upper Production Scenario

Topography

Potential impacts to topography in the study area as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, approximately 3,451 additional acres of land would be disturbed as a result of increased coal production, resulting in the total cumulative disturbance of approximately 335,640 acres of land (4.2 percent of the study area). Of the 335,640 acres, it is projected that 134,052 acres (40 percent) would be associated with coal mining activities.

Of the 335,640 acres of total cumulative disturbance, approximately 179,859 acres (54 percent) would be reclaimed by 2020. The remaining 155,781 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 134,052 acres of disturbance associated with coal mining, it is projected that approximately 61,341 acres (46 percent) would be reclaimed by 2020. Of the remaining 72,711 acres of coal mining-related disturbance, it is projected that approximately 28,242 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities which would be reclaimed near the end of each mine's life. Reclamation of the remaining 44,469 acres of disturbance would proceed concurrently with mining operations.

Geology

The effects on geology as a result of past and RFD activities in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, approximately 3,451 additional acres of disturbance associated with increased coal production would occur.

Mineral Resources

Coal Resources. Impacts to coal resources in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, coal production in 2020 is projected to be approximately 538 mmtpy, 82 mmtpy higher than production under the lower scenario in 2020.

Conventional Oil and Gas Resources. Under this scenario, impacts to conventional oil and gas resources in the study area would be the same as described under the 2020 – Lower Production Scenario.

CBNG Resources. Under this scenario, impacts to CBNG resources in the study area would be the same as described under the 2020 – Lower Production Scenario.

Other Mineral Resources. Under this scenario, impacts to other mineral resources in the study area would be the same as described under the 2020 – Lower Production Scenario.

Paleontology

Potential impacts to paleontological resources in the study area as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, approximately 3,451 additional acres would be disturbed, resulting in the total cumulative disturbance of approximately 335,640 acres of land by the year 2020, with a proportionate increase in potential impacts to paleontological resources. Of the 335,640 acres, it is projected that 134,052 acres (40 percent) would be associated with coal mining activities.

2.1.2.3 Year 2030 – Lower Production Scenario

Topography

Potential impacts to topography as a result of past and RFD activities in the study area would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, approximately 77,189 additional acres of land would be disturbed, resulting in the total cumulative disturbance of approximately 409,377 acres of land (5.2 percent of the study area) by 2030. Of the 409,377 acres, it is projected that 169,666 acres (41 percent) would be associated with coal mine development.

Of the 409,377 acres of total cumulative land disturbance, approximately 238,408 acres (58 percent) would be reclaimed by 2030. The remaining 170,970 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 169,666 acres of disturbance associated with coal mining, it is projected that approximately 89,074 (52 percent) would be reclaimed by 2030. Of the remaining 80,592 acres of coal mining-related disturbance, it is projected that approximately 31,447 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 49,146 acres of disturbance would proceed concurrently with mining operations.

Geology

The effects on geology as a result of past and RFD activities in the study area would be same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, approximately 77,189 additional acres of disturbance would occur, of which approximately 39,066 acres (51 percent) would be related to coal mining.

Mineral Resources

Coal Resources. Impacts to coal resources in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, coal production in 2030 is projected to be approximately 468 mmtpy, 12 mmtpy higher than production under the lower scenario in 2020.

Conventional Oil and Gas Resources. Impacts to conventional oil and gas resources in the study area as a result of past and RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, annual oil production is projected to be approximately 1.9 MMBO. The resulting cumulative oil production (1974 through 2030) would be 1.4 BBO. Annual associated and conventional natural gas production is projected to be approximately 9.8 Bcf, with cumulative production (1974 through 2030) reaching 2.6 Tcf.

CBNG Resources. Under this scenario, impacts to CBNG resources in the study area are projected to be the same as described under the 2020 – Lower Production Scenario, with the following exception. Annual CBNG production is projected to be approximately 283 Bcf, resulting in 8.3 Tcf of cumulative production (1974 through 2030).

Other Mineral Resources. Under this scenario, impacts to other mineral resources in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on information in the Task 2 report, annual sand and gravel production in the study area in year 2030 is projected to be approximately 3.1 million tons. Based on existing information, no uranium production is projected for year 2030 unless additional projects come online.

Paleontology

Potential impacts to paleontological resources in the study area as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, approximately 77,189 additional acres of land would be disturbed, resulting in the total cumulative disturbance of approximately 409,377 acres by the year 2030, with a proportionate increase in potential impacts to paleontological resources. Of the 409,377 acres, it is projected that 169,666 acres (41 percent) would be associated with coal mining activities.

2.1.2.4 Year 2030 – Upper Production Scenario

Topography

Potential impacts to topography as a result of past and RFD activities in the study area would be similar to the 2020 – Lower Production Scenario, with the following exception. Under this scenario, approximately 91,527 additional acres of land would be disturbed, resulting in the total cumulative disturbance of approximately 423,716 acres of land (5.2 percent of the study area) by 2030. Of the 423,716 acres, it is projected that 182,577 acres (43 percent) would be associated with coal mining activities.

Of the 423,716 acres of total cumulative disturbance, approximately 247,575 acres (58 percent) would be reclaimed by 2030. The remaining 176,141 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 182,577 acres of disturbance associated with coal mining, it is projected that approximately 97,988 (54 percent) would be reclaimed by 2030. Of the remaining 84,589 acres of coal mining-related disturbance, it is projected that approximately 32,609 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities which would be reclaimed near the end of each mine's life. Reclamation of the remaining 51,980 acres of disturbance would proceed concurrently with mining operations.

Geology

The effects on geology as a result of past and RFD activities in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, approximately 91,527 additional acres of disturbance would occur, of which approximately 51,976 acres (57 percent) would be related to coal mining.

Mineral Resources

Coal Resources. Impacts to coal resources in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Under this scenario, coal production in 2030 is projected to be approximately 615 mmtpy, 159 mmtpy higher than production under the 2020 - Lower Production Scenario.

Conventional Oil and Gas. Impacts to conventional oil and gas resources in the study area as a result of past and RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, annual oil production is projected to be approximately 1.8 MMBO. The resulting cumulative oil production (1974 through 2030) would be 1.4 BBO. Annual associated and conventional natural gas production is projected to be approximately 9.8 Bcf, with cumulative production (1974 through 2030) reaching 2.6 Tcf.

CBNG. Under this scenario, impacts to CBNG resources in the study area are projected to be the same as described under the 2020 – Lower Production Scenario, with the following exception. Annual CBNG production is projected to be approximately 283 Bcf, resulting in 8.3 Tcf of cumulative production (1974 through 2030).

Other Mineral Resources. Under this scenario, impacts to other mineral resources in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on information in the Task 2 report, annual sand and gravel production in the study area in year 2030 is projected to be approximately 3.1 million tons. Based on existing information, no uranium production is projected for year 2030 unless additional projects come online.

Paleontology

Potential impacts to paleontological resources in the study area as a result of RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Under this scenario, approximately 91,527 additional acres of land would be disturbed, resulting in the total cumulative disturbance of approximately 423,716 acres by the year 2030, with a proportionate increase in potential impacts to paleontological resources. Of the 423,716 acres, it is projected that 182,577 acres (43 percent) would be associated with coal development activities.

2.2 Soils and Alluvial Valley Floors

2.2.1 Study Area

The study area for soils and AVFs includes all or portions of Sheridan, Johnson, Campbell, and Converse counties (**Figure 1-1**). This includes all or portions of 18 subwatersheds (fourth order). It also includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**).

2.2.2 Cumulative Impacts

Soils

As described in Section 2.2.3 of the Task 1D report, soils information for the study area is available from published soil surveys conducted predominantly at a county level by the Natural Resources Conservation Service (NRCS). Detailed soils information was obtained from project-specific (e.g., coal mines and other industrial activities) state and federal permit applications and Soil Survey Geographic Database (SSURGO) databases. Additional information for soils within the study area is presented in the Task 1D report. A summary of the soil limitations and characteristics as a percent of each subwatershed in the study area is presented in **Table 2.2-1**.

Cumulative impacts to soils as a result of RFD activities in the study area primarily would result from increased vehicle traffic, vegetation removal, soil salvage and redistribution (including stripping, stockpiling, and redistribution), discharge of CBNG produced groundwater, and construction and maintenance of project-specific components (e.g., roads and rights-of-way (ROWs), well pads, industrial sites, and associated ancillary facilities). In general, soil disturbance and handling from these activities would generate both long-term and short-term impacts to soil resources through compaction, accelerated wind or water erosion, other declining soil quality factors, or the permanent removal of soil resources at industrial sites.

Impact minimization approaches, best management practices, and restrictions on activities as defined through project-specific NEPA assessments and permitting requirements would reduce the level of RFD-related cumulative impacts to soil resources and AVFs in the study area. Regulatory requirements of state and federal permitting agencies (e.g., WDEQ, BLM, Federal Energy Regulatory Commission, and U.S. Army Corps of Engineers [USACE]) include provisions for minimizing impacts to soils through erosion control practices, soil salvage and replacement, revegetation, and monitored stabilization practices. For example, measures that either are routinely required or can be required, if necessary, to reduce soil erosion during surface coal mining operations include: salvaging of soils suitable to support plant growth and stockpiling it or placing it directly on recontoured areas; protecting soil stockpiles from disturbance and erosional influences; interim seeding of topsoil stockpiles; watering of active work areas, inactive areas, and problem areas; watering and/or using chemical dust suppression on haul roads and exposed soils; using sediment control structures, as needed, to trap eroded soil; promptly revegetating exposed soils; and using mulching, cover crops, or other approved measures to control erosion on reclaimed lands prior to seeding with a final seed mix. Disturbances to AVFs and resources that may occur in similar settings (wetlands and waters of the U.S.) are highly regulated by the WDEQ and USACE, respectively. Compliance with such regulatory provisions and implementation of suitable management and control practices would minimize cumulative impacts to soil resources and AVFs over the short and long terms.

Table 2.2-1 Soil Limitations and Characteristics in the Wyoming PRB Study Area

Subwatershed	Characteristic (percent of subwatershed)								
	Depth to Bedrock[1]	Hydric[2]	Wind Erodible	Water Erodible	Compaction Prone	High Shrink-Swell Potential	Droughty	LRP[3]	Prime Farmland (if irrigated)
Antelope Creek	0.0	12.9	17.6	1.3	36.6	32.5	49.9	0.0	0.0
Clear Creek	100.0	4.5	0.3	14.4	28.6	45.6	35.6	0.7	1.5
Crazy Woman	100.0	1.2	0.0	9.8	37.9	10.8	19.7	0.5	0.2
Dry Fork Cheyenne River	0.0	3.8	19.4	1.7	44.5	37.9	45.9	0.0	0.0
Lightning Creek	7.7	3.3	18.6	0.1	40.9	43.7	45.4	0.1	0.0
Little Bighorn River	99.7	7.4	0.0	30.6	52.8	32.1	3.4	0.4	0.0
Little Missouri River	100.0	2.1	0.0	3.2	40.5	22.1	20.6	0.0	0.0
Little Powder River	96.0	14.7	0.1	7.1	37.0	25.5	16.3	0.4	0.0
Middle Fork Powder River	100.0	2.2	0.7	22.0	33.5	25.7	17.8	1.9	1.9
Middle North Platte River	23.7	2.2	34.8	0.4	19.6	24.2	55.6	0.0	0.0
Middle Powder River	99.9	6.1	0.0	10.4	43.6	34.9	9.8	0.1	0.0
North Fork Powder River	99.6	0.8	0.2	17.7	23.5	19.9	7.9	0.0	0.0
Salt Creek	82.4	4.2	4.0	11.1	29.8	41.0	44.3	1.0	0.1
South Fork Powder River	100.0	3.9	2.1	11.2	57.5	35.5	21.9	0.9	0.2
Upper Belle Fourche River	0.6	22.2	2.6	2.0	57.3	45.2	24.0	0.0	0.0
Upper Cheyenne River	0.0	33.6	2.0	3.3	64.9	45.3	35.9	0.0	0.0
Upper Powder River	73.2	9.4	0.9	10.4	50.8	34.9	19.6	0.6	0.7
Upper Tongue River	100.0	6.8	0.1	16.4	54.8	55.0	15.6	0.4	5.1

[1] Soils with linthic bedrock contact less than 60 inches deep.

[2] Includes map unit acreages for partially hydric soils (map units that contain both hydric and nonhydric soils). Due to the scale of mapping, actual acreages of hydric soils may not be accurately depicted.

[3] LRP = Limited Reclamation Potential.

Source: NRCS 2012.

Accelerated Wind Erosion. As indicated in the Task 1D report, severe wind erosion hazards are associated with fine sandy soils. Related impacts would include the loss of topsoil resources. Accelerated wind erosion would occur as soil is denuded and soil structure is degraded during vegetation clearing and soil handling on fine sandy soils. Impacts would be particularly likely on windward slopes and where relatively extensive areas of these soils are disturbed. The soils identified as most susceptible to wind erosion are located primarily in the southwestern and northeastern portions of the study area. **Table 2.2-1** identifies the percentage of wind erodible soils within each subwatershed.

Impacts from accelerated wind erosion typically would be controlled by implementing dust abatement practices (including water and/or tackifier applications); minimizing soil handling and the extent of bare ground; and using suitable cover crops, mulches, and revegetation species during concurrent and final reclamation.

Accelerated Water Erosion. Severe water erosion hazards, as indicated in the Task 1D report, have a K factor greater than 0.32 and a slope greater than 20 percent. Additionally, all soils on slopes over 30 percent were determined to be water erosion prone. Erosion prone soils occur along the western portions of the basin. Severe water erosion hazard soils also occur along the north and west borders of the basin, as well as scattered areas along the Powder River. **Table 2.2-1** identifies the percentage of water erodible soils within each subwatershed.

In a manner similar to that described for wind erosion, accelerated water erosion would occur as soil is denuded and soil structure is degraded during vegetation clearing, soil handling, and stockpiling of these materials. Sheet, rill, and gully erosion would occur on disturbed areas and nearby sites, with the type and severity of erosion depending on the slope steepness and length, soil texture and structure, organic matter content, plant cover and root density, and erosion control practices. Related impacts would include the loss of topsoil and subsoil resources and sediment deposition in downslope positions.

Potential impacts from accelerated water erosion would be most severe on moderately-coarse to moderately-fine textured soils that occur on steep slopes or on gentler but longer, unbroken slopes. Water discharged as a result of CBNG development would augment flows in drainages where releases are made near or directly to channels. In the case of direct discharges to on-channel impoundments/drainages, which for most subwatersheds are expected to account for between 14 and 100 percent of all CBNG water discharges (AECOM 2011), local channel bed degradation may occur due to the additional flow. In some cases, downcutting may lead to bank caving as well as gullying on uplands. Additional channel geometry changes may occur downstream due to bed aggradation from sediment deposition. However, due to high conveyance losses in the Wyoming PRB as noted in the Task 3B Report, Water Quality and Channel Stability (Anderson Consulting Engineers, Inc. [ACE] 2012), the areal extent of potential down channel impacts would be minor.

Impacts from accelerated water erosion typically would be controlled by minimizing soil handling and the extent of bare ground; controlling the length and degree of recontoured slopes; temporary runoff controls such as silt fencing and hay bales; long-term drainage and runoff controls such as ditches and retention ponds; and the use of suitable cover crops, mulches, and revegetation species during concurrent and final reclamation. Control practices, including management of CBNG produced waters, would be determined on a project-specific basis during permitting.

Coal mining in the Wyoming PRB study area currently occurs in the eastern portion of the basin within the Antelope Creek, Dry Fork Cheyenne River, Little Powder River, Upper Belle Fourche River, Upper Cheyenne River, and Upper Powder River subwatersheds. Based on SSURGO analyses of the soils in these six subwatersheds, the Dry Fork Cheyenne River and the Antelope Creek subwatersheds are the most susceptible to potential impacts from an overall combination of accelerated wind and water erosion. These subwatersheds constitute less than 1.0 million acres total, which is approximately 12 percent of the study area. The Upper Powder River and Little Powder River subwatersheds have the highest percentage of soils susceptible to water erosion. These two subwatersheds total approximately

2.5 million acres, which is approximately 30 percent of the study area. Therefore, the actual acreage of accelerated erosion impacts as a result of development-related activities may be greater in these areas.

Other Soil Quality Considerations. Additional cumulative impacts to soil resources would result from disturbance or modification of inherent soil characteristics such as salinity and alkalinity, microbial populations, organic matter and fertility, and soil texture and structure. The latter two characteristics particularly influence water infiltration, permeability, and aeration. Impacts to soil quality would result from increased root zone salinity or alkalinity from mixing of soil layers during salvage and redistribution; compaction or other disturbance to soil structure; and reductions in microbial populations, organic matter, and fertility from long-term soil stockpiling. In some cases, slope, depth to rock, and the presence of rock fragments limit the overall potential for reclamation use. In turn, these soil quality impacts may create impacts on vegetation establishment, crop growth and rangeland productivity, and surface water quality.

The control practices that typically mitigate such soil quality impacts generally include suitable soil salvage, stockpiling and redistribution practices, timely implementation of reclamation activities, and suitable seedbed preparation and amendment practices.

As discussed in the Task 1B Report for the PRB Coal Review (AECOM 2013b), the major water quality issues pertaining to CBNG water discharges are sodium adsorption ratio (SAR) and total dissolved solids (TDS), which generally may be indicated through field measurements of electrical conductivity (EC). As indicated in Figure 3.5-1 of the report, SAR and EC concentrations in Wyodak-Anderson coal zone waters generally are lowest in the south-southeastern portion of the Wyoming PRB and highest in the north-northwestern portion of the basin. Per Table 3.5-2 of the report, the median concentrations of SAR and TDS in CBNG-produced water are 8.8 and 838 milligrams per liter (mg/L), respectively. The potential impacts to soils as a result of CBNG water discharge would depend on the concentration of these constituents in the discharge water, the water treatment method (if any), the type of disposal method, and the subsequent use of the water.

Based on the information and data presented in the Task 2 Report for the PRB Coal Review (AECOM 2011), current CBNG groundwater discharge methods in the Wyoming PRB include discharge to: off-channel impoundments/headwater reservoirs, on-channel impoundments/drainages, playa lakes, or injection wells. The majority (approximately 82 percent) of the CBNG-produced water in the Wyoming PRB in 2008 was discharged to on-channel impoundments/drainages, with approximately 15 percent of the water discharged to off-channel impoundments/headwater reservoirs and approximately 3 percent discharged to playa lakes or injection wells in some locations of the basin. CBNG water discharge is regulated by the WDEQ for both quantity and quality.

CBNG water discharge to impoundments or headwater reservoirs, whether for containment or infiltration, would disturb soils where they are built. In addition, underlying soil materials may receive repeated discharges. Over time these materials could become increasingly saline and/or alkaline. Maintenance or closure of the facility may require removal and disposal of such materials in accordance with applicable regulations and/or agency guidelines.

Untreated discharges of CBNG waters to receiving streams are regulated in various PRB subwatersheds by the WDEQ. In the Powder River and Tongue River drainages, direct discharges to drainages typically are treated for SAR and/or EC (WDEQ 2010). It is possible that soils in lower geomorphic positions (such as alluvial terraces) may receive additional inputs of salinity and/or alkalinity as a result of CBNG water discharge to streams during high flows.

ACE (2012) evaluated the effects of CBNG discharge water on receiving streams in the Wyoming PRB, and the resulting effects on irrigation suitability of the receiving streams. The results showed that the receiving streams would remain suitable for irrigation purposes following mixing with CBNG discharge water during both normal and dry years, with the following exceptions. For Antelope Creek and the

Dry Fork Cheyenne River, the results showed that the receiving steams would be unsuitable for irrigation purposes during a portion of the irrigation season during both normal and dry years. The Upper Tongue River was reported as unsuitable for irrigation purposes both prior to and after mixing with CBNG discharge water.

For agricultural uses, the Wyoming water quality standard for SAR is 8.0, the pH standard is 4.5 to 9.0 standard units, and the TDS standard is 2,000 mg/L (WDEQ 2005). Depending on soil texture, chemistry, water availability, and plant adaptation, the growth of plants typically is severely restricted at soil SAR values of approximately 12 or more. As indicated in Figure 3.5-1 of the Update to the Task 1B report, the agricultural water quality standard for SAR typically is exceeded in Wyodak-Anderson coal zone waters produced in the Little Powder River subwatershed (mean SAR of 11.1), the Upper Belle Fourche subwatershed (mean SAR of 8.2), and the Upper Powder River subwatershed (mean SAR of 19.5).

While not equivalent to TDS, EC may be used as a general TDS indicator and typically can be related to TDS through a highly-correlated statistical line of best fit. EC commonly is used as a salinity measure for soils and agricultural assessments. In such investigations, the common units of measure are millimhos per centimeter (mmhos/cm) (or DeciSiemens per meter [dS/m]) at 25ºC.

As a general working set of indicators, salinity effects on crop yields are mostly negligible at EC values between 0 and 2 mmhos/cm, and yields of very sensitive crops may be restricted between 2 and 4 mmhos/cm. At EC values between 4 and 8 µmhos/cm, yields of many crops are restricted, and with EC between 8 and 16 mmhos/cm, only tolerant crops yield satisfactorily. Above EC values of 16 µmhos/cm, only a very few tolerant crops yield satisfactorily (USDA 1954). These classes are only general indicators; the actual growth and establishment of plants or crops under different salinity levels also varies with soil water-holding capacity, the actual amount of water supplied, plant adaptation (e.g., native range vegetation versus wheat), and other factors.

Alluvial Valley Floors

In the semi-arid West, the soils, topography, and hydrologic capabilities of AVFs provide the conditions for valuable agricultural land uses and wildlife habitats. This prompted Congress to protect these areas with the passage of Surface Mining Control and Reclamation Act (SMCRA) in 1977. In the Wyoming PRB, agricultural land use is primarily cattle or sheep ranching with some grain (typically wheat) being grown commercially (Rusmore et al. 1985). For most ranching operations, herd size and related economic conditions usually are limited by the land base or cash available to provide hay for winter feed. In the northern part of the study area, irrigated or subirrigated valley bottomlands produce almost all of this hay. (South of Gillette, upland pastures often are clear throughout the winter.) AVFs also provide generally better stock water, shelter from adverse weather, and the most suitable locations for calving, lambing, and feeding (Rusmore et al. 1985). In addition, AVFs provide habitat diversity, food, cover, and water for a variety of wildlife species.

As described in the Task 1D report, AVF regulatory determinations are made on a site-specific basis for coal mining activities. These detailed determinations consider a number of geomorphic, hydrologic, soil, and land use factors. Although soil surveys may serve as broad indicators of potential AVF occurrence, and reconnaissance investigations have been conducted to assist in identifying AVFs (Rusmore et al. 1985), regulatory determinations of AVF occurrence and location are part of coal mine permitting activities. As such, the locations and extent of AVFs have not been determined for the study area overall. However, AVFs do occur within the study area as documented in existing coal mining permits and described in the Task 1D report. Discussion of the potential occurrence of AVFs in the study area is based on the regional reconnaissance conducted in the early 1980s (Rusmore et al. 1985). However, actual AVF occurrence has not been verified except in limited areas of more detailed permit investigations. Potential cumulative impacts are qualitatively discussed on the basis of these permit investigations and the reconnaissance study.

Cumulative impacts to AVFs that are deemed significant to agriculture would be restricted by SMCRA rules and regulations as administered by the WDEQ and the Office of Surface Mining. The determination of significance to agriculture is made by the WDEQ/Land Quality Division (LQD), and is based on specific calculations related to the production of crops or forage on the AVF and the size of the existing agricultural operations on the land of which the AVF is a part. Impacts generally are not permitted if the AVF is determined to be significant to agriculture. If the AVF is determined not to be significant to agriculture, or if the permit to affect the AVF was issued prior to the effective date of SMCRA, the AVF can be disturbed during mining but must be restored as part of the reclamation process. As a result, cumulative impacts to AVFs that are deemed not significant to agriculture would be minimized by reclamation requirements, including restoration of the hydrologic balance.

Although the formal AVF definition and related regulatory programs pertain specifically to coal mining, impacts on AVF resources could result from other development-related activities in the study area. These activities may affect irrigated or subirrigated agricultural lands, jurisdictional waters of the U.S. (including wetlands), or floodplains. Minimization and/or mitigation of potential impacts to specific resources occurring in or along streams and floodplains would be required by the federal or state authorizing agencies (e.g., BLM, FS, USACE, WDEQ) at the time of permitting.

2.2.2.1 Year 2020 – Lower Production Scenario

Soils

Under this scenario, approximately 71,039 additional acres of soil in the study area would be disturbed as a result of RFD activities by 2020, resulting in approximately 332,189 total cumulative acres of soil disturbances (or disturbance to approximately 4.2 percent of the soils in the study area). Of this total, it is projected that by 2020 approximately 177,763 acres (54 percent) would be permanently reclaimed. In the Middle Powder River and Upper Powder River subwatersheds (**Figure 1-1**), the permanently reclaimed acreage would be substantially greater than the unreclaimed acreage, and cumulative impacts to soil resources are expected to be less than in other subwatersheds. In the Clear Creek and Middle North Platte River subwatersheds, the unreclaimed acreage is projected to be greater than the permanently reclaimed acreage, with correspondingly greater impacts expected. In the remainder of the subwatersheds, the cumulative reclaimed area would be roughly equal to the cumulative unreclaimed areas. In all subwatersheds, reclamation and stabilization activities are expected to minimize the severity and extent of disturbance-related impacts to soils and AVFs until successful permanent reclamation occurs.

Under this scenario, coal mining and other development activities would affect soils in the subwatersheds in the eastern Wyoming PRB study area (Antelope Creek, Dry Fork Cheyenne River, Little Powder River, Upper Belle Fourche River, Upper Cheyenne River, and Upper Powder River), as well as soils in the Upper Tongue River subwatershed. The soil characteristics in these seven subwatersheds are described in further detail below.

The Antelope Creek subwatershed is dominated by droughty, compaction prone, and high shrink-swell potential soils. These soils make up 50, 37, and 33 percent of the subwatershed, respectively. These soils are scattered throughout the subwatershed. Surface disturbance related to vehicle traffic could compact compaction prone soils, specifically when wet or moist. For soils with a high shrink/swell potential, rapid changes in volume can damage structures and roads. Soils with montmorillonite (smectite or bentonite) clays are considered to have a high shrink/swell potential. These soils also are prone to soil creep and landslides. These soils could create hazards where cut-fill slopes are created. All of the soils have calcium carbonate accumulations at depth, which may create soil quality impacts from salinity in some locations. These soils have few limitations for use as reclamation materials.

Major drainages in the Antelope Creek subwatershed are occupied by droughty soils. These soils are formed in calcareous sandy to moderately fine textured unconsolidated streamlain alluvium, and AVFs

may occur along valleys or drainages with these or other soils. In some areas, soil salinity may be a concern relative to reclamation of disturbance areas.

The Dry Fork Cheyenne River subwatershed is dominated by droughty, compaction prone, and high shrink-swell potential soils. These soils make up 46, 45, and 38 percent of the subwatershed, respectively. Droughty soils are scattered throughout the western portion of the subwatershed and along the Dry Fork of the Cheyenne River in the eastern portion of the subwatershed. Compaction prone and shrink-swell potential soils predominantly occur in the western portion of the subwatershed and in scattered areas throughout the eastern portion of the subwatershed. RFD-related disturbance may result in cumulative soil quality impacts due to compaction, accelerated erosion, and limited availability of suitable soil materials for reclamation.

Major drainages in the Dry Fork Cheyenne River subwatershed are occupied by droughty soils, as described previously for the Antelope Creek subwatershed.

The Little Powder River subwatershed is dominated by shallow soils, which make up 96 percent of the subwatershed. Compaction prone soils and soils with high shrink-swell potential also are prevalent in scattered locations throughout the subwatershed. These soils make up 37 and 26 percent of the subwatershed, respectively. Many of these soils have medium to moderately fine textures, and accelerated water erosion may occur on areas occupied by these soils due to their geographic position on ridges and hills. Soils that are shallow to bedrock may have poor reclamation potential, which may create cumulative impacts in RFD-related disturbance areas due to limited availability of suitable soil materials for reclamation.

Major drainages in the Little Powder River subwatershed are dominated by compaction prone and/or droughty soils. These soils are formed in calcareous sandy to moderately fine textured unconsolidated streamlain alluvium, and AVFs may occur along valleys or drainages with these or other soils. In some areas, cumulative impacts to soil quality as a result of soil salinity may be a concern relative to reclamation of disturbance areas.

The Upper Belle Fourche River subwatershed is expected to undergo the largest cumulative extent of disturbance under this scenario. The area is dominated by compaction prone and high shrink-swell potential soils. These soils make up 57 and 45 percent of the subwatershed, respectively, and occur throughout the subwatershed. Cumulative impacts to soil quality as a result of compaction, or soil salinity of subsoils, may be a concern relative to reclamation of disturbance areas.

The Upper Cheyenne River subwatershed is dominated by compaction prone and high shrink-swell potential soils. These soils make up 65 and 45 percent of the subwatershed, respectively, and are scattered throughout the subwatershed. Cumulative soil quality impacts from compaction may be anticipated as a result of the clayey nature of these soils. On steeper slopes, accelerated water erosion also may create cumulative impacts. This may make permanent reclamation of RFD-related disturbance areas more difficult in some areas.

Major drainages in the Upper Cheyenne River subwatershed are dominated by compaction prone soils, with soils prone to shrink-swell, droughty soils, and hydric soils occurring in scattered locations. The soils in this subwatershed were formed in calcareous unconsolidated streamlain alluvium. Cumulative soil quality impacts from compaction may be anticipated as a result of the clayey nature of these soils. On steeper slopes, accelerated water erosion also may create cumulative impacts.

The Upper Powder River subwatershed is dominated by shallow and compaction prone soils. These soils make up 73 and 51 percent of the subwatershed, respectively, and are scattered throughout the subwatershed. Soil quality declines from compaction are likely to be RFD disturbance-related impacts within this subwatershed, due to the extent of clayey materials. Additionally, many of these soils are

shallow to bedrock and some have poor reclamation potential, which may create cumulative impacts in RFD-related disturbance areas due to limited availability of suitable soil materials for reclamation.

Major drainages in the Upper Powder River subwatershed are dominated by shallow, compaction prone, and high shrink-swell potential soils. The soils and land types in this subwatershed were formed in calcareous unconsolidated streamlain alluvium. Cumulative impacts to soil quality as a result of soil salinity may be a concern relative to reclamation of disturbance areas.

The Upper Tongue River subwatershed is dominated by shallow soils. These soils make up approximately 100 percent of the subwatershed. Compaction prone soils and soils with high shrink-swell potential also are prevalent in scattered locations throughout the subwatershed. These soil types each constitute 55 percent of the subwatershed. Many of these soils have medium to moderately fine textures. Soils that are shallow to bedrock may have poor reclamation potential, which may create cumulative impacts in RFD-related disturbance areas due to limited availability of suitable soil materials for reclamation purposes.

Of the approximately 332,189 total cumulative acres of soil disturbance under this scenario, approximately 130,601 acres (39 percent) would be associated with coal mining activities. By year 2020, approximately 59,245 acres (45 percent) of the coal mine-related disturbance would be permanently reclaimed. Of the remaining 71,356 acres of coal mining-related disturbance, it is projected that approximately 27,931 acres would be unavailable for reclamation due to the presence of long-term facilities which would be reclaimed near the end of each mine's life. Reclamation of the remaining 43,425 acres of disturbance would proceed concurrently with mining operations.

Of the types of RFD projects in the study area, coal mining activities would create the most concentrated cumulative impacts to soils. This is due to the large acreages involved and the relatively contiguous, block nature of the anticipated mining activities. These factors would encourage widespread accelerated wind and water erosion, and extensive soil handling would reduce soil quality through compaction and corresponding loss of permeability to water and air; declining microbial populations, fertility, and organic matter; potential mixing of saline and/or alkaline soil zones into seedbeds; and the limited availability of suitable soil resources for reclamation uses in some areas. Potential measures that would be implemented to minimize these impacts are discussed in the introduction to Section 2.2.2.

Alluvial Valley Floors

Soils occurring in major drainages are described above for each of the seven subwatersheds in the eastern study area with projected new or ongoing coal mine development. The extent of cumulative impacts to AVFs in the study area as a result of coal mining activities cannot be quantified, due to the site-specific nature of AVF determinations and the current lack of information relative to the actual disturbance area footprint that would be required for mining of future reserves. However, their potential extent is described in general terms below. Past site-specific determinations are described in the Task 1D report.

Earlier intensive mine permitting studies indicate that within the Antelope Creek subwatershed, AVFs are located along Antelope Creek and Horse Creek in relation to the Antelope Mine, and an AVF existed within the original North Antelope permit area. A declared AVF is located near the confluence of Porcupine Creek and Antelope Creek; however, it is several miles downstream of the NARO North LBA tract, which was awarded to the North Antelope/Rochelle. Future activities at NARO may extend into the Upper Cheyenne River subwatershed. The regional reconnaissance indicates that the potential for AVF exists within the Antelope Creek subwatershed in narrow, sinuous delineations mainly along Antelope Creek, Sand Creek, the South Fork of Bear Creek, Bates Creek, Spring Creek, Horse Creek, and Porcupine Creek. Delineations range from a few tens of feet up to approximately 0.6 mile wide. These areas are thought to be largely subirrigated, with potential or actual surface irrigation primarily located along the South Fork of Bear Creek, Bates Creek, Spring Creek, and Porcupine Creek in the northern part of the subwatershed (Rusmore et al. 1985).

In the Dry Fork Cheyenne River subwatershed, no AVFs were identified through site-specific determinations, and no coal mining is projected to occur within the area. Reconnaissance indicates that subirrigated AVF potential exists along the Dry Fork itself and along scattered tributaries. These delineations of potential AVF occurrence follow the relatively narrow, meandering course of the streams, in widths varying from a few tens of feet to approximately 0.4 mile. Off-channel areas that are surface irrigated, or have the potential to be, are located along the downstream third of the Dry Fork (Rusmore et al. 1985). Although no coal mining is projected to occur in this subwatershed, potential impacts to resources associated with alluvial valley settings could occur from other RFD activities as discussed in the introduction to Section 2.2.2.

In the Little Powder River subwatershed, AVFs were declared in permit areas for the Buckskin, Eagle Butte, and Rawhide mines and at the former Fort Union Mine. These were determined not to be significant to agriculture, or else have been “grandfathered” with respect to this criterion. More extensive reconnaissance information indicates that additional potential for AVFs occurs along the Little Powder River itself, as well as along Rawhide Creek, Horse Creek, and Wildcat Creek. Fairly narrow, meandering, subirrigated potential zones occur along the creeks and the upper river, whereas the Little Powder River below Rawhide Creek has existing or potential surface irrigation in alluvial zones 0.5 mile wide or more (Rusmore et al. 1985).

Within the Upper Belle Fourche River subwatershed, AVFs were determined to occur at the Wyodak, Belle Ayre, Caballo, and Cordero-Rojo (Caballo Rojo and Cordero) mines. These AVFs occur mainly along Caballo Creek and Donkey Creek. An AVF also occurs along Duck Nest Creek on the Belle Ayr North LBA tract. Approximately 14.9 acres of the total declared acreage on Duck Nest Creek are located within the Belle Ayr North general analysis area (BLM 2009). In the future, the Wyodak Mine permit area may extend into the Little Powder River subwatershed (AECOM 2011). Reconnaissance investigations in the Upper Belle Fourche area indicate that the potential for additional AVF determinations occurs in narrow zones along Caballo Creek and its primary tributaries (notably Tisdale Creek and Gold Mine Draw, Bone Pile Creek, Bluegate Creek, and Hoe Creek). In addition, the potential for AVFs is extensive along the Belle Fourche River and its tributaries, including Timber Creek and several others in the vicinity of Reno Junction. Most of the potential AVF zones in this subwatershed are surface irrigated or may be suited to it. Small areas are likely to be subirrigated (Rusmore et al. 1985). Potential AVFs occupy zones up to approximately 0.5 mile wide along the streams.

In the Upper Cheyenne River subwatershed, AVF declarations were made at the Black Thunder and Jacobs Ranch mines, primarily along Little Thunder Creek and its North Prong tributary. These areas were “grandfathered” due to the early dates of mining operations, and the WDEQ removed the AVF declaration for the North Prong of Little Thunder Creek. More recently, the WDEQ/LQD declared 143 acres along the lower reach of Little Thunder Creek and 194 acres along the lower reach of North Prong Little Thunder Creek as AVFs. The declared AVFs are located several miles downstream from the Little Thunder LBA tract and would not be affected by mining. Reconnaissance investigations indicate that AVFs may occur elsewhere along both of these streams, as well as along School Creek and Black Thunder Creek (Rusmore et al. 1985). These zones typically are narrow (less than 0.2 mile wide), sinuous, alluvial terrace systems that may be suited for surface irrigation.

Currently, no site-specific AVF determinations have been made in the Upper Powder River subwatershed, and no coal mining is projected to occur within the area. However, widespread areas having the potential for positive AVF declarations exist in this subwatershed within the study area. Extensive areas of potential AVFs are delineated along the Powder River in reconnaissance studies, in zones up to 1 mile wide. Many of these areas along the river are based on the existence of surface irrigation or suitability for it. Based on the reconnaissance, subirrigated zones also occur all along the river. The potential for subirrigated or surface irrigated AVFs also occurs along every major Powder River tributary and several smaller tributaries. Such streams include Bitter Creek, SA Creek, LX Bar Creek, Spotted Horse Creek, Wild Horse Creek and its prongs, Fortification Creek, Barber Creek, Dead Horse Creek, and others. Potential AVF delineations along these streams typically are 0.2 mile wide or less

(Rusmore et al. 1985). Although no coal mining is projected to occur in this subwatershed, potential impacts to resources associated with alluvial valley settings could occur from other RFD activities as discussed in the introduction to Section 2.2.2.

In the Upper Tongue River subwatershed, one AVF was identified along Little Youngs Creek within the former PSO Ash Creek Mine permit area. This AVF was “grandfathered” in regard to significance to farming. AVFs also are present within the former Big Horn Mine permit boundary, portions of which were disturbed and permanently lost as was addressed in the mine’s Reclamation Plan. Although no coal mining is projected to occur in this subwatershed, potential impacts to resources associated with alluvial valley settings could occur from other RFD activities as discussed in the introduction to Section 2.2.2.

Although the actual occurrence of regulated AVFs has not been verified within these subwatersheds, it is likely that expanding mining activities under this scenario would encounter AVFs and related issues. Impacts on agriculture, soils, surface water and groundwater resources, vegetation, and wildlife habitats would vary with the characteristics of the specific site and watershed locale, as well as with the type of disturbance. The actual extent of impacts cannot be determined at this time, since AVF determinations are site-specific. In addition to considerations at a specific project location, impacts may extend upstream and downstream from the disturbance.

In general, potential impacts on AVFs as a result of coal mining or nearby mining activities would include disturbance of supporting hydrologic regimes, physicochemical alteration of underlying geologic materials, impacts to soils (as described above), alteration of vegetation communities, and modification of existing or potential land uses. The application of best management practices for reclamation and stabilization of such disturbance, in addition to compliance with regulatory programs and project-specific permit provisions, would minimize or mitigate these cumulative impacts over both the short and long terms.

2.2.2.2 Year 2020 – Upper Production Scenario

Soils

Under this scenario, cumulative impacts to soil resources as a result of RFD activities in the study area would be similar to, but slightly more extensive than, those described under the 2020 – Lower Production Scenario, due to approximately 3,451additional acres of disturbance. This additional acreage would be related to increased coal production.

Alluvial Valley Floors

It is anticipated that the overall acreage of AVFs affected by coal mining and the related impacts would be similar to those described under the 2020 – Lower Production Scenario. This assumption is based on the 3,451 total additional acres of coal mine-related disturbance projected for this scenario, a portion of which may occur on AVFs.

2.2.2.3 Year 2030 – Lower Production Scenario

Soils

Under this scenario, 77,189 additional acres of soils would be disturbed as a result of RFD activities in the study area, 51 percent of which would be related to coal mining. As a result, cumulative impacts to soil resources would be similar in nature, but much more extensive, than those described under the 2020 - Lower Production Scenario.

Alluvial Valley Floors

It is anticipated that the overall acreage of AVFs affected by RFD activities would be greater than under the 2020 – Lower Production Scenario. This assumption is based on the 39,066 total additional acres of coal mine-related disturbance projected for this scenario, a portion of which may occur on AVFs.

Whether from coal mining or other RFD activities, the types of impacts to AVFs (or resources in similar alluvial settings) would be similar to those described in the introduction to Section 2.2.2.

2.2.2.4 Year 2030 – Upper Production Scenario

Soils

Under this scenario, 91,527 additional acres of soils would be disturbed as a result of RFD activities in the study area, 57 percent of which would be related to coal mining. As a result, cumulative impacts to soil resources would be similar in nature, but much more extensive, than those described under the 2020 – Lower Production Scenario.

Alluvial Valley Floors

It is anticipated that the overall acreage of AVFs affected by RFD activities would be greater than under the 2020 – Lower Production Scenario. This assumption is based on the 51,976 total additional acres of coal mine-related disturbance projected for this scenario, a portion of which may occur on AVFs. Whether from coal mining or other RFD activities, the types of impacts to AVFs (or resources in similar alluvial settings) would be similar to those described in the introduction to Section 2.2.2.

2.3 Vegetation Including Wetlands and Riparian Areas

2.3.1 Study Area

The study area for vegetation (including wetlands and riparian areas) includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). It also includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**).

2.3.2 Cumulative Impacts

Based on the Task 2 Report for the PRB Coal Review (AECOM 2011), a total of approximately 261,150 acres of vegetation have been disturbed by development activities in the study area (as of end of 2008). Of the 261,150 acres of total disturbance, approximately 91,228 acres (35 percent) were associated with coal mining activities.

Of the 261,150 acres of total cumulative disturbance, approximately 102,855 acres (39 percent) have been reclaimed. The remaining 158,296 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 91,228 acres of total cumulative acres of disturbance associated with coal mine development, approximately 29,648 acres (32 percent) have been reclaimed (as of end of 2008). Of the remaining 61,580 acres of disturbance, approximately 26,656 acres currently are not available for reclamation, as they are occupied by long-term facilities needed to conduct continuing mining operations. These areas would be reclaimed near the end of each mine life. Reclamation of the remaining 34,924 acres, which represent areas of active mining and areas where coal has been recovered but reclamation has not been completed, would proceed concurrently with coal mining.

Potential impacts to vegetation within the study area would be similar to those described in the Task 1D Report for the PRB Coal Review (AECOM 2012). In general, impacts to vegetation can be classified as short-term and long-term. Potential short-term impacts would arise from the removal and disturbance of herbaceous species during a project's development and operation (e.g., coal mines, CBNG wells, etc.) and would cease upon project completion and successful reclamation in a given area. Potential long-term impacts would consist of the permanent loss of vegetation and vegetative productivity in areas that would not be reclaimed in the short term (e.g., power plant sites, etc.). The removal of woody species also would be considered a long-term impact since these species take approximately 25 years or longer to attain a size comparable to pre-disturbance conditions. Indirect impacts may include the dispersal of noxious and invasive weed species within and beyond the surface disturbance boundaries, which would result in the displacement of native species and changes in species composition in the long term. In addition, the discharge of produced water could result in the temporary creation or expansion (during the period of discharge) of wetlands in containment ponds and riparian areas along segments of drainages that previously supported upland vegetation, depending on the quality and quantity of water discharged. Alternately, the discharge of abnormally high flows or water with SARs of 13 or more could impact existing vegetation as discussed in the Task 1D report. Also, water with a SAR of greater than 8.0 is unsuitable for some irrigation purposes.

The discharge of CBNG-produced water in the study area is regulated by the WDEQ for both quantity and quality. Direct discharge to drainages in the Powder River and Tongue River drainages typically is treated for SAR and/or EC to ensure compliance (WDEQ 2010). In the eastern portion of the basin, CBNG-produced water generally is low in TDS and sodium and often of better quality than the surface water (AECOM 2012). Based on current discharge methods, the quality of CBNG-produced water in the eastern portion of the basin, treatment of discharge waters (as needed) to meet compliance, and WDEQ permit requirements for discharge to ephemeral drainages, potential water quality impacts to riparian and

wetland vegetation associated with on-channel impoundments and ephemeral drainages are anticipated to be minimal.

The effects to vegetation communities as a result of RFD activities in the study area under two production scenarios (lower and upper production scenarios) for the years 2020 and 2030 are discussed below.

2.3.2.1 Year 2020 – Lower Production Scenario

General Vegetation

Under this scenario, past and RFD activities in the study area would result in the total cumulative disturbance of approximately 332,189 acres of vegetation (or approximately 4.2 percent of the study area) by 2020. Of the 332,189 acres, it is projected that 130,601 acres (39 percent) of the vegetation disturbance would be associated with coal mining activities. The primary vegetation communities impacted by coal mining would include mixed- and short-grass prairie and sagebrush shrubland (33 and 65 percent of the projected disturbance, respectively, based on GIS mapping of projected future coal reserves and 2008 disturbance from coal mine development). Based on these percentages, these vegetation communities would account for 43,098 and 84,891 acres, respectively, of the projected coal mine-related disturbance area.

Of the 332,189 acres of total cumulative vegetation disturbance, approximately 177,763 acres (54 percent) would be reclaimed by 2020. The remaining 154,425 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 130,601 acres of disturbance associated with coal mine development, it is projected that approximately 59,245 acres (45 percent) would be reclaimed by 2020. Of the remaining 71,355 acres of coal mining-related disturbance, it is projected that approximately 27,931 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 43,425 acres of disturbance would proceed concurrently with mining operations.

Riparian and Wetland Vegetation

RFD activities in the study area would result in the removal or disturbance of wetland and riparian vegetation located within development-related disturbance areas. As the discrete locations of future CBNG-related facilities and actual disturbance footprints of future coal mine disturbance areas are not currently known, the spatial relationship between these activities and the isolated wetland and riparian communities in the study area cannot be determined at this time. As a result, potential impacts under this scenario cannot be quantified. However, based on the types of wetland and riparian communities in the vicinity of projected future coal reserves, it is anticipated that wetland/fen areas would be the primary wetland community impacted as a result of coal mining activities. In the case of coal mining, wetlands that meet the requirements for USACE regulatory review must be identified, and special permitting procedures are required to assure that after mining there would be no net loss of wetlands. Wetlands that are not under USACE jurisdiction are restored as required by the WDEQ/LQD (depending on the values associated with the wetland features), by the land management agency (on public land), or by the private landowner. For other types of development, such as oil and gas, disturbance of wetlands is avoided where possible. Where avoidance is not possible, mitigation for impacts to wetlands is evaluated on a project-specific basis.

Operations associated with RFD activities in the study area would result in the use of groundwater. As of 2020, all coal mine-produced water would be consumed during operations. Projected CBNG wells would produce a projected 15,325 million gallons per year (mmgpy). Of this total, approximately 14,668 mmgpy of CBNG-produced water would be discharged to impoundments and drainages, with approximately 657 mmgpy discharged to playas or reinjected. This discharge of water would result in the creation of wetlands in containment ponds and riparian areas along drainages that previously supported upland vegetation. In addition, existing wetlands and riparian areas that would receive additional water would

become more extensive and potentially support a greater diversity of wetland species. It is assumed that related effects to stream flow and associated riparian and wetland vegetation primarily would be limited to within a few miles of the discharge outfall, depending on the time of year, the presence and number of on-channel impoundments, the amount of vegetation with and along the channel, and the permeability of the alluvium. This assumption was based on a detailed study of CBNG water discharge conveyance loss and potential recharge to shallow alluvial groundwater that was conducted by the Wyoming Geological Survey (Payne and Saffer 2005) in the Upper Beaver Creek drainage of the Wyoming PRB. The study evaluated conveyance loss of CBNG water discharged to ephemeral drainages both with and without on-channel impoundments. Based on the results of the study, most of the water discharged by CBNG wells to on-channel impoundments or directly to drainages is lost through infiltration, evaporation, and depending on season, evapotranspiration. Based on the approximate 9-year life cycle of CBNG wells and the east to west migration of CBNG development in the study area through 2020, as projected in the Task 2 report, the potential increase in riparian and wetland vegetation density and diversity in any one location would be short term and temporary.

As discussed in Section 2.3.2, CBNG water discharge in the study area is regulated by the WDEQ for both quantity and quality. As a result, it is anticipated that potential effects to wetland and riparian vegetation would be minimal.

If perennial seeps or springs are present within areas affected by coal mine- or CBNG-related groundwater drawdown, and if the seeps or springs have hydraulic connections to the affected aquifers, there would be potential for cumulative groundwater drawdown-related effects to associated wetland vegetation (primarily wetland/fen areas). The cumulative impact to wetland vegetation due to groundwater drawdown, if it should occur, would be long term.

Invasive and Non-native Species

RFD-related construction and operation activities likely would result in the dispersal of noxious and invasive weed species within and beyond the surface disturbance boundaries, which would result in the displacement of native species and changes in species composition in the long term. The potential for these impacts would be higher in relation to the development of linear facilities (e.g., pipeline ROWs, oil- and gas-related road systems, etc.) than for site facilities (e.g., mines, power plants, etc.) due to the potential for dispersal of noxious weeds over a larger area. In the case of coal mining, the mining and reclamation plans approved by the WDEQ include plans to control invasion by weedy (invasive nonnative) plant species. Oil and gas operators currently are required to submit an Integrated Pest Management Plan as part of their applications to drill on federal oil and gas leases.

Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the Endangered Species Act (ESA), or are sensitive species considered candidates for such listing by the USFWS, as well as the BLM, FS, and WGFD sensitive species.

In accordance with the ESA, as amended, land management agencies in coordination with the USFWS must ensure that any action they authorize, fund, or carry out would not adversely affect a federally listed threatened or endangered species. In addition, as stated in Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-151), it also is BLM policy “to conserve listed species and the ecosystems on which they depend, and to ensure that actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list any special status species, either under the provisions of the ESA or other provisions” identified in the 6840 Policy.

As discussed in the Task 1D report, special status species known to occur in the study area include two federally listed species (Ute ladies-tresses and blowout penstemon), six BLM sensitive species (Porter’s

sagebrush, Laramie columbine, limber pine, many-stemmed spiderflower, Williams' wafer-parsnip, and Laramie false-sagebrush), and eight FS sensitive species (Barr's milkvetch, Iowa moonwart, foxtail sedge, prairie dodder, elliptic spike rush, Visher's buckwheat, common twinpod, and American cranberrybush). No WGFD sensitive species were identified in the study area.

Potential direct impacts to special status plant species in the study area could include the incremental loss or alteration of potential or known habitat, which would include an unquantifiable portion of the approximately 332,189 acres of cumulative vegetation disturbance (native vegetation and previously disturbed vegetation) associated with development-related activities. Direct impacts also could include the direct loss of individual plants within the study area depending on their location in relation to RFD activities. Indirect impacts could occur due to increased dispersal and establishment of noxious weeds, which may result in the displacement of special status plant species in the long term.

2.3.2.2 Year 2020 – Upper Production Scenario

General Vegetation

Potential impacts to vegetation as a result of RFD activities would be similar to those described under the 2020 – Lower Production Scenario, except approximately 3,451 additional acres would be disturbed as a result of increased coal mine production. Under this scenario, development-related activities in the study area are projected to result in the total cumulative disturbance of approximately 335,640 acres of vegetation (or approximately 4.2 percent of the study area) by the year 2020. Of the 335,640 acres, it is projected that 134,052 acres (40 percent) would occur in association with coal mining activities. Based on GIS mapping, approximately 42,897 acres (32 percent) and 83,112 acres (62 percent) would be associated with the short- and mixed-grass prairie and sagebrush shrubland communities, respectively.

Of the 335,640 acres of total cumulative vegetation disturbance, approximately 179,859 acres (54 percent) would be reclaimed by 2020. The remaining 155,781 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 134,052 acres of disturbance associated with coal mine development, it is projected that approximately 61,341 (46 percent) would be reclaimed by 2020. Of the remaining 72,711 acres of coal mining-related disturbance, it is projected that approximately 28,424 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 44,469 acres of disturbance would proceed concurrently with mining operations.

Wetland and Riparian Areas

Potential impacts to wetland and riparian vegetation as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of disturbance to wetland and riparian vegetation would be greater due to the increase in total projected disturbance acreage (an additional 3,451 acres) under this scenario.

Invasive and Non-native Species

Potential impacts related to invasive and non-native species would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of dispersing invasive and non-native species within and beyond the surface disturbance boundaries would increase due to the increased surface disturbance (an additional 3,451 acres) that would occur under this scenario.

Special Status Species

Potential impacts to special status species as result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of affecting potential or known habitat for special status plant species, or individual plants, would increase due to the increased surface disturbance (an additional 3,451 acres) that would occur under this scenario.

2.3.2.3 Year 2030 – Lower Production Scenario

General Vegetation

Potential impacts to vegetation as a result of RFD activities would be similar to those described under the 2020 – Lower Production Scenario, except approximately 77,189 additional acres would be disturbed. Under this scenario, development-related activities in the study area would result in the total cumulative disturbance of approximately 409,377 acres of vegetation (or approximately 5.2 percent of the study area) by the year 2030. Of the 409,377 acres, it is projected that 169,666 acres (41 percent) would occur in association with coal mining activities. Based on GIS mapping, approximately 57,686 acres (34 percent) and 105,193 acres (62 percent) would be associated with the short- and mixed-grass prairie and sagebrush shrubland communities, respectively.

Of the 409,377 acres of total cumulative vegetation disturbance, approximately 238,408 acres (58 percent) would be reclaimed by 2030. The remaining 170,970 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 169,666 acres of disturbance associated with coal mining activities, it is projected that approximately 89,074 acres (52 percent) would be reclaimed by 2030. Of the remaining 80,592 acres of coal mining-related disturbance, it is projected that approximately 31,447 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 49,146 acres of disturbance would proceed concurrently with mining operations.

Wetland and Riparian Areas

Potential surface disturbance-related impacts to wetland and riparian vegetation as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of disturbance to wetland and riparian vegetation would be greater due to the increase in total projected disturbance acreage (an additional 77,189 acres) under this scenario.

Potential impacts to wetland and riparian vegetation as a result of groundwater production and disposal would be the same as described under the 2020 – Lower Production Scenario with the following exception. Approximately 895 additional mmgpy of groundwater would be discharged in association with CBNG operations.

Invasive and Non-native Species

Potential impacts related to invasive and non-native species would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of dispersing invasive and non-native species within and beyond the surface disturbance boundaries would increase due to the increased surface disturbance (an additional 77,189 acres) that would occur under this scenario.

Special Status Species

Potential impacts to special status species as result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of affecting potential or known habitat for special status plant species, or individual plants, would increase due to the increased surface disturbance (an additional 77,189 acres) that would occur under this scenario.

2.3.2.4 Year 2030 – Upper Production Scenario

General Vegetation

Potential impacts to vegetation as a result of RFD activities would be similar to the 2020 – Lower Production Scenario, except approximately 91,527 additional acres would be disturbed. Under this scenario, past and projected activities in the study area would result in the total cumulative disturbance of approximately 423,716 acres of vegetation (or approximately 5.2 percent of the study area) by the

year 2030. Of the 423,716 acres, it is projected that approximately 182,577 acres (43 percent) would occur in association with coal mining activities. Based on GIS mapping, approximately 62,076 acres (34 percent) and 109,546 acres (60 percent) would be associated with the short- and mixed-grass prairie and sagebrush shrubland communities, respectively.

Of the 423,716 acres of total cumulative vegetation disturbance, approximately 247,575 acres (58 percent) would be reclaimed by 2030. The remaining 176,141 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 182,577 acres of disturbance associated with coal mine development, it is projected that approximately 97,988 acres (54 percent) would be reclaimed by 2030. Of the remaining 84,589 acres of coal mining-related disturbance, it is projected that approximately 32,609 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 51,980 acres of disturbance would proceed concurrently with mining operations.

Wetland and Riparian Areas

Potential surface disturbance-related impacts to wetland and riparian vegetation as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of disturbance to wetland and riparian vegetation would be greater due to the increase in total projected disturbance acreage (an additional 91,527 acres) under this scenario.

Potential impacts to wetland and riparian vegetation as a result of groundwater production and disposal would be the same as described under the 2020 – Lower Production Scenario with the following exception. Approximately 895 additional mmgpy of groundwater would be discharged in association with CBNG operations.

Invasive and Non-native Species

Potential impacts related to invasive and non-native species would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of dispersing invasive and non-native species within and beyond the surface disturbance boundaries would increase due to the increased surface disturbance (an additional 91,527 acres) that would occur under this scenario.

Special Status Species

Potential impacts to special status species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exception. The probability of affecting potential or known habitat for special status plant species, or individual plants, would increase due to the increased surface disturbance (an additional 91,527 acres) that would occur under this scenario.

2.4 Wildlife, Fisheries, and Related Habitat Values

2.4.1 Study Area

The study area for wildlife, fisheries, and related habitat values includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). The study area includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**).

2.4.2 Cumulative Impacts

Based on the Task 2 Report for the PRB Coal Review (AECOM 2011), a cumulative total of approximately 261,150 acres (3 percent) of wildlife habitat have been disturbed by development-related activities in the study area (as of 2008). Of the 261,150 acres of total habitat disturbance, approximately 91,228 acres (35 percent) have been associated with coal mine development.

Of the 261,150 acres of total cumulative habitat disturbance, approximately 102,855 acres (39 percent) have been reclaimed. The remaining 158,296 acres of habitat would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 91,228 total cumulative acres of habitat disturbance associated with coal mine development, approximately 29,648 acres (32 percent) have been reclaimed (as of end of 2008). Of the remaining 61,580 acres of disturbance, approximately 26,656 acres currently are not available for reclamation, as they are occupied by long-term mine facilities required during continuing operations. These areas would be reclaimed near the end of the mine life. Reclamation of the remaining 34,924 acres, which represent areas of active mining and areas where coal has been recovered but reclamation has not been completed, would proceed concurrently with coal mining.

Potential impacts to wildlife within the study area would be similar to those discussed in the Task 1D Report for the PRB Coal Review (AECOM 2012). In general, impacts to wildlife can be classified as short-term and long-term. Potential short-term impacts arise from habitat removal and disturbance associated with a project's development and operation (e.g., coal mines, CBNG wells, etc.) and would cease upon project completion and successful reclamation in a given area. Potential long-term impacts consist of permanent changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success, and habitat disturbance related to longer term projects (e.g., power plant facilities, rail lines, etc.). Direct impacts to wildlife populations as a result of development activities in the study area could include direct mortalities, habitat loss or alteration, habitat fragmentation, or animal displacement.

Habitat fragmentation from activities such as roads, well pads, mines, pipelines, and electrical power lines also can result in the direct loss of potential wildlife habitat. Other indirect habitat fragmentation effects such as increased noise, elevated human presence, dispersal of noxious and invasive weed species, and dust deposition from unpaved road traffic can extend beyond the surface disturbance boundaries. These effects result in overall changes in habitat quality, habitat loss, increased animal displacement, reductions in local wildlife populations, and changes in species composition. However, the severity of these effects on terrestrial wildlife would depend on factors such as sensitivity of the species, seasonal use, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, climate) (see the Task 1D report).

The effects to terrestrial wildlife from development activities within the study area under two production scenarios (lower and upper production scenarios) for the years 2020 and 2030 are presented below.

2.4.2.1 Year 2020 – Lower Production Scenario

Terrestrial Wildlife

Under this scenario, RFD activities in the study area are projected to result in an incremental loss or alteration of approximately 71,039 additional acres of habitat by 2020, resulting in a total cumulative disturbance of approximately 332,189 acres of habitat. Of the 332,189 acres (approximately 4.2 percent of the study area) of total cumulative habitat disturbance, it is projected that 130,601 total acres (39 percent) of cumulative habitat disturbance would be associated with coal mining activities.

Of the 332,189 acres of total cumulative habitat disturbance, approximately 177,763 acres (54 percent) of habitat would be reclaimed by 2020. The remaining 154,425 acres of habitat disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and project-specific permit requirements. Of the 130,601 acres of total cumulative habitat disturbance associated with coal mining activities, it is projected that approximately 59,245 acres (45 percent) would be reclaimed by 2020. Of the remaining 71,355 acres of coal mining-related disturbance, it is projected that approximately 27,931 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 43,425 acres of disturbance would proceed concurrently with mining operations.

Operations associated with RFD activities in the study area would result in the use of groundwater. It is assumed that all coal mine-produced water would continue to be consumed during operations. The annual water production associated with CBNG activities would be approximately 15,325 mmgpy. Up to approximately 14,818 mmgpy of CBNG-produced water would be discharged to impoundments, drainages, or playas and would be available for area wildlife (e.g., waterfowl). Although much of the water would evaporate or infiltrate into the ground, it is anticipated that substantial quantities of water would remain on the surface and would result in the expansion of wetlands, stock ponds, and reservoirs, potentially increasing waterfowl breeding and foraging habitats. As discussed in the Task 1D report, the median sodium concentration of CBNG-produced water from the Fort Union Formation is 270 mg/L. If sodium concentrations are maintained below 17,000 mg/L in the impoundments, the potential adverse effects to waterfowl would be minimal. CBNG water discharge is regulated by the WDEQ for both quantity and quality.

Game Species. Potential direct impacts to big game species (i.e., pronghorn, white-tailed deer, mule deer, elk, and moose) would include the incremental loss or alteration of approximately 71,039 additional acres of potential forage (native vegetation and previously disturbed vegetation) and ground cover associated with construction and operation of RFD activities (e.g., vegetation removal for coal mines and CBNG wells, ancillary facilities, and transportation and utility corridors). The potential total cumulative habitat disturbance would be approximately 332,189 acres. Indirect impacts to big game species would include increased habitat fragmentation effects as a result of increased noise levels and human presence, dispersal of noxious and invasive weed species, and dust effects from unpaved road traffic.

Assuming that adjacent habitats would be at or near carrying capacity, the variabilities associated with drought conditions, and the human activities in the study area, displacement of wildlife species (e.g., big game) as a result of RFD activities would create some unquantifiable reduction in wildlife populations.

As discussed in the Task 1D report, a number of big game habitat ranges occur within the study area. Certain habitat ranges are considered crucial for maintenance of game populations. In Wyoming, the WGFD and the BLM have established several categories based on seasonal use of the habitat. For example, crucial winter range areas are considered essential in determining a game population's ability to maintain itself at a certain level over the long term. Big game ranges within the study area that could be affected by RFD activities would include ranges for pronghorn, white-tailed deer, mule deer, elk, and moose. As discussed in the Task 2 report, discrete locations for most RFD disturbance and reclamation areas cannot be determined based on existing information. As a result, the spatial relationship between

projected future disturbance and reclamation areas for the RFD scenarios and the resource-specific information in the GIS layers cannot be determined. However, GIS layers for future coal reserves are available and have been used to provide some level of quantification of potential future coal mining-related impacts to big game ranges. This information is presented in **Table 2.4-1**.

Direct and indirect impacts to small game species (i.e., upland game birds, waterfowl, small game mammals) within the study area as a result of RFD activities would be the same as discussed above for big game species. Impacts would result from the incremental surface disturbance of approximately 332,189 total cumulative acres of potential wildlife habitat, increased noise levels and human presence, dispersal of noxious and invasive weed species, and dust effects from unpaved road traffic.

Table 2.4-1 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2020 – Lower Production Scenario

	Big Game Ranges (acres and percent affected)[2]					
Species[1]	**Crucial Winter**	**Severe Winter**	**Crucial Winter Yearlong**	**Winter Yearlong**	**Spring, Summer, Fall**	**Yearlong**
Pronghorn	NA	1,419 (3 percent)	0	51,664 (3 percent)	0	60,443 (1 percent)
White-tailed Deer	NA	NA	NA	0	NA	1,153 (0.1 percent)
Mule Deer	0	NA	0	6,962 (0.2 percent)	0	48,055 (1 percent)
Elk	629 (2 percent)	NA	0	439 (0.5 percent)	0	2,084 (0.6 percent)

1 There are no designated moose ranges in the vicinity of the coal mines in the eastern Wyoming PRB.

2 Reflects potential cumulative coal mine-related impacts to big game ranges based on GIS analysis. Includes approximate coal mined-out areas through 2008 and future coal reserve areas through 2020 for the Lower Production Scenario as presented in the Task 2 report.

Note: NA = not applicable.

Nongame Species. Potential direct impacts to nongame species (e.g., small mammals, raptors, passerines, amphibians, and reptiles) would include the incremental loss or alteration of approximately 71,039 additional acres of potential foraging and breeding habitats (native vegetation and previously disturbed vegetation) from construction and operation of RFD activities (e.g., vegetation removal for coal mines and CBNG wells, ancillary facilities, and transportation and utility corridors). The total cumulative area of potential habitat disturbance would be approximately 332,189 acres. Impacts also could result in mortalities of less mobile species (e.g., small mammals, reptiles, amphibians, and invertebrates), nest or burrow abandonment, and loss of eggs or young as a result of crushing from vehicles and equipment. Indirect impacts would include increased noise levels and human presence, dispersal of noxious weeds, and dust effects from unpaved road traffic. Assuming that adjacent habitats would be at or near carrying capacity, the variabilities associated with drought conditions, and human activities in the study area, displacement of wildlife species would result in an unquantifiable reduction in wildlife populations.

As discussed in the Task 1D report, a number of migratory bird species occur within the study area. In the event that RFD activities were to occur during the breeding season (April 1 through July 31), these activities could result in the abandonment of a nest site or territory or the loss of eggs or young, resulting in the loss of productivity for the breeding season. Loss of an active nest site, incubating adults, eggs, or young would not comply with the intent of the Migratory Bird Treaty Act (MBTA) and potentially could affect populations of important migratory bird species that may occur within the study area.

Breeding raptor species that occur within the study area include golden eagle, accipiters (Cooper's hawk and sharp-shinned hawk), buteos (red-tailed hawk and Swainson's hawk), falcons (American kestrel, merlin, and prairie falcon), osprey, and owls (barn owl, Eastern screech owl, great-horned owl, and long-eared owl) (BLM 2012b). (Note: Special status raptor species are discussed in the Special Status Species subsection below.) Potential direct impacts to raptors would result from the surface disturbance of nesting and foraging habitat in the study area. In the event that RFD activities were to occur during the breeding season (February 1 through July 31), these activities could result in the abandonment of a nest site or territory or the loss of eggs or young, resulting in the loss of productivity for the breeding season. As discussed above for migratory bird species, loss of an active nest site, incubating adults, eggs, or young would not comply with the intent of the MBTA.

New power line segments in the study area incrementally would increase the collision potential for migrating and foraging bird species (e.g., raptors and waterfowl) (Avian Power Line Interaction Committee [APLIC] 1994). However, collision potential typically is dependent on variables such as the location in relation to high-use areas (e.g., nesting, foraging, and roosting), line orientation to flight patterns and movement corridors, species composition, visibility, and design. In addition, new power lines could pose an electrocution hazard for raptor species attempting to perch on the structure. Configurations less than 1 kilovolt (kV) or greater than 69 kV typically do not present an electrocution potential, based on conductor placement and orientation (APLIC 1996). It is assumed that future permitting for power lines would require the use of appropriate raptor-deterring designs, thereby minimizing potential impacts. For example, SMCRA requires that surface coal mine operators use the best technology currently available to ensure that electric power lines are designed and constructed to minimize electrocution hazards to raptors. In addition, many of the power lines for CBNG development currently are being constructed underground.

Fisheries

Potential cumulative effects to fisheries as a result of RFD activities in the study area would be closely related to impacts to surface water resources. Relevance to groundwater resources depends on whether the aquatic habitat has a hydraulic connection to areas of aquifers affected by coal mine- or CBNG-related groundwater drawdown. In general, RFD activities could affect fish species in the following ways: 1) alteration or loss of habitat as a result of surface disturbance; 2) changes in water quality as a result of surface disturbance or introduction of contaminants into drainages; and 3) changes in available habitat as a result of water withdrawals or discharge. Under this scenario, approximately 154,425 total cumulative acres of unreclaimed surface disturbance would exist within the study area. This would be a 3 percent decrease in unreclaimed surface disturbance in comparison to base year (2008) conditions. Approximately 46 percent of the unreclaimed acreage in the study area would be related to coal mining activities. The potential effects of RFD activities on fisheries are discussed below.

Habitat Loss. RFD activities could result in the loss of aquatic habitat as a result of direct surface disturbance. As discussed in the introduction of Chapter 2.0, discrete locations for RFD disturbance and reclamation areas cannot be determined based on existing information. However, the RFD activities would involve the construction of additional linear facilities (e.g., pipeline projects, product gathering lines, and road systems associated with conventional oil and gas and CBNG activities) and site facilities (e.g., coal mine expansions) that could result in the loss of aquatic habitat. Typically, site-specific stream crossing methods and reclamation would be determined at the time of project permitting. Future coal mining also could remove intermittent or ephemeral streams and stock ponds in the Little Powder River, Upper Belle Fourche River, Upper Cheyenne River, and Antelope Creek subwatersheds. As discussed in the Task 1B Report for the PRB Coal Review (AECOM 2013b), coal mine permits provide for removal of first- through fourth-order drainages. During reclamation, third- and fourth-order drainages must be restored; first- and second-order drainages often are not replaced (Martin et al. 1988). Due to a lack of water on a consistent basis in the potentially affected streams, existing aquatic communities mainly are limited to invertebrates and algae that can persist in these types of habitats. The removal of stock ponds would eliminate habitat for invertebrates and possibly fish species. It is assumed that surface disturbance activities would not be allowed in perennial stream segments or reservoirs on public land that contain

game fish species. It is assumed that other types of RFD activities would not occur within stream channels nor remove ponds or reservoirs as part of construction or operation and, therefore, would not result in the direct loss or alteration of fish habitat.

Water Quality Effects on Habitat. Past and RFD activities would result in surface disturbance in each of the study area subwatersheds (with the exception of the North Fork Powder River), with unreclaimed disturbance areas ranging from 79 acres in the Little Bighorn River subwatershed to 39,293 acres in the Upper Belle Fourche River subwatershed. In general, perennial stream habitat in the study area is limited to the Little Powder River, headwater tributary streams and mainstem portion of the Upper Tongue River, a few streams in the northwestern portion of the study area, and reaches of various other rivers and streams. The predominant type of aquatic habitat in the study area consists of intermittent and ephemeral streams and scattered ponds and reservoirs. Warmwater game fish and nongame fish species are present in the perennial stream segments and numerous scattered reservoirs and ponds. Based on information presented in the Task 1D report, game fish and nongame fish occurrence has been reported in all subwatersheds within the study area with the exception of the Dry Fork Cheyenne River, Lightning Creek, and Middle North Platte River subwatersheds (AECOM 2012).

Surface disturbance activities can result in sediment input to waterbodies, which affects water quality parameters such as turbidity and bottom substrate composition. Contaminants also can be introduced into waterbodies through chemical characteristics of the sediment. Potential related effects on aquatic biota could include physiological stress, movement to avoid the affected area, or alteration of spawning or rearing areas (Waters 1995). Studies have shown that TDS levels in streams near reclaimed coal mine areas have increased from 1 to 7 percent (Martin et al. 1988). Typically, sedimentation effects are short-term in duration and localized in terms of the affected area. Suspended sediment concentrations would stabilize and return to typical background concentrations after construction activities have been completed. It is anticipated that sediment input associated with RFD disturbance areas would be minimized by implementation of appropriate erosion control measures, as would be determined during future project permitting.

The contribution of effects of coal mine development on fish species and their habitat was assessed using surface disturbance information. Of the approximately 154,425 acres of total unreclaimed surface disturbance that is projected to exist within the study area under this scenario, approximately 71,355 acres (46 percent) would be associated with coal mine development. This percentage provides a relative indicator of coal mining's potential contribution to water quality effects on fish habitat. However, as discussed in the Task 1B report (AECOM 2013b), the release of stormwater runoff from mine disturbance areas would be regulated by each mine's National Pollutant Discharge Elimination System (NPDES) permit; therefore, it should have little effect on drainages. Based on these permit requirements and implementation of required erosion control measures, it is assumed that coal mine-related impacts to fisheries as a result of stormwater discharge would be low.

The removal of streamside vegetation and the resultant reduction in shade and potential for increased bank erosion also could degrade aquatic habitats. It is assumed these types of impacts would be limited to intermittent and ephemeral streams, since a buffer protection zone typically is required for development activities near perennial streams. ROW clearing for linear projects could remove riparian vegetation at stream crossings. However, effects on aquatic habitat would be limited to a relatively small portion of the stream (up to 100 feet in width depending on the RFD activity). It is anticipated that reclamation procedures to restore riparian vegetation would be required during future project permitting, thereby minimizing impacts.

Water Quantity Effects on Habitat. Of the RFD activities, coal mining and CBNG development are the main types of activities that use or manage water as part of their operations. It is projected that all coal mine-produced water would continue to be consumed during operations. Based on data presented in the Task 2 report, total water production from CBNG wells in 2020 would be approximately 15,325 mmgpy, of which approximately 12,400 mmgpy would be discharged to on-channel impoundments/ephemeral

drainages. Based on current and projected trends, it is assumed that all or portions of the CBNG water discharged in the Antelope Creek, Crazy Woman Creek, Little Powder River, Middle Powder River, Upper Belle Fourche River, Upper Cheyenne River, Upper Powder River, and Upper Tongue River subwatersheds would be to on-channel impoundments/ephemeral drainages. Based on a study by the Wyoming Geological Survey (Payne and Saffer 2005) in the upper Beaver Creek drainage of the Wyoming PRB, a projected 72 percent of the CBNG water discharged to on-channel impoundments and ephemeral drainages is lost through infiltration and evaporation. Thus, related flow primarily is limited to within a few miles of the discharge outfall. Therefore, water quantity changes as a result of CBNG water discharge are not expected to affect fish populations in perennial streams in the study area subwatersheds.

Where perennial streams occur within the projected areas of cumulative coal mine- or CBNG-related groundwater drawdown, there would be a potential for related water quantity impacts to fish species, if the streams have a hydraulic connection to groundwater in affected water-bearing sand units of the Wasatch Formation. Due to the isolated nature of the water-bearing sand units and the limited extent of perennial stream reaches in the study area with base elevations below the groundwater elevations in the Wasatch Formation, as discussed in the Task 3B Report for the PRB Coal Review (AECOM 2009b), the cumulative impact to perennial stream flows, if it should occur, would be limited to isolated stream reaches.

Special Status Species

Special Status Wildlife Species. Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the ESA, or are considered candidates for such listing by the USFWS, as well as the BLM, FS, and WGFD sensitive species. Special status species potentially occurring in the study area are identified in Section 2.4.3.5 of the Task 1D report.

Potential impacts to special status terrestrial species would be similar to those discussed above for nongame wildlife (e.g., small mammals, birds, amphibians, and reptiles). Potential direct impacts would include the incremental loss or alteration of approximately 71,039 additional acres of potential habitat (native vegetation and previously disturbed vegetation) from construction and operation of RFD activities (e.g., vegetation removal for coal mines and CBNG wells, ancillary facilities, and transportation and utility corridors). The total cumulative area of potential habitat disturbance would be approximately 332,189 acres (approximately 4.2 percent of the study area). Impacts also could result in mortalities of less mobile species (e.g., small mammals, reptiles, and amphibians), nest or burrow abandonment, and loss of eggs or young as a result of crushing from vehicles and equipment. Indirect impacts would include increased noise levels and human presence, dispersal of noxious weeds, and dust effects from unpaved road traffic.

In general, direct and indirect impacts to special status species would result in a reduction in habitat suitability and overall carrying capacity in the study area. Development within potential habitat for special status species likely would decrease its overall suitability and potentially would reduce or preclude use of a species habitat due to increased activity and noise. Although future use of habitat by a special status species would be strongly influenced by habitat quality, the degree of these potential impacts would depend on a number of variables including the location of a nest or den site, the species' relative sensitivity, breeding phenology, and possible topographic shielding.

As discussed in the Task 1D report, the greater sage-grouse, a federal candidate species, has been identified as occurring within the study area. Additionally, a number of special status bird species (non-raptor species) have been identified as occurring within the study area including American bittern, white-faced ibis, trumpeter swan, mountain plover, long-billed curlew, black tern, western yellow-billed cuckoo, Lewis' woodpecker, olive-sided flycatcher, loggerhead shrike, sage thrasher, grasshopper sparrow, Baird's sparrow, sage sparrow, Brewer's sparrow, McCown's longspur, and chestnut-collared

longspur. In the event that RFD activities were to occur during the breeding season (April 1 through July 31), these activities could result in the abandonment of a nest site or territory or the loss of eggs or young, resulting in the loss of productivity for the breeding season.

Special status raptor species for which documented breeding has been reported in the study area include bald eagle, northern harrier, ferruginous hawk, peregrine falcon, short-eared owl, and western burrowing owl (BLM 2012b). Northern goshawk also may occur in the study area; however, suitable habitat is extremely limited. Potential direct impacts to raptors would result from the surface disturbance of breeding and foraging habitat within the study area. If present in or adjacent to the RFD activities, breeding raptors could abandon breeding territories, nest sites, or lose eggs or young as a result of construction and operation of these activities. Loss of an active nest site, incubating adults, eggs, or young would not comply with the intent of the MBTA and potentially could affect populations of important migratory bird species that may occur within the study area.

New power line segments in the study area incrementally would increase the collision potential for migrating and foraging bird species (e.g., raptors and waterfowl) (APLIC 1994). However, collision potential typically is dependent on variables such as the location in relation to high-use areas (e.g., nesting, foraging, and roosting), line orientation to flight patterns and movement corridors, species composition, visibility, and design. In addition, new power lines could pose an electrocution hazard for raptor species attempting to perch on the structure. Configurations less than 1 kV or greater than 69 kV typically do not present an electrocution potential, based on conductor placement and orientation (APLIC 1996). It is assumed that future permitting for power lines would require the use of appropriate raptor-deterring designs, thereby minimizing potential impacts. As discussed above, SMCRA requires that surface coal mine operators use the best technology currently available to ensure that electric power lines are designed and constructed to minimize electrocution hazards to raptors. In addition many of the power lines for CBNG development currently are being constructed underground.

As discussed in the Task 1D report, a total of 295 greater sage-grouse lek sites were identified in the study area as of 2008, of which 258 of the leks had disturbance-related impacts within the 2-mile protection buffer. As discussed in the introduction to Chapter 2.0, the spatial relationship between projected future disturbance and reclamation areas for the RFD scenarios and the resource-specific information in the GIS layers cannot be determined based on existing information. However, GIS layers for future coal reserves have been used to provide some quantification of potential future coal mining-related impacts. Based on GIS mapping of future coal reserve areas through 2020 for the lower production scenario as presented in the Task 2 report, and known lek site locations (WGFD 2011), four additional leks would be directly disturbed by coal mine development and two additional lek sites would occur within 2 miles of coal mining activities by 2020. However, an unquantifiable number of these lek sites initially could be impacted by CBNG activity, which would occur in advance of coal mine development. Potential direct impacts to greater sage-grouse, if present, could include abandonment of a lek site, or loss of eggs or young as a result of RFD activities.

Special Status Fish Species. As discussed in the Task 1D report, nine special status fish species potentially occur in the study area: flathead chub (Antelope Creek, Clear Creek, Crazy Woman Creek, Little Bighorn River, Little Powder River, Middle Fork Powder River, Middle Powder River, Salt Creek, South Fork Powder River, Upper Cheyenne River, Upper Powder River, and Upper Tongue River subwatersheds); plains topminnow (Antelope Creek and Upper Cheyenne River subwatersheds); Yellowstone cutthroat trout (Upper Tongue River subwatershed); sauger (Clear Creek, Upper Powder River, and Upper Tongue River subwatersheds); sturgeon chub (Upper Powder River subwatershed); goldeye (Clear Creek, Crazy Woman Creek, Little Powder River, Middle Powder River, and Upper Powder River subwatersheds); western silvery minnow (Little Missouri River, Little Powder River, and Middle Powder River subwatersheds); plains minnow (Antelope Creek, Clear Creek, Little Missouri River, Little Powder River, Middle Powder River, Salt Creek, South Fork Powder River, Upper Belle Fourche River, Upper Cheyenne River, Upper Powder River, and Upper Tongue River subwatersheds); and shovelnose sturgeon (Crazy Woman Creek and Upper Power River subwatersheds).

Potential impacts to special status fish species as a result of RFD activities would be similar to effects discussed above for fisheries, with the following exceptions. Surface disturbance as a result of past and RFD activities in the 14 subwatersheds identified above could alter habitat or affect water quality conditions for special status fish species. The projected total cumulative unreclaimed disturbance in the 14 subwatersheds as of 2020 would be 149,287 acres, of which 71,356 acres (48 percent) would be related to coal mining activities in four of the subwatersheds (Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River). Erosion control measures, as required by existing base year (2008) and future permits, and NPDES permit requirements would be implemented for each project. These measures would help minimize increased sediment input to stream segments that may contain one of more of the special status fish species. Therefore, it is anticipated that impacts to special status fish species would be low.

2.4.2.2 Year 2020 – Upper Production Scenario

Terrestrial Wildlife

Potential impacts to wildlife habitat under this scenario would be similar to those described under the 2020 – Lower Production Scenario, except approximately 3,451 additional acres of habitat would be disturbed. Under this scenario, past and RFD activities in the study area would result in the total cumulative disturbance of approximately 335,640 acres of habitat (or approximately 4.2 percent of the study area) by the year 2020. Of the 335,640 acres of total disturbance, it is projected that 134,052 acres (40 percent) would be associated with coal mining activities.

Of the 335,640 acres of total cumulative habitat disturbance, approximately 179,859 acres (54 percent) would be reclaimed by 2020. The remaining 155,781 acres of habitat disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 134,052 acres of habitat disturbance associated with coal mining activity, it is projected that approximately 61,341acres (46 percent) would be reclaimed by 2020. Of the remaining 72,711 acres of coal mining-related disturbance, it is projected that approximately 28,242 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 44,469 acres of disturbance would proceed concurrently with mining operations.

Game Species. Impacts to game species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. There would be slightly higher impacts to pronghorn, mule deer, and elk ranges as a result of increased coal mine development in the cumulative effects area (**Table 2.4-2**). Approximately 3,451 additional acres of potential small game species habitat would be disturbed under this scenario.

Nongame Species. Potential impacts to nongame species as a result of RFD activities would be the same as discussed for the 2020 – Lower Production Scenario, except approximately 3,451 additional acres of potential habitat would be disturbed under this scenario as a result of coal mining activities.

Fisheries. Under this scenario, impacts to fisheries as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, except the cumulative unreclaimed surface disturbance would be slightly higher (an additional 1,355 acres associated with coal mining activities). The higher level of unreclaimed surface disturbance could result in slightly higher sediment input to drainages. However, impacts to stream habitat that may support fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

Table 2.4-2 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2020 – Upper Production Scenario

Species[1]	Big Game Ranges (acres and percent affected)[2]					
	Crucial Winter	Severe Winter	Crucial Winter Yearlong	Winter Yearlong	Spring, Summer, Fall	Yearlong
Pronghorn	NA	1,419 (3 percent)	0	51,924 (3 percent)	0	61,780 (1 percent)
Mule Deer	0	NA	0	7,033 (0.2 percent)	0	48,688 (1 percent)
Elk	629 (2 percent)	NA	0	439 (0.5 percent)	0	2,087 (0.6 percent)

1 There are no designated moose ranges in the vicinity of the coal mines in the eastern Wyoming PRB. Coal mine-related impacts to designated white-tailed deer range would be the same as identified in **Table 2.4-1**.

2 Reflects potential cumulative coal mine-related impacts to big game ranges based on GIS analysis. Includes approximate coal mined-out areas through 2008 and future coal reserve areas through 2020 for the Upper Production Scenario as presented in the Task 2 report.

Note: NA = not applicable.

Special Status Species

Special Status Wildlife Species. Potential impacts to special status species as a result of RFD activities would be the same as discussed for the 2020 – Lower Production Scenario, except that approximately 3,451 additional acres of potential habitat would be disturbed under this scenario as a result of coal mining activities.

Potential impacts to greater sage-grouse lek sites as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario.

Special Status Fish Species. Under this scenario, impacts to special status fish species as a result of RFD activities would be the same as described for the 2020 – Lower Production Scenario, except the cumulative unreclaimed surface disturbance acreage would be slightly higher (an additional 1,355 acres) as a result of coal mining activities in the Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River subwatersheds. The higher level of surface disturbance could result in slightly higher sediment input to drainages. However, it is anticipated that impacts to special status fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

2.4.2.3 Year 2030 – Lower Production Scenario

Terrestrial Wildlife

Potential impacts to wildlife habitat as a result of RFD activities would be similar to those described under the 2020 – Lower Production Scenario, except approximately 77,189 additional acres would be disturbed. Under this scenario, past and RFD activities in the study area are projected to result in the total cumulative disturbance of approximately 409,377 acres of habitat (or approximately 5.2 percent of the study area) by the year 2030. Of the 409,377 acres of total disturbance, it is projected that approximately 169,666 acres (41 percent) would be associated with coal mining activity.

Of the 409,377 acres of total cumulative habitat disturbance, approximately 238,408 acres (58 percent) would be reclaimed by 2030. The remaining 170,970 acres of habitat disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and

permit requirements. Of the acres of habitat disturbance associated with coal mining activities, it is projected that approximately 89,074 acres (52 percent) would be reclaimed by 2030. Of the remaining 80,592 acres of coal mining-related disturbance, it is projected that approximately 31,477 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 49,146 acres of disturbance would proceed concurrently with mining operations.

Game Species. Impacts to game species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on GIS analysis, there would be slightly higher impacts to pronghorn, mule deer, and elk ranges as a result of increased coal mine development in the cumulative effects area (**Table 2.4-3**). Approximately 77,189 additional acres of potential small game species habitat would be disturbed under this scenario, of which approximately 39,066 acres (51 percent) would be associated with coal mining activities.

Table 2.4-3 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2030 – Lower Production Scenario

Species[1]	Big Game Ranges (acres and percent affected)[2]					
	Crucial Winter	Severe Winter	Crucial Winter Yearlong	Winter Yearlong	Spring, Summer, Fall	Yearlong
Pronghorn	NA	1,419 (3 percent)	0	63,366 (3 percent)	0	87,822 (2 percent)
Mule Deer	0	NA	0	7,530 (0.2 percent)	0	64,534 (2 percent)
Elk	629 (2 percent)	NA	0	439 (0.5 percent)	0	2,190 (0.6 percent)

1 There are no designated moose ranges in the vicinity of the coal mines in the eastern Wyoming PRB. Coal mine-related impacts to designated white-tailed deer range would be the same as identified in **Table 2.4-1**.

2 Reflects potential cumulative coal mine-related impacts to big game ranges based on GIS analysis. Includes approximate coal mined-out areas through 2008 and future coal reserve areas through 2030 for the Lower Production Scenario as presented in the Task 2 report.

Note: NA = not applicable.

Potential impacts associated with RFD-related groundwater production and disposal would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Approximately an additional 895 mmgpy of CBNG-produced water would be discharged, resulting in an increase in water availability for area wildlife (e.g., waterfowl).

Nongame Species. Potential impacts to nongame species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, except approximately 77,189 additional acres of potential habitat would be disturbed under this scenario. Approximately 51 percent of this acreage (39,066 acres) would be associated with coal mining activities.

Fisheries. Under this scenario, impacts to fisheries as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. RFD activities would result in an additional 16,544 acres of cumulative unreclaimed surface disturbance. The higher level of unreclaimed surface disturbance could result in higher sediment input to drainages. Most of the increased surface disturbance would occur in the Antelope Creek, Clear Creek, Upper Belle Fourche River, Upper Cheyenne River, and Upper Tongue River subwatersheds. It is anticipated that impacts to

fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

CBNG water discharge-related impacts to fisheries would be the same as described under the 2020 - Lower Production Scenario, with the following exceptions. By 2030, it is projected that CBNG development and related water discharge to on-channel impoundments and ephemeral drainages also would occur in the Dry Fork Cheyenne River and Lightning Creek subwatersheds. Based on data presented in the Task 2 report, total water production from CBNG wells in the study area would be approximately 16,220 mmgpy (an increase of approximately 895 mmgpy). However, 6,193 fewer mmgpy are projected to be discharged to on-channel impoundments/ephemeral drainages. Based on the relatively low discharge volumes and conveyance loss through infiltration and evaporation (approximately 72 percent), there would be no related effect to perennial streams.

Special Status Species

Special Status Wildlife Species. Potential impacts to special status species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, except approximately 77,189 additional acres of potential habitat would be disturbed under this scenario. Approximately 51 percent of this acreage (39,066 acres) would be associated with coal mining activities.

Potential impacts to greater sage-grouse lek sites as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on GIS mapping of future coal reserve areas through 2030 for the lower production scenario as presented in the Task 2 report, and known lek site locations (WGFD 2011), two additional leks would be directly disturbed by coal mine development.

Special Status Fish Species. Under this scenario, impacts to special status fish species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. An additional 16,750 cumulative acres of unreclaimed surface disturbance would exist in the 14 subwatersheds where special status fish species potentially occur, of which approximately 9,237 acres (55 percent) would be related to coal mining activities in the Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River subwatersheds. The higher level of unreclaimed surface disturbance could result in slightly higher sediment input to drainages. However, it is anticipated that associated impacts to special status fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

CBNG water discharge-related effects to special status fish species would be the same described under the 2020 – Lower Production Scenario, with the following exceptions. Approximately 15,667 mmgpy of CBNG produced groundwater would be discharged in the 14 subwatersheds with potential special status fish species occurrence (an increase of approximately 342 mmgpy); however, approximately 6,746 fewer mmgpy would be discharged to on-channel impoundments/ephemeral drainages.

2.4.2.4 Year 2030 – Upper Production Scenario

Terrestrial Wildlife

Potential impacts to wildlife habitat as a result of RFD activities would be similar to those under the 2020 - Lower Production Scenario, except approximately 91,527 additional acres would be disturbed. Under this scenario, past and RFD development activities in the study area would result in the total cumulative disturbance of approximately 423,716 acres of habitat (or approximately 5.2 percent of the study area) by the year 2030. Of the 423,716 acres of total disturbance, it is projected that 182,577 acres (43 percent) would be associated with coal mining activities.

Of the 423,716 acres of total cumulative habitat disturbance, approximately 247,575 (58 percent) would be reclaimed by 2030. The remaining 176,141 acres of habitat disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and

permit requirements. Of the 182,577 acres of habitat disturbance associated with coal mining activities, it is projected that approximately 97,988 acres (54 percent) would be reclaimed by 2030. Of the remaining 84,589 acres of coal mining-related disturbance, it is projected that approximately 32,609 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 51,980 acres of disturbance would proceed concurrently with mining operations.

Game Species. Impacts to game species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on GIS analysis, there would be increased impacts to pronghorn, mule deer, and elk ranges as a result of coal mining activities in the cumulative effects area (**Table 2.4-4**). Impacts to small game species would be the same as described under the 2020 – Lower Production Scenario, except approximately 91,527 additional acres of potential habitat would be disturbed under this scenario, of which approximately 51,976 acres (57 percent) would be associated with coal mining activities.

Table 2.4-4 Potential Cumulative Disturbance to Big Game Ranges from Coal Mine Development under the Year 2030 – Lower Production Scenario

Species[1]	Big Game Ranges (acres and percent affected)[2]					
	Crucial Winter	Severe Winter	Crucial Winter Yearlong	Winter Yearlong	Spring, Summer, Fall	Yearlong
Pronghorn	NA	1,419 (3 percent)	0	67,409 (4 percent)	0	94,847 (2 percent)
Mule Deer	0	NA	0	7,694 (0.2 percent)	0	66,716 (2 percent)
Elk	629 (2 percent)	NA	0	439 (0.5 percent)	0	2,209 (0.6 percent)

[1] There are no designated moose ranges in the vicinity of the coal mines in the eastern Wyoming PRB. Coal mine-related impacts to designated white-tailed deer range would be the same as identified in **Table 2.4-1**.

[2] Reflects potential cumulative coal mine-related impacts to big game ranges based on GIS analysis. Includes approximate coal mined-out areas through 2008 and future coal reserve areas through 2030 for the Upper Production Scenario as presented in the Task 2 report.

Note: NA = not applicable.

Potential impacts associated with RFD-related groundwater production and disposal would be the same as described under the 2020 – Lower Production Scenario, with the following exception. Approximately 895 additional mmgpy of CBNG-produced water would be discharged, resulting in an increase in water availability for area wildlife (e.g., waterfowl).

Nongame Species. Potential impacts to nongame species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, except approximately 91,527 additional acres of potential habitat would be disturbed under this scenario. Approximately 57 percent of this acreage (51,976 acres) would be associated with coal mining activities.

Fisheries. Under this scenario, impacts to fisheries as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. RFD activities would result in an additional 21,715 acres of cumulative unreclaimed surface disturbance, of which approximately 13,233 acres (61 percent) would be related to increased coal mine production in the Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River subwatersheds. However, it is anticipated that impacts to fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

CBNG water discharge-related impacts to fisheries would be the same as described under the 2020 - Lower Production Scenario, with the following exceptions. By 2030, it is projected that CBNG development and related water discharge to on-channel impoundments and ephemeral drainages also would occur in the Dry Fork Cheyenne River and Lightning Creek subwatersheds. Based on data presented in the Task 2 report, total water production from CBNG wells in the study area would be approximately 16,220 mmgpy (an increase of approximately 895 mmgpy). However, 6,193 fewer mmgpy are projected to be discharged to on-channel impoundments/ephemeral drainages. Based on the relatively low discharge volumes and conveyance loss through infiltration and evaporation (approximately 72 percent), there would be no related effect to perennial streams.

Special Status Species

Special Status Wildlife Species. Potential impacts to special status species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, except approximately 91,527 additional acres of potential habitat would be disturbed under this scenario. Approximately 57 percent of this acreage (51,976 acres) would be associated with coal mining activities.

Potential impacts to greater sage-grouse lek sites as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Based on GIS mapping of future coal reserve areas through 2030 for the Upper Production Scenario, as presented in the Task 2 report, and known lek site locations (WGFD 2011), two additional leks would be directly disturbed by coal mine development.

Special Status Fish Species. Under this scenario, impacts to special status fish species as a result of RFD activities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. An additional 21,921 cumulative acres of unreclaimed surface disturbance would exist in the 14 subwatersheds where special status fish species potentially occur, of which approximately 13,233 acres (60 percent) would be related to coal mining activities in the Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River subwatersheds. The higher level of unreclaimed surface disturbance could result in slightly higher sediment input to drainages. However, it is anticipated that associated impacts to special status fish species would be low, based on implementation of erosion control measures and NPDES permit requirements.

CBNG water discharge-related effects to special status fish species would be the same described under the 2020 – Lower Production Scenario, with the following exceptions. Approximately 15,667 mmgpy of CBNG produced groundwater would be discharged in the 14 subwatersheds with potential special status fish species occurrence (an increase of approximately 342 mmgpy); however, approximately 6,746 fewer mmgpy would be discharged to on-channel impoundments/ephemeral drainages.

2.5 Grazing

2.5.1 Study Area

The study area for grazing includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**). Private lands comprise most of the surface ownership in the study area.

2.5.2 Cumulative Impacts

As described in the Task 2 Report for the PRB Coal Review (AECOM 2011), a total of approximately 261,150 acres of vegetation have been disturbed by development activities in the study area (as of end of 2008). Of the 261,150 acres of total disturbance, approximately 91,228 acres (35 percent) were associated with coal mining activities.

Of the 261,150 acres of total cumulative disturbance, approximately 102,855 acres (39 percent) have been reclaimed. The remaining 158,296 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Of the 91,228 total cumulative acres of vegetation disturbance associated with coal mine development, approximately 29,648 acres (32 percent) have been reclaimed (as of end of 2008). Of the remaining 61,580 acres of disturbance, approximately 26,656 acres currently are not available for reclamation, as they are occupied by long-term facilities that are needed to conduct mining operations. These areas would be reclaimed near the end of the mine life. Reclamation of the remaining 34,924 acres, which represent areas of active mining and areas where coal has been recovered but reclamation has not been completed, would proceed concurrently with coal mining.

In general, potential impacts to grazing and other agricultural uses in the study area as a result of past and RFD activities can be classified as short-term and long-term. Potential short-term impacts arise from the temporary loss of forage as a result of vegetation removal/disturbance, temporary loss of animal unit months (AUMs), temporary loss of water-related range improvements (e.g., improved springs, water pipelines, stock ponds) and other range improvements (e.g., fences, cattle guards, etc.), and restricted movement of livestock within an allotment due to a project's development and operation (e.g., coal mines, etc.). These impacts would cease following successful reclamation and replacement of water-related and other range improvements. The discharge of CBNG-produced water could increase the availability of water to livestock, which may offset the temporary loss of water-related range improvements. CBNG water discharge is regulated by the WDEQ for both quantity and quality; therefore, potential effects to livestock would be minimal. Potential long-term impacts consist of the permanent loss of forage productivity in areas that would not be reclaimed in the near term (e.g., power plant sites, etc.). Indirect impacts may include dispersal of noxious and invasive weed species within and beyond the surface disturbance boundaries, which would decrease the amount of desirable forage available for livestock grazing in the long term.

Based on existing information, discrete locations for future well sites and disturbance footprints associated with mining of future coal reserves currently are unknown. As a result, the location of these future disturbance areas, and locations of related reclamation areas, in relation to BLM- and FS-administered rangeland cannot be determined. However, in an effort to quantify potential impacts to grazing as a result of RFD activities, the total number of potentially affected AUMs (regardless of land ownership) has been determined for each scenario and time period in this study.

The effects to grazing and other agricultural uses from RFD activities in the study area under two production scenarios (lower and upper) for the years 2020 and 2030 are discussed below.

2.5.2.1 Year 2020 – Lower Production Scenario

Grazing

General impacts to grazing would be the same as described in Section 2.5.2. Under this scenario, past and RFD activities in the study area would result in approximately 332,189 acres of total cumulative disturbance on BLM- and FS-administered, state, and private lands by 2020. Of this total, approximately 177,763 acres would be reclaimed by 2020. Based on an average stocking rate of 6 acres per AUM, this disturbance would result in the temporary loss of approximately 55,365 AUMs, of which approximately 29,627 AUMs would have been recovered by 2020 following successful reclamation. Of the remaining 25,738 AUMs, approximately 46 percent (11,839 AUMs) would be related to coal mining activities and would be recovered following successful reclamation. Reclamation would occur concurrent with, or following the completion of, operations, depending on the type of project. Impacts to range improvements potentially could occur, depending on their location in relation to the RFD activities.

Other Agricultural Uses

It is projected that by 2020, approximately 130,601 total cumulative acres of disturbance would occur in association with coal mining activities, inclusive of approximately 2,015 acres (approximately 1.5 percent) of agricultural land. Other RFD activities could result in short- and long-term impacts to agricultural land, depending on their spatial relationship. Short-term impacts would include the loss of crop production during development and operational phases of a project. Long-term impacts would include the permanent loss of agricultural land due the development of permanent facilities (e.g., power plants, railroads, etc.).

2.5.2.2 Year 2020 – Upper Production Scenario

Grazing

Potential impacts to livestock grazing as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. An additional 575 AUMs temporarily would be lost as a result of the projected 3,451 acres of additional surface disturbance. Of the approximately 55,940 total AUMs lost as a result of past and projected development-related disturbance, approximately 29,976 AUMs would have been recovered following successful reclamation. Of the remaining 25,963 AUMs, approximately 47 percent (12,118 AUMs) would be related to coal mining activities and would be recovered following successful reclamation. Additional impacts to range improvements and water-related range improvements potentially could occur as a result of the increased level of surface disturbance.

Other Agricultural Uses

Impacts to agricultural lands as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exception. An additional 3,451 acres of disturbance would occur as a result of coal mine development, inclusive of approximately 11 additional acres of agricultural land.

2.5.2.3 Year 2030 – Lower Production Scenario

Grazing

Potential impacts to livestock grazing as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. Approximately 12,865 AUMs temporarily would be lost as a result of 77,189 acres of additional surface disturbance. Of the approximately 68,229 total AUMs lost as a result of past and projected development-related disturbance, approximately 39,735 AUMs would have been recovered following successful reclamation. Of the remaining 28,494 AUMs, approximately 47 percent (13,423 AUMs) would be related to coal mining activities and would be recovered following successful reclamation. Additional impacts to range

improvements and water-related range improvements potentially could occur as a result of the increased level of surface disturbance.

Other Agricultural Uses

Impacts to agricultural lands as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exception. Approximately 39,066 additional acres of disturbance would occur, inclusive of approximately 549 additional acres of agricultural land.

2.5.2.4 Year 2030 – Upper Production Scenario

Grazing

Potential impacts to livestock grazing as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exceptions. An additional 15,254 AUMs temporarily would be lost as a result of 91,527 acres of additional surface disturbance. Of the approximately 70,619 total AUMs lost as a result of past and projected development-related disturbance, approximately 41,262 AUMs would have been recovered following successful reclamation. Of the remaining 29,357 AUMs, approximately 48 percent (14,098 AUMs) would be related to coal mining activities and would be recovered following successful reclamation. Additional impacts to range improvements and water-related range improvements potentially could occur as a result of the increased level of surface disturbance.

Other Agricultural Uses

Impacts to agricultural lands as a result of past and RFD activities would be similar to those described under the 2020 – Lower Production Scenario, with the following exception. Approximately 51,976 additional acres of disturbance would occur, inclusive of approximately 701 additional acres of agricultural land.

2.6 Land Use and Recreation

2.6.1 Study Area

The study area for land use and recreation includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**), with private lands comprising most of the surface ownership in the study area. Conversely, the majority of the mineral ownership in the study area is federal (**Figure 1-4**). A somewhat larger perimeter around this primary study area was considered for wilderness issues because of the greater sensitivity (both practical and statutory) that wilderness and potential wilderness areas embody.

2.6.2 Cumulative Impacts

Based on the Task 2 Report for the PRB Coal Review (AECOM 2011), a total of approximately 261,150 acres (3 percent) of land area have been disturbed by development-related activities in the study area as of the end of 2008. Of this total, approximately 91,228 acres of disturbance (35 percent of the total) were the result of coal mining activities.

Of the total disturbance acreage, approximately 102,855 acres (39 percent) have been reclaimed. Reclamation of the remaining 158,296 acres of disturbance would occur concurrently with, or following the completion of operations, depending on the type of development activity. A coal mine, for example, would be reclaimed incrementally (with the exception of permanent facilities areas) as portions of the mine are completed. Oil and gas projects would be reclaimed following a project's or facility's completion. Disturbance from a power plant or other major industrial type project would continue for the life of the project. In general, reclamation would be guided by permit requirements, depending on the type of development activity.

Approximately 29,648 acres (32 percent) of the total 91,228 acres of disturbance associated with coal mine development were reclaimed as of the end of 2008. Of the remaining 61,580 acres of disturbance, approximately 26,656 acres currently are not available for reclamation, as they are occupied by long-term facilities that are needed to conduct mining operations. These areas would be reclaimed near the end of the mine life. Reclamation of the remaining 34,924 acres, which represent areas of active mining and areas where coal has been recovered but reclamation has not been completed, would proceed concurrently with coal mining.

Potential effects of past and RFD activities on land use and recreation may be either short- or long-term in nature, although the time frames involved would not be consistent, varying with the type of development. The effects of a coal mine, for example, would be considered short-term. Although the land use would change (most likely from rangeland or agriculture) to a mine during operations, the land use would return to range or agriculture once the economically recoverable coal had been removed and the disturbance area successfully reclaimed. In contrast, a power plant or an urban community development would be considered long-term as the change in use virtually would be permanent, lasting for the economic life of the activity, or longer. Even if a community becomes obsolete (ghost town scenarios are common in the natural resource driven history of the West), there often are no requirements or standards for reclamation of urban developments.

In general, short-term effects to land use and recreation would occur during construction and operation of those development-related activities that have a definite end date (e.g., oil and gas wells, coal mine pits), with requirements and standards for reclamation that would return the land to its original use or end the effect on recreation opportunities. Long-term effects would be associated with development-related activities that have a long and indeterminate life expectancy (e.g., power plants) and, in some instances (e.g., railroads), no expectation of future reclamation.

The potential effects of projected RFD activities on land use and recreation opportunities in the study area under two (lower and upper) coal production scenarios are discussed below for the years 2020 and 2030.

2.6.2.1 Year 2020 – Lower Production Scenario

Land Use, Access, and Easements

Under this scenario, past and RFD activities in the study area would result in a total disturbance of approximately 332,189 acres (approximately 4.2 percent of the study area) by 2020. Of the 332,189 acres, it is projected that 130,601 acres (39 percent) of the disturbance would be associated with coal mining activities. It is assumed that a substantial majority of the directly affected land use would be grazing land, which comprises the majority (approximately 85 percent) of the study area, with agricultural land disturbance following as a distant second. It is expected that this pattern would apply to both coal-related disturbance and total cumulative disturbance.

Approximately 177,763 acres (53 percent) of the total 332,189 acres of disturbance would be reclaimed by 2020. The remaining 154,425 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. A relatively small, but unquantifiable, portion of the total disturbance would remain disturbed over the long term. Of the 130,601 acres of disturbance associated with coal mine development, it is projected that approximately 59,245 acres (45 percent) would be reclaimed by 2020. Of the remaining 71,355 acres of coal mining-related disturbance, it is projected that approximately 27,931 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities, which would be reclaimed near the end of each mine's life. Reclamation of the remaining 43,425 acres of disturbance would proceed concurrently with mining operations.

A large, but unquantifiable, majority of the anticipated disturbance under this scenario would occur on split estates (privately owned surface lands with federally owned minerals). This would result in continued conflicts between surface users, which are mainly ranching interests, and minerals developers. There also may be conflicts with some dispersed rural residences, although specific locations cannot be identified at this time.

It is anticipated there would be additional expansion of urban residential and commercial development as a result of the projected 21 percent growth in population in Campbell County (between the 2010 Census and 2020) and 11 percent growth in Sheridan County. Campbell and Sheridan counties were used for this study as a proxy for the Wyoming PRB study area because the majority of the population increases are projected to occur in these counties. (See the Task 3C Report for the PRB Coal Review, Social and Economic Effects [AECOM 2013a] for additional information on employment and population issues in the study area.) A majority of the new urban development would be expected to occur adjacent to existing communities, including primarily Gillette and Sheridan. These communities would account for approximately 60 and 19 percent of the population growth in Campbell and Sheridan counties, respectively. Most of this development would occur on land that is currently in use for grazing or agriculture.

Mineral development would comply with state and federal laws and regulations, but would be exempt from local land use regulation as stipulated by state law.

Recreation

Few, if any, of the developed recreation sites in the study area would be affected by RFD-related disturbance under this scenario. As most of the projected disturbance area would occur on privately owned surface land, the extent of effects on dispersed recreation activities largely would depend on whether the disturbance areas had been open to public or private lease hunting. It is projected that RFD activities, especially the dispersed development associated with CBNG and, to a lesser extent, conventional oil and gas, would tend to exacerbate the trend toward a reduction in private land available

for public hunting, which has been observed by WGFD in recent years (Jahnke 2012). A reduction in available private land for dispersed recreation would contrast with the anticipated increase in demand for recreational opportunities and would tend to push more recreationists toward public lands where the BLM has projected a 5 percent increase in use every 5 years for most recreational activities (BLM 2003).

It is expected that the RFD activities also would tend to expand and exacerbate the qualitative degradation of the dispersed recreation experience, in general, and of the hunting experience, in particular, as reported by the WGFD (Jahnke 2005). As noted in the Task 1D Report of the PRB Coal Review (AECOM 2012), a reduction in land available for hunting also makes herd management more difficult for the WGFD and reduces its hunting derived revenues (Shorma 2005).

Approximately 177,763 acres (53 percent) of the cumulative total of 332,189 acres of disturbance would be reclaimed by 2020. The remaining 154,425 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. After coal mining and oil and gas development activities have been completed, and reclamation successfully accomplished, many of the adverse effects on dispersed recreation activities would be substantially reduced.

Recreation planning for the study area would be affected to the degree that assumptions used in previous planning efforts might no longer be valid. These assumptions, particularly regarding supply and demand considerations, should be revisited and updated as development proposals become more concrete.

Wilderness and Roadless Areas

No direct effects on wilderness or roadless areas would be expected as a result of RFD activities under this scenario. There are no designated wilderness areas in the study area, and mineral development would not be permitted in the Fortification Creek Wilderness Study Area until, and unless, Congress acts to remove it from wilderness consideration.

2.6.2.2 Year 2020 – Upper Production Scenario

Land Use, Access, and Easements

Potential land use effects resulting from RFD activities in the study area essentially would be the same as those described under the 2020 – Lower Production Scenario, except approximately 3,451 additional acres would be disturbed as a result of increased coal production. Under this scenario, a total of approximately 335,640 acres (approximately 4.2 percent of the study area) would be disturbed by the year 2020. Of the 335,640 acres, it is projected that 134,052 acres (40 percent) would be associated with coal mining activities.

Of the 335,640 acres of total disturbance, approximately 179,859 (53 percent) would be reclaimed by 2020. The remaining 155,781 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. Approximately 61,341 acres (46 percent) of the coal mining-related disturbance would be reclaimed by 2020. Of the remaining 72,711 acres of coal mining-related disturbance, it is projected that approximately 28,242 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 44,469 acres of disturbance would proceed concurrently with mining operations.

Under this scenario, the expected effects on land use in the study area would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Both the cumulative disturbance area and the cumulative unreclaimed disturbance area would be 1.0 percent larger. The population in Campbell County is projected to increase by approximately 23 percent, or would be 2 percent greater than under the 2020 – Lower Production Scenario. Population growth in Sheridan County, although projected to increase more than under the 2020 – Lower Production

Scenario, would be similar at 11 percent. Overall, the projected increase in the urban development area would be comparable to the 2020 – Lower Production Scenario.

Recreation

The effects of RFD activities in the study area on recreation resources and activities would be similar to those described under the 2020 – Lower Production Scenario, except the magnitude would be increased in approximate proportion to the 1.0 percent increase in unreclaimed acreage.

Wilderness and Roadless Areas

The direct effects on wilderness and roadless areas under this scenario would be the same as described under the 2020 – Lower Production Scenario.

2.6.2.3 Year 2030 – Lower Production Scenario

Land Use, Access, and Easements

Potential land use effects from RFD activities in the study area would be similar to those described under the 2020 – Lower Production Scenario, except a total of approximately 409,377 acres (or approximately 5.2 percent of the study area) would be disturbed. This would be an increase of 77,188 acres, or 23 percent higher than the disturbance under the 2020 – Lower Production Scenario. It is projected that 169,666 acres (41 percent of the total) would be associated with coal mining activities.

Approximately 238,408 acres (58 percent of the total disturbance) would be reclaimed by 2030, leaving 170,970 acres of unreclaimed disturbance. The unreclaimed area would be 10 percent greater than under the 2020 – Lower Production Scenario. The unreclaimed areas would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. By 2030, a projected 80,592 acres (47 percent) of the coal mining-related disturbance would remain unreclaimed. Of this acreage, it is projected that approximately 31,447 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 49,146 acres of disturbance would proceed concurrently with mining operations.

Under this scenario, the expected effects on land use in the study area would be the same as described under the 2020 – Lower Production Scenario, except the cumulative disturbance area would be 23 percent larger, and the unreclaimed disturbance area would be 10 percent larger. The increases in total disturbance, and especially unreclaimed disturbance, would result in proportionately greater conflicts with existing land uses, which primarily would be grazing and agricultural uses. The population is projected to increase by approximately 27 percent in Campbell County (6 percent greater than under the 2020 – Lower Production Scenario) and 12 percent in Sheridan County (1 percent greater than under the 2020 – Lower Production Scenario), which would result in a proportional increase in the urban development area.

Recreation

Under this scenario, the effects on recreation resources and activities would be similar to those described under the 2020 – Lower Production Scenario, except the magnitude would increase in approximate proportion to the 10 percent increase in unreclaimed acreage.

Wilderness and Roadless Areas

The direct effects on wilderness and roadless areas under this scenario would be the same as described under the 2020 – Lower Production Scenario.

2.6.2.4 Year 2030 – Upper Production Scenario

Land Use, Access, and Easements

Potential impacts to land use as a result of RFD activities would be similar to those described under the 2020 – Lower Production Scenario, except a total of approximately 423,716 acres (approximately 5.2 percent of the study area) would be disturbed. This would be an increase of approximately 91,527 acres, or 26 percent higher than the disturbance under the 2020 – Lower Production Scenario. A projected 182,577 acres (43 percent of the disturbance) would result from coal mining activities.

Approximately 247,575 acres (58 percent of the total disturbance) would be reclaimed by 2030, and the unreclaimed acreage would be 176,141 acres, or approximately 14 percent greater than the unreclaimed acreage under the 2020 – Lower Production Scenario. The unreclaimed areas would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. By 2030, approximately 97,988 acres of the coal mining-related disturbance (54 percent) would be reclaimed. Of this acreage, it is projected that approximately 32,609 acres would be unavailable for concurrent reclamation due to the presence of long-term facilities that would be reclaimed near the end of each mine's life. Reclamation of the remaining 51,980 acres of disturbance would proceed concurrently with mining operations.

Under this scenario, the expected effects on land use in the study area would be of the same type as described under the 2020 – Lower Production Scenario, except the cumulative disturbance area would be approximately 26 percent larger, and the unreclaimed disturbance area would be approximately 14 percent larger. The increases in total disturbance, and especially unreclaimed disturbance areas, would result in proportionately greater conflicts with existing land uses, which primarily would be grazing and agricultural uses. The population is projected to increase by approximately 33 percent in Campbell County (12 percent greater than under the 2020 – Lower Production Scenario) and 13 percent in Sheridan County (2 percent greater than under the 2020 – Lower Production Scenario), which would result in a proportional increase in the urban development area.

Recreation

Under this scenario, the effects on recreation resources and activities as a result of RFD activities in the study area essentially would be the same as described under the 2020 – Lower Production Scenario, except the magnitude would increase in approximate proportion to the 14 percent increase in unreclaimed acreage.

Wilderness and Roadless Areas

The direct effects on wilderness and roadless areas under this scenario would be the same as described under the 2020 – Lower Production Scenario.

2.7 Transportation and Utilities

2.7.1 Study Area

The study area for transportation and utilities includes all or portions of Sheridan, Johnson, Campbell, and Converse counties, inclusive of all or portions of 18 subwatersheds (fourth order) (**Figure 1-1**). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS (**Figure 1-2**). State and private lands also are included in the study area (**Figure 1-3**).

2.7.2 Cumulative Impacts

Generally, the amount of disturbance and the relative amount of unreclaimed disturbance associated with RFD activities are not likely to directly affect transportation systems in the study area. Site-specific instances of disturbance may require that segments of highways, pipelines, transmission lines, or railroads be moved to accommodate expansion of certain coal mines. Regardless, construction of alternative routing would be required prior to closing existing links so any disruptive effects on transportation systems would be minimal.

As discussed in the Task 2 Report for the PRB Coal Review (AECOM 2011), the coal mines in Subregion 1 (North Gillette) currently ship most of their coal via the east-west Burlington Northern and Santa Fe Railroad (BNSF) rail line through Gillette. The coal mines in this subregion produced 76 mmtpy of coal in 2008, which was 30 percent of the estimated 250 mmtpy capacity of the BNSF rail line. The coal mines in Subregions 2 and 3 (South Gillette and Wright, respectively) produced approximately 368 mmtpy of coal in 2008, which was 82 percent of the estimated 450 mmtpy capacity of the joint Union Pacific (UP)/BNSF line serving those areas. An unknown amount of coal shipped from the Subregion 1 mines on the BNSF line was transported farther south along the joint UP/BNSF line. This unknown amount was not included in the estimated utilization of the joint UP/BSNF line; therefore, actual utilization of the joint line in 2008 may have been higher.

Potential effects of past and RFD activities on transportation and utilities may be either short- or long-term in nature, varying with the type of development. The effects of coal production and the related demand for rail capacity could vary with market changes, although the trend in recent years has been upward, and it is expected that the trend would continue (AECOM 2011). Similarly, the demand for pipeline capacity would vary with market conditions as well as with the rate of depletion of the oil or gas resource. In contrast, a power plant or an urban community development would be considered long-term, and the demand for transmission line capacity would be virtually permanent, lasting for the economic life of the activity.

Potential direct effects to roads and highways would include increased vehicular traffic and risk of traffic accidents on existing roadways in the study area from daily travel by workers and their families. Indirect effects would include increased wear and tear on existing roads, additional air emissions, fugitive dust from roads, noise, increased potential access to remote areas, and an increased risk of vehicle collisions with livestock and wildlife. Direct effects on railroads, pipelines, and transmission lines primarily would include increased demand for capacity to move coal, oil and gas, and electricity from production locations in the study area to markets outside the area.

As discussed in the Task 2 report, power generating projects in the study area as of 2008 included five coal-fired power plants with a combined production capacity of approximately 543 megawatts (MW), three gas-fired power plants with a combined winter production capacity of approximately 68 MW, and one 99 MW wind energy project. Existing 230-kV transmission lines connect these facilities to the regional power distribution system.

The potential effects of projected RFD activities on transportation and utilities in the study area under two (lower and upper) coal production scenarios are discussed below for the years 2020 and 2030.

2.7.2.1 Year 2020 – Lower Production Scenario

Transportation

As discussed in the Task 3C Powder River Basin Coal Review, Cumulative Social and Economic Effects (AECOM 2013a), population is projected to increase by approximately 21 percent in Campbell County (between the 2010 Census and 2020) and 11 percent in Sheridan County. Campbell and Sheridan counties were used for this study as a proxy for the study area because the majority of the population increases are projected to occur in these counties. Based on traffic studies and estimates elsewhere, vehicle miles traveled (VMT) tend to increase at or above the rate of population growth. Consequently, highway traffic would be expected to increase by at least 16 percent by 2020. Approximately 60 percent of the population growth would occur in or near Gillette and 19 percent would occur near Sheridan, which would indicate that the same proportion of traffic would originate in these urban areas. The remainder of the traffic growth would be dispersed throughout the study area. Under this scenario, the greatest impact on traffic would occur in the Gillette area, where existing traffic volume to capacity ratios are highest. The increased traffic would be expected to cause delays in the urban areas and might require widening of some streets and roads or other measures to increase traffic capacity. It is anticipated that there would be an increase in the risk of traffic accidents approximately proportional to the increase in traffic. Highway capacity on major routes away from the urban areas would be expected to be sufficient to accommodate the growth without substantial constraints.

Under this scenario, rail lines would be expected to continue to accommodate approximately 700 mmtpy of coal by 2020, including the existing 250 mmtpy on the BNSF northern route and 450 mmtpy on the joint UP/BNSF southern route. Projected coal production under the 2020 – Lower Production Scenario would be 75 mmtpy from Subregion 1 (north) and 381 mmtpy from Subregions 2 and 3 (south). As a result, rail capacity would be sufficient to carry the projected production. Assuming the subregional production would be shipped by the nearest rail lines, the Subregion 1 coal would use 30 percent of the northern BNSF capacity, and Subregions 2 and 3 coal would use 85 percent of the joint UP/BNSF southern line capacity.

Utilities

Current gas pipeline take-away capacity from the PRB is approximately 2.1 Bcf per day; average conventional natural gas and CBNG production in 2008 totaled approximately 1.55 Bcf per day (AECOM 2011). Based on the information in the Task 2 report, potential total gas production (conventional natural gas and CBNG) is projected to decline to 485 million cubic feet per day by 2020. The Bison Pipeline Project, projected to be operational prior to 2020, would run from Dead Horse Creek, Wyoming, to Morton County, North Dakota, and would increase the take-away capacity from the PRB to approximately 2.5 Bcf per day (AECOM 2011).

Although no enhanced oil recovery (EOR) projects are projected in the study area, one carbon dioxide pipeline project (Greencore Pipeline) was projected to be completed prior to 2020 to support EOR activities in Montana (AECOM 2011). This pipeline would cross the study area, running from the Lost Cabin Plant in Wyoming to the Bell Creek Field in southeastern Montana.

By 2020, two additional coal-fired power plants would be operational in the study area, resulting in a total of seven operating plants with a combined production capacity of 900 MW. Five additional wind energy projects also would be operational, resulting in a total of six operating facilities with a combined capacity of 686 MW. Operation of the three existing gas-fired power plant (68 MW) is projected to continue. The recently completed Hughes Transmission Line and the projected Wyodak South Transmission Line (both 230 kV) would add to the existing transmission line capacity to provide the necessary supporting infrastructure for the additional power generating facilities. The Hughes Transmission Line runs from Rozet, Wyoming, through Gillette to Sheridan. The Wyodak South Transmission Line would run from near Gillette to Pumpkin Buttes and on to the vicinity of the Dave Johnston Power Plant.

2.7.2.2 Year 2020 – Upper Production Scenario

Transportation

Under this scenario, population is projected to increase by approximately 23 percent in Campbell County and approximately 11 percent in Sheridan County (AECOM 2013a). This would be approximately 2 percent higher in Campbell County than under the 2020 – Lower Production Scenario. Population growth in Sheridan County, although projected to increase slightly, would be similar to that under the 2020 – Lower Production Scenario. The VMT would be expected to increase at or above the rate of population growth. Consequently, effects on traffic and highways would be similar to, but proportionately greater than, the effects described under the 2020 – Lower Production Scenario.

The projected effects of coal production on rail line capacity would be the same as under the 2020 – Lower Production Scenario, with the following exceptions. The UP/BNSF rail line would be upgraded to accommodate a total of 500 mmtpy of coal. Projected coal production from Subregion 1 (north) would increase to 90 mmtpy, with 448 mmtpy produced from Subregions 2 and 3 (south). Assuming the subregional production would be shipped by the nearest rail lines, the Subregion 1 coal would use 36 percent of the northern BNSF capacity, and Subregions 2 and 3 coal would use 90 percent of the joint UP/BNSF south line capacity.

Utilities

The effects of projected RFD activities on utilities would be the same as described under the 2020 – Lower Production Scenario.

2.7.2.3 Year 2030 – Lower Production Scenario

Transportation

Under this scenario, population is projected to increase by approximately 27 percent in Campbell County and 12 percent in Sheridan County (AECOM 2013a). This would be approximately 6 and 1 percent higher than under the 2020 – Lower Production Scenario in Campbell and Sheridan counties, respectively. The VMT would be expected to increase at or above the rate of population growth. Consequently, effects on traffic and highways would be similar to, but proportionately greater than, the effects described under the 2020 – Lower Production Scenario.

The projected effects of coal production on rail line capacity would be the same as under the 2020 – Lower Production Scenario, with the following exceptions. Subregions 2 and 3 (south) would produce 393 mmtpy of coal. This coal would use 87 percent of the UP/BNSF 450 mmtpy capacity.

Utility ROWs

The effects of projected RFD activities on utilities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Two additional wind energy projects with a combined capacity of 198 MW are projected to be in operation in the southern portion of the study area. One additional 230-kV transmission line potentially would be in service by 2030.

2.7.2.4 Year 2030 – Upper Production Scenario

Transportation

Under the 2030 – Upper Production Scenario, population is projected to increase by approximately 33 percent in Campbell County and 13 percent in Sheridan County (AECOM 2013a). This would be approximately 12 and 2 percent higher than under the 2020 – Lower Development Scenario in Campbell and Sheridan counties, respectively. The VMT would be expected to increase at or above the rate of population growth. Consequently, effects on traffic and highways would be similar to, but proportionately greater than, the effects described above for the 2020 – Lower Production Scenario.

The projected effects of coal production on rail line capacity would be the same as under the 2020 – Lower Production Scenario, with the following exceptions. The UP/BNSF rail line would be upgraded to accommodate a total of 500 mmtpy of coal, and projected construction of the Dakota, Minnesota, & Eastern (DM&E) rail line would add 100 mmtpy of rail capacity. Projected production under this scenario would be 100 mmtpy from Subregion 1 (north) and 515 mmtpy from Subregions 2 and 3 (south). Assuming the subregional production would be shipped by the nearest rail lines, the Subregion 1 coal would use 40 percent of the northern BNSF capacity, and Subregions 2 and 3 coal would use 86 percent of the combined DM&E and joint UP/BNSF south line capacity.

Utilities

The effects of projected RFD activities on utilities would be the same as described under the 2020 – Lower Production Scenario, with the following exceptions. Two additional wind energy projects with a combined capacity of 198 MW are projected to be in operation in the southern portion of the study area. One additional 230-kV transmission line potentially would be in service by 2030.

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