

## 4.0 CUMULATIVE ENVIRONMENTAL CONSEQUENCES

Cumulative impacts result from the incremental impacts of an action added to other past, present, and reasonably foreseeable future actions, regardless of who is responsible for such actions. Cumulative impacts can result from individually minor, but collectively significant, actions occurring over time.

This section summarizes the cumulative impacts that are occurring as a result of existing development in the Powder River Basin (PRB<sup>1</sup>) and considers how those impacts would change if other projected development in the area occurs and if the six lease by application (LBA) tracts in the general Wright analysis area are leased and mined.

BLM completed three regional Environmental Impact Statements (EISs) evaluating the potential cumulative impacts of surface coal development in the 1970s and early 1980s (BLM 1974, 1979, and 1981). A draft document for a fourth regional EIS was prepared and released in 1984 (BLM 1984). Since those regional EISs were prepared, BLM has prepared a number of NEPA (National Environmental Policy Act of 1969) analyses evaluating coal leasing actions and oil and gas development in the PRB. Each of these NEPA analyses includes an analysis of cumulative impacts in the Wyoming PRB.

Recently, the BLM completed a regional technical study, called the PRB Coal Review, to help evaluate the cumulative impacts of coal and other mineral development in the PRB. The PRB Coal Review consists of three tasks:

- Task 1 identifies existing resource conditions in the PRB for the baseline year (2003) and, for applicable resources, updates the BLM's 1996 status check for coal development in the PRB.
- Task 2 defines the past and present development activities in the PRB and their associated development levels as of 2003 and develops a forecast of reasonably foreseeable development in the PRB through 2020. The reasonably foreseeable activities fall into three broad categories: coal development (coal mine and coal-related), oil and gas development (conventional oil and gas, coal bed natural gas, and major transportation pipelines), and other development, which includes development that is not energy-related as well as other energy-related development.
- Task 3 predicts the cumulative impacts that could be expected to occur to air, water, socioeconomic, and other resources if the development occurs as projected in the forecast developed under Task 2.

A series of reports have been prepared to present the results of the PRB Coal Review task studies. The Task 1, 2, and 3 reports represent components of a technical study of cumulative development in the PRB; they do not evaluate

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<sup>1</sup> Refer to page xxvii for a list of abbreviations and acronyms used in this document.

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specific proposed projects, but they provide information that BLM is using to evaluate the cumulative impacts that would be expected to occur if specific projects or applications, such as the six LBA tracts in the general Wright analysis area, are approved. The Task 1 reports, which include air quality conditions, water resources conditions, social/economic conditions, and other environmental resource conditions, and the Task 2 Report have been completed. An update of the Task 2 Report is reflected in this document. The Task 3 reports for air quality conditions, social/economic conditions, and other resource conditions have been completed. The Task 3A Cumulative Air Quality Effects were included in the draft of this EIS to project air quality effects for 2015. After the draft of this EIS was issued, modeling of Cumulative Air Quality Effects for 2020 was completed (the Task 3A Supplemental Report) and the new data and analysis is reflected in this Final EIS. The groundwater impacts modeling portion of the Cumulative Water Effects (the Task 3B Report) was recently completed and is also reflected in this document along with the cumulative surface water effects. The information in these reports is summarized later in this chapter, and the completed reports are available for viewing at the BLM offices in Casper and Cheyenne and on the Wyoming BLM website at [http://www.blm.gov/wy/st/en/programs/energy/Coal\\_Resources/PRB\\_Coal/prbdocs.html](http://www.blm.gov/wy/st/en/programs/energy/Coal_Resources/PRB_Coal/prbdocs.html).

The PRB includes portions of northeastern Wyoming and southeastern Montana. The Wyoming portion of the PRB is the primary focus of the PRB Coal Review reports. The Montana portion of the PRB is included in the Task 2 Report and in the Task 1 and 3 air resources studies. For the majority of resources in the Task 1 reports and for the Task 2 Report, the Wyoming portion of the PRB Coal Review study area encompasses all of Campbell County, all of Sheridan and Johnson counties outside of the Bighorn National Forest, and the northern portion of Converse County (Figure 4-1). For some components of the Task 2 Report and for the Task 1 and 3 air resource studies, the Montana PRB Coal Review study area includes portions of Big Horn, Custer, Powder River, Rosebud, and Treasure counties. For several resources, the Task 1 and Task 3 study areas include only potentially affected portions of the Wyoming PRB Coal Review study area; for other resources, the study area extends outside of Wyoming and Montana because the impacts would extend beyond the PRB. For example, the groundwater drawdown is evaluated in the area surrounding and extending west of the mines, because that is the area where surface coal mining operations and coal bed natural gas (CBNG) production operations would impact groundwater resources; but air quality impacts are evaluated over a multi-state area because they would be expected to extend beyond the PRB.

Section 4.1 summarizes the information presented in the PRB Coal Review Task 1 and Task 2 reports. Section 4.2 summarizes the predicted cumulative impacts to air, water, socioeconomic, and other resources presented in the PRB Coal Review Task 3 reports.

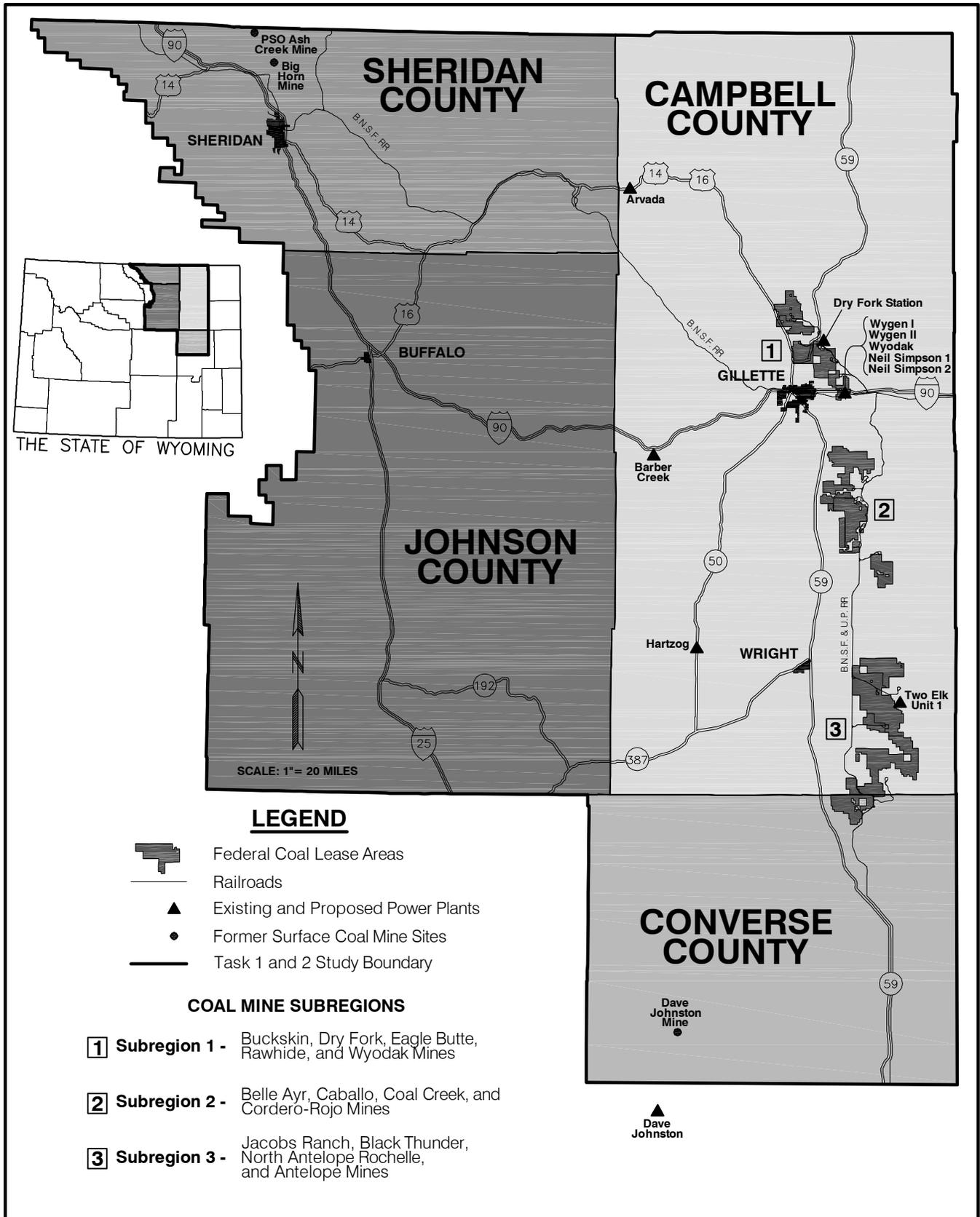


Figure 4-1. Wyoming Study Area for PRB Coal Review Evaluating Current and Projected Levels of Development.

#### **4.1 Past, Present, and Reasonably Foreseeable Development**

Past, present, and reasonably foreseeable development in the Wyoming PRB are considered in the Task 1 and Task 2 reports for the PRB Coal Review. The Task 1 reports describe the existing situation as of the end of 2003, which reflects the past and present levels of development. The Task 2 Report defines the past and present development activities in the PRB as of the end of 2003 and projects reasonably foreseeable development in the Wyoming PRB through 2020. Task 2 was updated based on actual levels of development through 2007, and current development estimates available through year 2009 (BLM 2009b).

##### 4.1.1 Coal Development

###### 4.1.1.1 Coal Mine Development

The Powder River Federal Coal Region was decertified as a federal coal production region by the Powder River Regional Coal Team (PRRCT) in 1990. Decertification of the region allows leasing to take place on an application basis, as discussed in the regulations at 43 CFR 3425.1-5. Between 1990 and January 2009, the BLM's Wyoming State Office held 25 competitive coal lease sales and issued 20 new federal coal leases containing almost 5.8 billion tons of coal using the LBA process. The lease sales are listed in Table 1-1, and the leased tracts are shown in Figure 1-1. This leasing process has undergone the scrutiny of two appeals to the Interior Board of Land Appeals (IBLA) and one audit by the General Accounting Office (GAO). As can be seen in Figure 4-2, leasing activity has generally paralleled production since decertification. This is consistent with the PRRCT's objective at the time of decertification, which was to use the LBA process to lease tracts of federal coal to maintain production at existing mines.

The pending applications in the Wyoming PRB are shown in Table 1-2.

BLM has also completed three exchanges involving federal coal resources in the Wyoming PRB since decertification:

- Belco Exchange – an exchange of lease rights for a portion of the former Hay Creek federal coal tract for lease rights to coal near Buffalo, Wyoming, which became unmineable when Interstate 90 was constructed. This exchange was authorized by Public Law 95-554 and completed in 2000.
- Pittsburg and Midway Coal Mining Company (P&M) Exchange – an exchange of federal coal in Sheridan County, Wyoming, for land and mineral rights in Lincoln, Carbon, and Sheridan counties, Wyoming, completed in 2004.

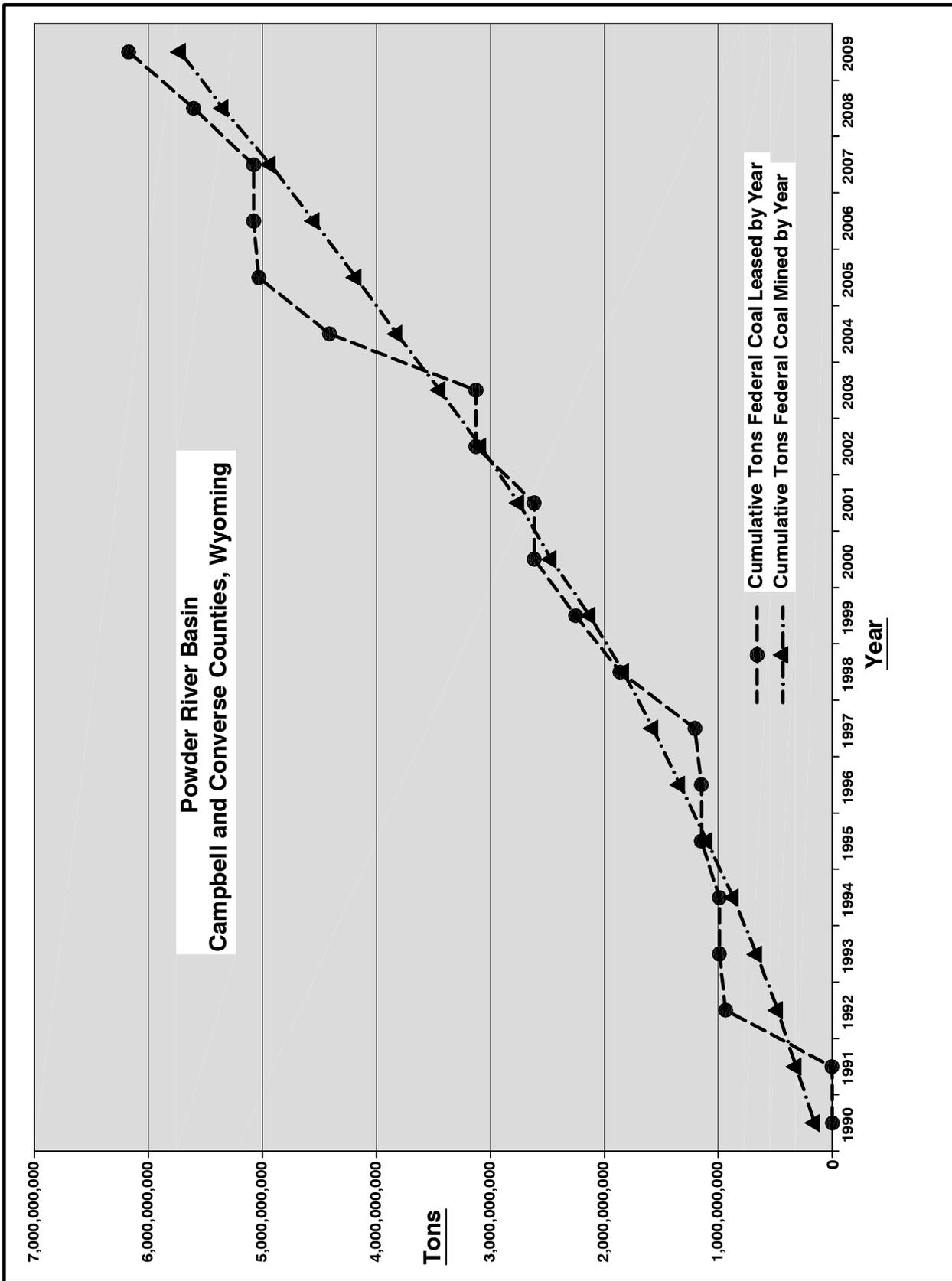


Figure 4-2. Tons of Federal Coal Leased Versus Tons of Federal Coal Mined Since 1990.

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- Powder River Coal Company AVF Exchange – an exchange of lease rights underlying an AVF at the Caballo Mine, which cannot be mined, for lease rights of equal value adjacent to existing federal leases at Powder River Coal Company’s North Antelope Rochelle Mine, completed in 2006.

Table 4-1 provides information about the status, ownership and production levels for the existing surface coal mines in the Wyoming PRB in 2003 and their status as of 2007. In 2003, which was the baseline year for the PRB Coal Review Task 1 and Task 2 studies, there were 12 active surface coal mines and one inactive mine. Since 2003, the inactive mine (Coal Creek) has resumed operations and the North Rochelle Mine has been incorporated into the Black Thunder Mine following its purchase by the operator of the Black Thunder Mine. The North Rochelle Mine leases were divided between Black Thunder and North Antelope Rochelle Mine in 2006. Peabody has deferred startup of their new mine, the School Creek Mine, which is located between the Black Thunder and North Antelope Rochelle mines, until at least late 2010, or later. These mines are all located in Campbell and Converse counties, just west of the outcrop of the Wyodak coal, where the coal is at the shallowest depth (Figure 1-1). As indicated in Table 4-1, there have been numerous changes in mine ownership since decertification, which have resulted in mine consolidations and mine closings within the PRB.

Two recently active surface coal mines (the Big Horn Coal Mine in northern Sheridan County and the Dave Johnston Mine in southern Converse County) in the PRB have ended mining operations, relinquished their federal coal leases, and reclaimed areas of disturbance. The lands within the Dave Johnston Mine permit boundary are owned by PacifiCorp. PacifiCorp requested a change in post mining land use from livestock/wildlife grazing to industrial for the areas that would be affected by a wind energy project right-of-way. Some of the area was on full reclamation bond release and some area included was on pre-law lands. Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD) approved this change of land use in three stages between September of 2007 and May of 2008. The Glenrock Wind Energy Project is sited at the reclaimed surface coal mine and it began operations in late 2008 and early 2009.

There are existing permits for other surface coal mining-related operations in the PRB. These include the Ash Creek and Welch Mine permits in Sheridan County and the Izita Mine permit in Campbell County. Operations at these sites are completed and the disturbed areas have been reclaimed, but monitoring of the reclaimed areas is no longer ongoing. The KFx Mine, located north of Gillette on privately owned coal, has stopped mining coal for processing at the KFx coal enhancement plant, which is discussed in Section 4.1.1.2.4. The Fort Union plant was idled down in March 2008, until further notice.

The active mines in the Wyoming PRB are geographically grouped into three subregions (Figure 4-1). For purposes of this cumulative impact discussion,

Table 4-1. Status and Ownership of Wyoming PRB Coal Mines for 2003, the PRB Coal Review Baseline Year, and for 2007.

2003 Mine	1994 Mine Owner	2007 Mine Owner	2007 Coal Production (mm Tons) <sup>1</sup>	Permitted Production Level (mm Tons) <sup>2</sup>	Status and Additional Comments
<b>SUBREGION 1 (North Gillette)</b>					
Buckskin	SMC (Zeigler)	Kiewit Mining Properties	25.3	42.0	Active
Dry Fork	Phillips/WFA & Fort Union Ltd	WFA	5.3	15.0	Active (includes former Fort Union Mine)
Eagle Butte	Cyprus-Amax	Foundation Coal West	25.0	35.0	Active
Rawhide	Carter (Exxon)	Peabody Holding Co.	17.1	24.0	Active
Wyodak	Wyodak Resources	Wyodak Resources	5.0	12.0	Active (includes former Clovis Point Mine)
<b>Total</b>			<b>77.7</b>	<b>128.0</b>	
<b>SUBREGION 2 (South Gillette)</b>					
Belle Ayr	Cyprus-Amax	Foundation Coal West	26.6	45.0	Active
Caballo	Carter (Exxon) & Western Energy	Peabody Holding Co.	31.2	50.0	Active (includes Rocky Butte and West Rocky Butte leases)
Cordero Rojo	Kennecott & Drummond	Rio Tinto Energy America <sup>3</sup>	40.5	65.0	Active (consolidation of former Cordero and Caballo Rojo Mines)
Coal Creek	ARCO	Arch Coal Inc.	10.2	25.0	Inactive in 2003, operations resumed in 2006
<b>Total</b>			<b>108.5</b>	<b>185.0</b>	
<b>SUBREGION 3 (Wright)</b>					
Antelope	Kennecott	Rio Tinto Energy America <sup>3</sup>	34.5	36.0	Active
Black Thunder	ARCO	Arch Coal Inc.	65.3	100.0	Active
Jacobs Ranch	Kerr-McGee	Rio Tinto Energy America <sup>3</sup>	38.1	55.0	Active
North Antelope Rochelle	Peabody	Peabody Holding Co.	91.5	99.0	Active (consolidation of former North Antelope and Rochelle Mines)
North Rochelle	SMC (Zeigler)	Arch Coal Inc.	20.9	35.0	Inactive since 2005, leases split between Black Thunder and North Antelope Rochelle Mines
<b>Total</b>			<b>250.3</b>	<b>325.0</b>	
<b>TOTAL FOR 3 MINE GROUPS</b>			<b>436.5</b>	<b>638.0</b>	

<sup>1</sup> Wyoming State Inspector of Mines (2007a) and Shamley (2008)<sup>2</sup> WDEQ 2007 permitting levels (Shamley 2008)<sup>3</sup> Kennecott Energy Company changed its name to Rio Tinto Energy America in 2006.

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these subregions are called the North Gillette, South Gillette, and Wright subregions. Table 4-1 lists the mines included in each subregion.

A fourth subregion includes former and proposed mines in Sheridan County and existing mines just north of Sheridan County, in Montana. There are currently no active mines in the Wyoming portion of the fourth subregion. However, the PRB Coal Review Task 2 Report projected that a new mine would be developed near Sheridan by 2010. In April, 2007, P&M and CONSOL Energy Inc. announced that they have formed a new company, Youngs Creek Mining Company, LLC, and entered into a joint agreement to develop a new mine in Wyoming north of Sheridan (Reuters 2007). According to the announcement, engineering, environmental and permitting work are in progress, but actual mine construction will not start until the joint venture has enough coal sales under contract to justify the investment. The coal reserves included in this project are all privately owned.

The surface coal mines listed in Table 4-1 currently produce over 96 percent of the coal produced in Wyoming each year. Since 1989, coal production in the PRB has increased by an average of 6 percent per year. The increasing production is primarily due to increasing sales of low-sulfur, low-cost PRB coal to electric utilities who must comply with the Phase I requirements of Title III of the 1990 Clean Air Act Amendments. Electric utilities account for 97 percent of Wyoming's coal sales. In 2009, production from the Wyoming PRB coal mines dropped by about 7 percent from the 2008 levels, the first drop since the early 1900s. This drop coincided with a national coal production decline due to reduced industrial electric demand in 2009.

In 2003 (the baseline year for the PRB Coal Review), more than 35 percent of the coal mined in the United States came from the Wyoming PRB. By 2007, about 38 percent of the coal mined in the United States came from the Wyoming PRB (USDOE 2009a), and according to the U.S. Department of Energy (USDOE), over 38 percent of the coal mined in the United States came from the Wyoming PRB by 2009.

BLM estimates that the surface coal mines listed in Table 4-1 currently have about 125,180 acres of federal coal leased in Campbell and Converse counties. This represents approximately 4.1 percent of Campbell County, where the majority of the leases are located.

Task 2 of the PRB Coal Review projected coal development into the future for the years 2010, 2015, and 2020. Due to the variables associated with future coal production, two projected coal production scenarios (representing an upper and a lower production level) were developed to bracket the most likely foreseeable regional coal production level. The basis for the projected production levels included:

- 1) an analysis of historic PRB production levels in comparison to the gross domestic product and national coal demand;

- 2) an analysis of PRB coal market forecasts that model the impact of gross domestic product growth, potential regulatory changes affecting coal-fired power plants, and mining and transportation costs on PRB coal demand;
- 3) the availability, projected production cost, and quality of future mine-specific coal reserves within the PRB region; and
- 4) the availability of adequate infrastructure for coal transportation.

The projected upper and lower production levels subsequently were allocated to the Wyoming PRB subregions, discussed above, and to individual mines based on past market shares. Individual mine production levels were reviewed relative to potential future production constraints (e.g., loadout capacities), permitted production levels, mining costs, and coal quality. Then the projected future production was aggregated on a subregion basis. The actual 2003 and 2005 production levels and the two projected coal production scenarios for those years are shown on Figure 4-3. The two projected production levels for 2010, 2015, and 2020 are shown on Figure 4-3 and in Tables 4-2 and 4-3. The actual 2007 and 2008 production levels are also shown on Figure 4-3 as a reference.

Tables 4-2 and 4-3 show the cumulative coal mining disturbance as of the baseline year and the cumulative coal mine disturbance projected for the future years for the upper and lower coal production scenarios. In these tables, the baseline year (2003), actual values as of 2007, and cumulative projected disturbance areas for 2010, 2015 and 2020 are broken down into three categories:

- areas which are or projected to be permanently reclaimed;
- areas which are or projected to be undergoing active mining or which have been mined but are not yet reclaimed; and,
- areas which are or projected to be occupied by mine facilities, haul roads, stockpiles, and other long-term structures, and which are therefore unavailable for reclamation until mining operations are completed.

Tables 4-2 and 4-3 also include estimates of baseline year and projected future coal mining employment, water consumption, and water production.

The six LBA tracts in the general Wright analysis area are associated with three of the four currently operating mines (Jacobs Ranch, Black Thunder, North Antelope Rochelle, and Antelope) in the southern-most group of mines in the eastern PRB (Figure 1-1). This group of mines is referred to as the Wright Subregion or Subregion 3 in the PRB Coal Review. Each of these four operating mines has a least one LBA pending (Table 1-2). The analysis

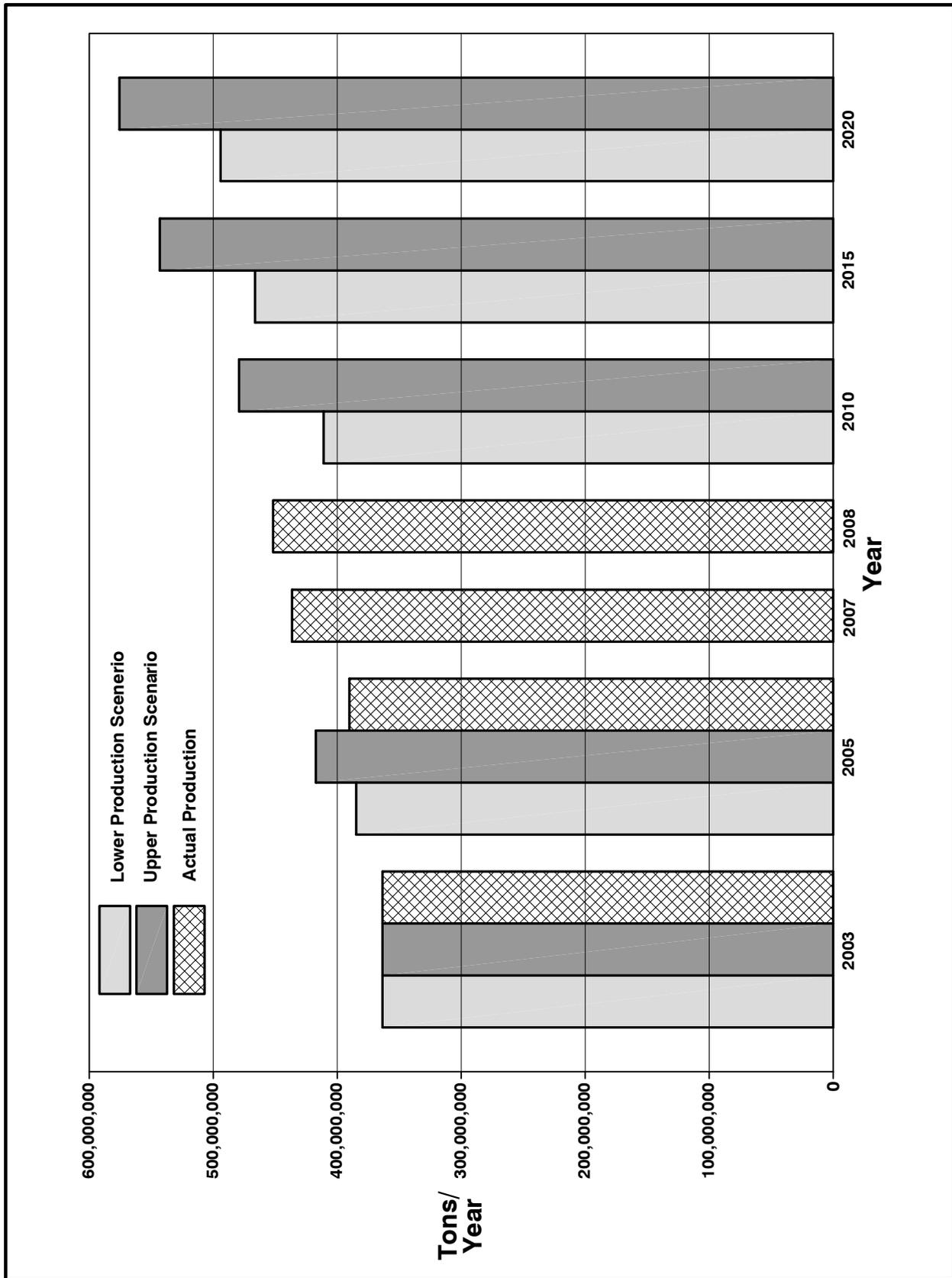


Figure 4-3. Projected and Actual Total Coal Production from Campbell and Converse Counties Under the Lower and Upper Production Scenarios.

Table 4-2. Actual and Projected Wyoming PRB Coal Mine Development, Lower Coal Production Scenario.

<b>Subregion</b>	<b>Annual Production (million tons)</b>	<b>Cumulative Disturbed Area (acres)</b>	<b>Cumulative Permanently Reclaimed Area (acres)</b>	<b>Cumulative Active Mining Area and Unreclaimed Mined Area (acres)</b>	<b>Cumulative Area Disturbed and Unavailable for Reclamation<sup>1</sup> (acres)</b>	<b>Total Mine Employment</b>	<b>Annual Water Consumption (mmgpy)</b>	<b>Annual Water Production (acre-ft)</b>
<b>Original Baseline Year (2003)</b>								
North Gillette Subregion	55	12,047	3,054	3,360	5,633	746	387	191
South Gillette Subregion	77	21,249	6,783	6,107	8,359	861	544	447
Wright Subregion	232	35,498	11,401	13,992	10,105	3,090	1,709	748
<b>Total for 2003</b>	<b>364</b>	<b>68,794</b>	<b>21,238</b>	<b>23,459</b>	<b>24,097</b>	<b>4,697</b>	<b>2,640</b>	<b>1,386</b>
<b>Actual 2007</b>								
North Gillette Subregion	78	14,421	3,658	8,342	5,781	1,032	351	191
South Gillette Subregion	100	23,630	6,441	12,353	9,273	1,424	544	447
Wright Subregion	250	45,542	15,785	31,577	11,941	3,077	1,709	748
<b>Total for 2007</b>	<b>428</b>	<b>83,593</b>	<b>25,884</b>	<b>52,272</b>	<b>24,338</b>	<b>5,533</b>	<b>2,604</b>	<b>1,386</b>
<b>Reasonably Foreseeable Development for 2010</b>								
North Gillette Subregion	62	15,231	5,004	3,968	6,260	787	628	165
South Gillette Subregion	95	28,021	12,183	6,830	9,008	1,323	50	675
Wright Subregion	254	55,410	27,751	16,588	11,070	3,153	1,115	1,419
<b>Total for 2010</b>	<b>411</b>	<b>98,662</b>	<b>44,938</b>	<b>27,386</b>	<b>26,338</b>	<b>5,263</b>	<b>1,793</b>	<b>2,258</b>
<b>Reasonably Foreseeable Development for 2015</b>								
North Gillette Subregion	74	17,457	6,654	4,202	6,601	830	724	165
South Gillette Subregion	112	32,356	15,683	7,314	9,359	1,369	458	675
Wright Subregion	281	67,423	38,851	16,983	11,589	3,186	1,277	1,419
<b>Total for 2015</b>	<b>467</b>	<b>117,236</b>	<b>61,188</b>	<b>28,499</b>	<b>27,549</b>	<b>5,405</b>	<b>2,059</b>	<b>2,258</b>
<b>Reasonably Foreseeable Development for 2020</b>								
North Gillette Subregion	78	19,729	8,429	4,350	6,950	840	456	165
South Gillette Subregion	126	36,994	19,683	7,589	9,723	1,476	72	675
Wright Subregion	291	80,720	51,351	17,243	12,124	3,215	1,334	1,419
<b>Total for 2020</b>	<b>495</b>	<b>137,443</b>	<b>79,463</b>	<b>29,182</b>	<b>28,797</b>	<b>5,531</b>	<b>2,162</b>	<b>2,258</b>

<sup>1</sup> Area unavailable for reclamation includes disturbed areas occupied by permanent or long-term facilities such as buildings, roads, topsoil stockpiles, etc.  
Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

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Table 4-3. Actual and Projected Wyoming PRB Coal Mine Development, Upper Coal Production Scenario.

<b>Subregion</b>	<b>Annual Production (million tons)</b>	<b>Cumulative Disturbed Area (acres)</b>	<b>Cumulative Permanently Reclaimed Area (acres)</b>	<b>Cumulative Active Mining Area and Unreclaimed Mined Area (acres)</b>	<b>Cumulative Area Disturbed and Unavailable for Reclamation<sup>1</sup> (acres)</b>	<b>Total Mine Employment</b>	<b>Annual Water Consumption (mmgpy)</b>	<b>Annual Water Production (acre-ft)</b>
<b>Original Baseline Year (2003)</b>								
North Gillette Subregion	55	12,047	3,054	3,360	5,633	746	387	191
South Gillette Subregion	77	21,249	6,783	6,107	8,359	861	544	447
Wright Subregion	232	35,498	11,401	13,992	10,105	3,090	1,709	748
<b>Total for 2003</b>	<b>364</b>	<b>68,794</b>	<b>21,238</b>	<b>23,459</b>	<b>24,097</b>	<b>4,697</b>	<b>2,640</b>	<b>1,386</b>
<b>Actual 2007</b>								
North Gillette Subregion	78	14,421	3,658	8,342	5,781	1,032	351	191
South Gillette Subregion	100	23,630	6,441	12,353	9,273	1,424	544	447
Wright Subregion	250	45,542	15,785	31,577	11,941	3,077	1,709	748
<b>Total for 2007</b>	<b>428</b>	<b>83,593</b>	<b>25,884</b>	<b>52,272</b>	<b>24,338</b>	<b>5,533</b>	<b>2,604</b>	<b>1,386</b>
<b>Reasonably Foreseeable Development for 2010</b>								
North Gillette Subregion	78	15,911	5,404	4,217	6,290	811	788	165
South Gillette Subregion	117	29,279	13,416	7,536	8,328	1,375	58	675
Wright Subregion	284	57,258	27,951	18,236	11,070	3,153	1,184	1,419
<b>Total for 2010</b>	<b>479</b>	<b>102,448</b>	<b>46,771</b>	<b>29,989</b>	<b>25,688</b>	<b>5,339</b>	<b>2,030</b>	<b>2,258</b>
<b>Reasonably Foreseeable Development for 2015</b>								
North Gillette Subregion	104	18,490	7,329	4,500	6,660	905	492	165
South Gillette Subregion	138	35,624	18,616	8,248	8,760	1,431	75	675
Wright Subregion	301	70,431	39,451	19,391	11,589	3,186	1,333	1,419
<b>Total for 2015</b>	<b>543</b>	<b>124,545</b>	<b>65,396</b>	<b>32,139</b>	<b>27,009</b>	<b>5,522</b>	<b>1,897</b>	<b>2,258</b>
<b>Reasonably Foreseeable Development for 2020</b>								
North Gillette Subregion	121	21,311	9,529	4,766	7,013	1,019	880	165
South Gillette Subregion	148	42,981	25,016	8,758	9,206	1,444	86	675
Wright Subregion	307	84,797	51,651	21,021	12,124	3,215	1,437	1,419
<b>Total for 2020</b>	<b>576</b>	<b>149,089</b>	<b>86,196</b>	<b>34,545</b>	<b>28,345</b>	<b>5,678</b>	<b>2,403</b>	<b>2,258</b>

<sup>1</sup> Area unavailable for reclamation includes disturbed areas occupied by permanent or long-term facilities such as buildings, roads, topsoil stockpiles, etc.

Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

assumes that if the LBAs are offered and if the applicant becomes the lessee, each mine will increase current production to a level where the four mines collectively will produce at an aggregate production level midway between the low and high projected coal production scenarios for 2015 and 2020 shown on Figure 4-3 and in Tables 4-2 and 4-3. The coal development levels and associated disturbance shown in Tables 4-2 and 4-3 include production at the four Wright area mines during the baseline year (2003) and projected production at the mines for 2010, 2015, and 2020.

As discussed above, the projected development levels shown in Tables 4-2 and 4-3 are based on projected demand and coal market forecasts, which are not affected by a decision to lease or not to lease the six LBA tracts in the general Wright analysis area. The reserves in these six LBA tracts, if offered, and if the applicants become the lessees, would add to the mine life of each of the three Wright Area Coal (WAC) mines.

As discussed in Sections 1.1 and 2.1, Ark Land Company (ALC) estimates that there were 1,169.4 million tons of recoverable coal reserves on the existing Black Thunder Mine at the end of 2008. In 2008, the mine produced approximately 67.4 million tons and the currently approved (by Wyoming Department of Environmental Quality/Air Quality Division) air quality permit allows mining of up to 135 million tons of coal per year (mmtpy). If the mine produces at the estimated average of 135 mmtpy, the remaining recoverable reserves would be depleted in about 9 years (by 2017). ALC estimates that the North Hilight Field LBA Tract includes approximately 263.4 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the North Hilight Field LBA Tract would increase the recoverable reserves at the Black Thunder Mine by about 23 percent. At the estimated future production level (135 mmtpy), mine life would be extended by about 2 years. However, if the Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD) approves a higher annual rate of production, the coal would be recovered more quickly. ALC estimates that the South Hilight Field LBA Tract includes approximately 213.6 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the South Hilight Field LBA Tract would increase the recoverable reserves at the Black Thunder Mine by about 18 percent. At the estimated future production level (135 mmtpy), mine life would be extended by about 1.6 years. However, if WDEQ/AQD approves a higher annual rate of production, the coal would be recovered more quickly. ALC estimates that the West Hilight Field LBA Tract includes approximately 377.9 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the West Hilight Field LBA Tract would increase the recoverable reserves at the Black Thunder Mine by nearly 32 percent. At the estimated future production level (135 mmtpy), mine life would be extended by about 2.8 years. However, if WDEQ/AQD approves a higher annual rate of production, the coal would be recovered more quickly.

As discussed in Sections 1.1 and 2.1, Jacobs Ranch Coal Company (JRCC) estimates that there were 379.4 million tons of recoverable coal reserves on the

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existing Jacobs Ranch Mine at the end of 2008. In 2008, the mine produced approximately 42.1 million tons and the currently approved (by WDEQ/AQD) air quality permit allows mining of up to 55 mmtpy. If the mine produces at the estimated average of 40 mmtpy, the remaining recoverable reserves would be depleted in about 9.6 years (by 2018). JRCC estimates that the West Jacobs Ranch LBA Tract includes approximately 669.6 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the West Jacobs Ranch LBA Tract would increase the recoverable reserves at the Jacobs Ranch Mine by about 177 percent. At the estimated future production level (40 mmtpy), mine life would be extended by about 16.7 years. However, if production levels increase to the currently permitted level (55 mmtpy) or if WDEQ/AQD approves a higher annual rate of production, the coal would be recovered more quickly.

As discussed in Sections 1.1 and 2.1, BTU Western Resources, Inc. (BTU) estimates that there were 933.8 million tons of recoverable coal reserves on the existing North Antelope Rochelle Mine at the end of 2008. In 2008, the mine produced approximately 97.6 of coal million tons and the currently approved (by WDEQ/AQD) air quality permit allows mining of up to 140 mmtpy. If the mine produces at the estimated average of 95 mmtpy, the remaining recoverable reserves would be depleted in about 9.9 years (by 2018). BTU estimates that the North Porcupine LBA Tract includes approximately 601.2 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the North Porcupine LBA Tract would increase the recoverable reserves at the North Antelope Rochelle Mine by about 64 percent. At the estimated future production level (95 mmtpy), mine life would be extended by about 6.3 years. However, if production levels increase to the currently permitted level (140 mmtpy) or if WDEQ/AQD approves a higher annual rate of production, the coal would be recovered more quickly. BTU estimates that the South Porcupine LBA Tract includes approximately 309.7 million tons of recoverable coal as applied for. Based on that estimate, acquisition of the South Porcupine LBA Tract would increase the recoverable reserves at the North Antelope Rochelle Mine by about 33 percent. At the estimated future production level (95 mmtpy), mine life would be extended by about 3.3 years. However, if production levels increase to the currently permitted level (140 mmtpy) or if WDEQ/AQD approves a higher annual rate of production, the coal would be recovered more quickly.

##### 4.1.1.2 Coal-Related Development

Coal-related development as defined for this analysis includes railroads, coal-fired power plants, major (230-kV) transmission lines, and coal technology projects. Table 4-4 summarizes the estimated disturbance associated with coal-related development activities for the baseline year and the projected disturbance through 2020. The subsequent paragraphs summarize the existing coal-related development in the Wyoming PRB and the reasonably foreseeable development considered in the PRB Coal Review.

Table 4-4. Actual and Projected Wyoming PRB Coal-Related Development Scenario.

	<b>2003</b>	<b>2007</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>
<b>Coal-Related Disturbance (Acres)</b>	4,892	5,802	5,963	6,915	6,914

Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

#### 4.1.1.2.1 Coal Transportation

As discussed above, electric utilities account for about 97 percent of Wyoming's coal sales. Most of the coal sold to electric utilities is transported to power plants by rail. A small part, about 2 percent in 2007, of national coal production is exported abroad, but data are not published as to where this export coal is produced. The coal mines in the South Gillette and Wright subregions are served by a joint Burlington Northern Santa Fe and Union Pacific (BNSF & UP) rail line. For the baseline year of 2003, the existing capacity of the line was estimated at approximately 350 mmtpy. For that same year, the existing capacity of the BNSF line, which services the North Gillette subregion, was estimated at 250 mmtpy.

The PRB Coal Review projected that two coal transportation projects would be developed prior to 2020 in Wyoming: expansion of the BNSF & UP rail facilities south of Gillette, and the construction of the Dakota, Minnesota & Eastern Railroad Corporation (DM&E) rail line in Wyoming and South Dakota. A third project proposed by the Tongue River Rail Company would be built between Decker and Miles City, Montana.

BNSF & UP completed work to improve sections of the existing joint rail line and had increased capacity from 350 mmtpy to 450 mmtpy by 2008 with plans to improve additional sections of the existing joint rail line and to further increase capacity to 500 mmtpy by 2012 (BNSF 2008, CANAC 2007). This work includes construction of third and fourth main line track segments where needed. The increased capacity would accommodate the projected upper and lower production rates at the southern mines, which are projected to produce 439 mmtpy and 455 mmtpy by 2020. The remaining planned expansion projects are considered highly likely to occur.

The proposed DM&E rail line would include new rail construction in South Dakota and Wyoming (approximately 15 and 265 miles, respectively) and 600 miles of rail line rehabilitation in South Dakota and Minnesota. Approximately 78 miles of the new rail line construction would provide new rail services to the coal mines in the South Gillette and Wright subregions. The Surface Transportation Board (STB) released a Final Supplemental EIS for the DM&E project on December 30, 2005 and granted final approval to construct the rail line on February 15, 2006. The Supplemental EIS, which addressed issues that were successfully appealed after an EIS was completed in 2001, was also appealed. The Supplemental EIS was upheld by the U.S. Court of Appeals for the Eighth Circuit in December 2006. In 2007, Canadian Pacific Railway Ltd.

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(CP) acquired DM&E and the STB approved CP's acquisition of DM&E on September 30, 2008 (All Business 2008). The railroad's expansion into the PRB would require a substantial financial commitment and CP is concentrating on the integration of DM&E's operation before making a decision on the expansion project. No decision has been made on whether or not CP will build the PRB extension. This decision is contingent on several conditions: (1) acquire the necessary right-of-way to build the line, (2) execute agreements with PRB mines on terms for operations by DM&E over their loading tracks and facilities, (3) secure sufficient contractual commitments from prospective coal shippers to route their traffic over the PRB line to justify the investment required to build the line, (4) arrange financing for the project, and (5) an economic and regulatory environment that would support a long-term investment of this magnitude must be present (DM&E 2009).

The STB announced approval of the final stretch of the rail line proposed by the Tongue River Railroad Company in October 2007. The company must acquire necessary federal and state permits and rights-of-way (ROWs) through private and public property before constructing the line. If it is constructed, it would provide a shorter route for some of the mines in the North Gillette subregion, which ship coal on the existing BNSF rail line (Billings Gazette 2007).

For the purposes of the PRB Coal Review, it was projected that the DM&E line would be constructed when the total rail haulage requirement from the eastern Wyoming PRB reaches 450 to 500 mmtpy and would potentially be operational by 2015. The construction of this rail line is considered moderately likely to occur. The PRB Coal Review assigned a low likelihood of development by 2010 under the upper coal production scenario, and projected the construction of the Tongue River Railroad Company line would not occur unless the Otter Creek Mine is developed. Development of the Otter Creek tracts—more than a billion tons of state and private coal—could initiate expansion of the region's coal industry and facilitate construction of the Tongue River Railroad. Appraisals of the Otter Creek lease tracts were completed in April 2009 (Billings Gazette 2009a) and the Montana Land Board voted to lease the 572 million tons of state-owned coal in December 2009 (Billings Gazette 2009b). The Montana Board of Land Commissioners voted to approve the lease of the Otter Creek tracts to Ark Land Company on March 18, 2010 (MDNRC 2010).

##### 4.1.1.2.2 Electric Power Generation

Currently, there are five existing coal-fired power plants in the Wyoming study area for the PRB Coal Review Tasks 1 and 2 (Figure 4-1). Black Hills Power Corporation owns and operates the Neal Simpson Units 1 and 2 (21.7-megawatts [MW] and 80-MW, respectively), Wygen I and II (80-MW and 95-MW, respectively), and Wyodak (330-MW) power plants, all of which are located approximately five miles east of Gillette, Wyoming. Pacific Power and Light's Dave Johnston Power Plant is located near Glenrock, Wyoming, outside of but adjacent to the study area.

There are also three separate interconnected gas-fired power plants (Hartzog, Arvada, and Barber Creek) located near Gillette, Wyoming (Figure 4-1). Each contains three separate 5-MW-rated turbines that provide electric power to Basin Electric and its customers. In winter, the maximum capacity can reach 22.6-MW from each site. All units are in operating condition, although they do not operate at maximum capacity.

Several additional power plants are projected to be built prior to 2020. The PRB Coal Review assumed that proposed coal-fired power plants that plan to initiate operation by 2010 would have to have been undergoing air permit review by 2003 in order to obtain the required construction permits and complete construction by 2010. The study identified the following four projects as likely for 2015 development:

- Black Hills Power and Light has received an air permit for the start of construction of WYGEN III; issues related to that permit currently are being resolved. WYGEN III would be a 100-MW facility located adjacent to WYGEN II. The plant is in construction and nearing completion. Operation of this facility by 2015 is considered highly likely.
- Basin Electric Power Cooperative has obtained an air construction permit for a 385-MW coal-fired power plant (Dry Fork Station) near Gillette, Wyoming. The estimated startup date is 2011. It is estimated that 1.2 million tons of coal per year would be required to fuel the facility. The cooling technology includes a dry scrubber, since that type of operation commonly is installed for PRB coal-fired units. Operation of this facility by 2015 is considered highly likely.
- North American Power Group (NAPG) has permitted a 280-MW coal-fired power plant (Two Elk Unit #1) at a 40-acre site located approximately 15 miles southeast of Wright, Wyoming. As originally permitted, the project also would include installation of a 45-MW gas-fired turbine. The air permit originally was issued in August 2002; construction has been initiated, with actual startup expected in 2011. This unit would be dry-cooled, requiring very little water. Campbell County approved more than \$123 million in industrial revenue bonds for application to the Two-Elk financing. Operation of this facility by 2015 is considered moderately likely.
- Wyoming Power Company (a subsidiary of NAPG) has submitted a permit application for Two-Elk Unit #2. This unit would be a 750-MW supercritical pulverized coal-fired electric generating unit that would burn coal from the nearby mines. The unit would be located on an approximately 60-acre site adjacent to Two-Elk Unit #1. The permit was expected to be issued in 2008, and operation of this unit is considered moderately likely in 2015.

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The PRB Coal Review assumes that all existing power plants in the PRB region would remain operational through 2020.

### 4.1.1.2.3 Transmission Lines

Major transmission lines in the Wyoming PRB study area that support the regional distribution system are associated with the Dave Johnston power plant located near Glenrock, Wyoming, and the power plants operated by Black Hills Power Corporation, which are located east of Gillette. These 230-kV transmission lines have been in place for several years, and their associated permanent disturbance is minimal. Distribution power lines associated with conventional oil and gas and coal bed natural gas (CBNG) development also occur within the study area. For the PRB Coal Review, these lines were included by factoring them in proportionally on a per well basis.

The PRB Coal Review estimated that by 2020, four major transmission lines would be constructed. Markets would dictate the size and location of such facilities, and these are not known as of this time. Because transmission lines are a necessary supporting infrastructure for power generating facilities to provide connection to the grid, the PRB Coal Review assumes they would be required as part of the overall system development for the proposed power plants discussed in the previous section. Six specific proposals for these transmission lines have been identified by the PRB Coal Review analysis update. There is currently insufficient information to analyze or assign likelihood of development by 2020.

The governors of California, Nevada, Utah, and Wyoming entered into a Memorandum of Understanding to encourage development of a high voltage power transmission line, the Frontier Line, connecting those states in April, 2005. Since that time, no specific plans have been announced as to the location or timing of the Frontier Line. The 345-kV Wyoming-Colorado Intertie, as well as the Trans West and Gateway West and South projects, have been proposed in Wyoming in order to move power from Wyoming to growing Idaho and Nevada and other western U.S. load demand areas (Casper Star Tribune 2007b). The TransWestern Express proposes to move electric power from Wyoming to Arizona through Colorado or Utah. The High Plains Express is proposed to move power from Wyoming to New Mexico and Arizona.

### 4.1.1.2.4 Coal Conversion Technology

With rising energy prices, there has been considerable interest in either enhancing the quality of PRB coal and/or converting the coal to other fuels. Test facilities were previously constructed by AMAX (predecessor to Foundation Coal West, Inc. and Alpha Coal West, Inc.) at the Belle Ayr Mine, and by ENCOAL at the Buckskin Mine, but no commercial production occurred and these facilities have either been dismantled or are no longer in use. Evergreen Energy (formerly operating as KFx) previously built a prototype commercial-scale coal upgrading plant near the old Fort Union Mine (now part of the Dry

Fork Mine). The facility did achieve commercial production levels of K-Fuel® (the company's enhanced coal product) for a short period (2006 through early 2008); it was used for testing and demonstration purposes. Approximately 60 people were employed at the plant. Evergreen Energy decided to idle the plant in May 2008, laying off all but a caretaker staff.

The following coal conversion projects have been proposed, and are described in some detail in the PRB Coal Review. These projects were not included in the PRB Coal Review analysis because the likelihood of their occurrence was not known when the analysis was conducted:

- Evergreen Energy Coal Beneficiation Project. Long-term plans for Evergreen Energy's coal upgrading plant near the Dry Fork Mine have not been announced, although re-opening and dismantling the currently idle plant and redeploying some of the equipment to another location have surfaced as possibilities.
- Rentech Inc. Coal Liquefaction Project. In 2004, Rentech completed a feasibility study for a coal liquefaction facility, based on the historic Fischer-Tropsch process, to produce low-sulfur diesel fuel from sub-bituminous coal. Thereafter, Rentech continued to consider the potential of developing a commercial-scale facility in the PRB, while simultaneously investing in a product demonstration facility near Denver, Colorado.
- White Energy Company, NRG Energy, and Buckskin Mining Company. In March 2008, the three companies entered into a joint development agreement to complete a feasibility study of building and operating a plant having a capacity to produce at least 1 million tons of binderless coal briquettes annually at the Buckskin Mine.
- GreatPoint Energy and Peabody Coal. These two companies entered into an agreement in January 2008, under which Peabody Coal would become the preferred provider of coal to GreatPoint Energy for use in a commercial-scale coal-to-gas conversion plant in the PRB.
- Wyoming Infrastructure Authority. The Wyoming Infrastructure Authority (WIA) was created in 2004 by the Wyoming State Legislature. It was tasked with promoting the state's economic development by assisting in the development of interstate electric transmission infrastructure. In 2006, WIA's role was expanded to also promote advanced coal technologies related to electric generation (WIA 2008a). In 2007, WIA selected PacifiCorp from a list of 17 candidate firms and entered into a public-private partnership to assess the feasibility of developing an integrated gasification combined cycle power plant. The initial study focused on a site in southwestern Wyoming, but may open the way for similar projects elsewhere in the state (WIA 2008a), including the PRB.

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- Additionally, there currently is a developing technology that would use existing oil and gas wells to generate biologically-formed methane by enhancing the methane production from naturally occurring microbes in the coal. This process is proposed for commercial testing. It is a hybrid between conventional in-situ coal gasification and conventional CBNG development. A policy to authorize and regulate this activity currently is being developed.

##### 4.1.1.2.5 Carbon Sequestration

Carbon sequestration, the process of carbon capture, separation, and storage or reuse, is being researched as a means to stabilize and reduce concentrations of carbon dioxide (a greenhouse gas). Direct options for carbon sequestration would involve means to capture carbon dioxide (CO<sub>2</sub>) at the source (e.g., power plant) before it enters the atmosphere coupled with “value-added” sequestration (e.g., use of captured CO<sub>2</sub> in enhanced oil recovery [EOR] operations). Indirect sequestration would involve means of integrating fossil fuel production and use with terrestrial sequestration and enhanced ocean storage of carbon.

No carbon sequestration projects currently exist in the Wyoming PRB study area. However, there is CO<sub>2</sub> being injected underground for the purpose of EOR near the study area in the Salt Creek area.

The 59<sup>th</sup> Session of the Wyoming State Legislature passed, and Governor Freudenthal signed into law, legislation that could affect long-term energy-related development in the PRB (House Bills 0089 and 0090) (Wyoming Legislative Services 2008). The former (now part of Wyoming Statute 34-1) specified the ownership of subsurface “pore” space, established the rights to use such space for the purpose of carbon sequestration, and maintained the primacy of the mineral estate and the owners of such estate to reasonable use of the surface for the purpose of mineral exploration and production.

Legal provisions enacted as a result of House Bill 0090 vested regulatory control over carbon sequestration with WDEQ and directed the department to promulgate rules, regulations (including permitting processes), and standards for such use. The legislation also specifies that applications for a carbon sequestration project must describe the geology of the area, aquifers above and below the intended injection zone, drill holes and operating wells in the area, potential impacts to other fluid resources, and identify a program for detecting migration or excursion of the CO<sub>2</sub>. Finally, the enacted legislation (Wyoming Statute 35-11-103) specifically states that the act is not intended to impede or impair the rights of oil and gas operators to inject CO<sub>2</sub> through an approved EOR project and establish, verify, register, and sell emissions reduction credits.

Based on the coal- and oil and gas-related development in the PRB study area, the potential exists for future development of carbon sequestration in the area. However, no commercial projects specifically targeted at capturing and

sequestering carbon have been identified at this time. Sequestration was not included in the PRB Coal Review analysis because the likelihood of projects occurring was not known when the analysis was conducted.

A summary of past, present, and reasonably foreseeable coal mines, coal-related facilities, coal production, coal mine employment, and coal and coal-related disturbance in the Wyoming PRB is presented in Table 4-5.

Table 4-5. Past, Present, and Projected Wyoming PRB Coal Mine and Coal-Related Development Scenario.

Year	Coal Production (mmtpy)	Number of Active Coal Mines <sup>1</sup>	Number of Active Power Plants	Number of Active Coal Conversion Facilities <sup>2</sup>	Direct Coal Mine Employment	Total Coal Disturbance (acres) <sup>3</sup>
<b>Past and Present</b>						
<b>1990</b>	163	18	3	1	2,862	na
<b>1995</b>	247	19	4	1	3,177	na
<b>2000</b>	323	12	4	2	3,335	na
<b>2003</b>	364	12	4	0	4,697	68,794
<b>2007</b>	428	13	5	0	5,533	83,593
<b>Projected Development - Lower Coal Production Scenario</b>						
<b>2010</b>	411	13 <sup>1</sup>	7	1 <sup>2</sup>	5,433	98,662
<b>2015</b>	467	13 <sup>1</sup>	7	1 <sup>2</sup>	5,705	117,236
<b>2020</b>	495	13 <sup>1</sup>	7	1 <sup>2</sup>	5,731	137,443
<b>Projected Development - Upper Coal Production Scenario</b>						
<b>2010</b>	479	13 <sup>1</sup>	7	1 <sup>2</sup>	5,509	102,448
<b>2015</b>	543	13 <sup>1</sup>	7	1 <sup>2</sup>	5,722	124,545
<b>2020</b>	576	13 <sup>1</sup>	8	1 <sup>2</sup>	5,998	149,089

<sup>1</sup> Mines have consolidated and may continue to do so in the future. Also, new mines may be permitted to better access the coal reserves projected for mining by 2020.

<sup>2</sup> Several coal conversion facilities currently are being evaluated; however, there is only one for which the likelihood of future development currently can be assessed.

<sup>3</sup> Disturbance area includes coal mine and coal-related disturbance areas.

Source: Annual Report of the Wyoming State Mine Inspector (Wyoming Department of Employment 1990, 1995, 2000, 2003, and 2007a) and PRB Coal Review Task 2 Update Report (BLM 2009b)

#### 4.1.2 Oil and Gas Development

The following information on existing conventional and CBNG development is summarized from the PRB Coal Review Task 2 Report (BLM 2009b). The information reported is for 2003, which was the baseline year for the coal review.

##### 4.1.2.1 Conventional Oil and Gas

Conventional oil and gas development includes all non-CBNG development activity. Approximately 1,500 conventional oil and gas wells, including producing, non-producing and injection wells, were drilled between 1990 and 2003 (IHS 2004) in the PRB Coal Review Task 2 Study Area. Of those, 60

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percent were development wells, drilled in established producing areas. The remaining 40 percent were classified as wildcat wells, which are wells that are drilled in non-producing areas or drilled to evaluate untested prospective zones in producing areas. Approximately 75 percent of the wildcat wells were plugged and abandoned. By 2003, the successful new field wildcat wells had resulted in the discovery of 61 new fields that produced 719,000 barrels of oil and 1.45 billion cubic feet (bcf) of non-CBNG (WOGCC 2004).

As of the end of 2003, there were approximately 3,500 producing conventional oil and gas wells in the Wyoming PRB study area plus 1,386 seasonally active wells (IHS 2004). The Wyoming Oil and Gas Conservation Commission (WOGCC) reported that these wells produced approximately 13 million barrels of oil (mmbo) and 41 bcf of conventional gas in 2003 (WOGCC 2004). The U.S. Geological Survey (USGS) estimated that the mean undiscovered non-coal bed hydrocarbon resource in the PRB (including Montana) is 1.8 billion barrels of oil equivalent (boe) (USGS 2002a).

By the end of 2007, there were approximately 3,857 producing conventional oil and gas wells in the Wyoming PRB study area plus an estimated 1,500 seasonally active wells (IHS 2008). WOGCC reported that these wells produced approximately 11.4 mmbo and 22 bcf of conventional gas in 2007 (WOGCC 2008c).

Most of Wyoming's current oil production is from old oil fields with declining production and the level of exploration drilling to discover new fields has been low (WSGS 2002). This situation is reflected in the PRB where, over the 10-year period from 1992 through 2002, oil production from conventional oil and gas wells in Campbell and Converse counties decreased approximately 60.4 percent (from 32.8 million barrels in 1992 to 13.0 million barrels in 2002). Oil prices have been increasing, which is reversing projections of a continuing decline in oil and gas production; production is now expected to increase in the PRB, with a peak around 2010 of approximately 15.7 million barrels (WSO-RMG 2005). Oil production in the short term may also be bolstered by some planned CO<sub>2</sub> flood projects in the PRB (WSGS 2003). This projected temporary upward trend in conventional oil and gas development is reflected in the PRB Coal Review projections (Table 4-6).

The active wells identified in Table 4-6 include wells that produce year-round, seasonally producing wells, and service wells (mainly injection wells). It is estimated that there are approximately 2,000 idle conventional oil and gas wells in the PRB study area (WOGCC 2008a); however, the number of idle wells gradually would be reduced in the future through plugging programs, and the idle well locations (once the wells are abandoned) would be reclaimed and no longer represent a disturbance.

Table 4-6. Actual and Projected Wyoming PRB Conventional Oil and Gas Development Scenario.

Production and Wells	Actual		Projected		
	2003	2007	2010	2015	2020
<b>Annual Gas Production (bcf)</b>	39.9	22.0	42.7	39.0	35.1
<b>Annual Oil Production (mmbo)</b>	12.9	11.4	15.7	14.3	12.9
<b>Active Wells</b>	5,067 <sup>1</sup>	3,857 <sup>2</sup>	5,603	5,115	4,625
<b>Inactive Wells</b>	1,994	0 <sup>3</sup>	954	563	332

<sup>1</sup> Total includes approximately 1,500 seasonally active wells.

<sup>2</sup> Total includes approximately 1,500 seasonally active wells and an unknown number of inactive wells.

<sup>3</sup> Unknown.

Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

#### 4.1.2.2 CBNG Development

Natural gas production has been increasing in Wyoming. In the PRB, this is due to the development of shallow CBNG resources. Commercial development of these resources began in limited areas west of and adjacent to the northernmost surface coal mines in the late 1980s. Since that time, CBNG development has spread south and west into other parts of the PRB Coal Review Task 1 and Task 2 study area (Figure 4-1).

On private and state oil and gas leases, the WOGCC and the Wyoming State Engineers Office (SEO) authorize CBNG drilling. On federal oil and gas leases, BLM must analyze the individual and cumulative environmental impacts of all drilling (federal, state, and private), as required by NEPA, before CBNG drilling can be authorized. BLM does not authorize drilling on state or private leases but must consider the impacts from those wells in their NEPA analyses. In many areas of the PRB, the coal estate is federally owned, but the oil and gas estate is privately owned. A June 7, 1999 Supreme Court decision (98-830) assigned the rights to develop CBNG on a piece of land to the owner of the oil and gas estate.

Annual CBNG production increased rapidly in the PRB between 1999 and 2003 but has leveled off somewhat since then. At the end of 2003, there were 14,758 producing CBNG wells in the study area (IHS 2004), and total production for that year was 346 bcf, or 88 percent of the total gas production from the basin (WOGCC 2004). Total CBNG production in the PRB was 377 bcf for 2006, 432 bcf for 2007, and 536 bcf for 2008 (WOGCC 2009). Average daily CBNG production was about 947 million cubic feet per day (mmcfpd) in 2003 (Holcomb 2003), 1,033 mmcfpd in 2006, 1,177 mmcfpd in 2007, and 1,469 mmcfpd in 2008. From 1987 to 2003, the total cumulative gas production from PRB coals was over 1.2 trillion cubic feet. The total water

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production for the same time period was approximately 2.3 billion barrels (96,600 million gallons). According to the WOGCC database (WOGCC 2009), water production in the PRB associated with CBNG production has ranged between 567 million barrels (23,814 million gallons), or about 1.6 million barrels per day in 2003 to 679 million barrels, or about 1.9 million barrels per day in 2008.

Since the early 1990s, the Wyoming BLM has completed numerous Environmental Assessments (EAs) and two EISs analyzing CBNG projects. The most recent of these is the Final EIS and Proposed Plan Amendment for the PRB Oil and Gas Project, which was completed in January 2003 (BLM 2003). The level of CBNG development since 2003 appears to be lower than was forecast in that document. New CBNG well numbers fell from a high of slightly more than 4,600 in 2001 to approximately 2,000 in 2004. The PRB Coal Review Task 2 Report discusses the uncertain trends for future CBNG activity in recent years. The methodology used to project future activity is detailed in Appendix E of that report. Table 4-7 shows the 2003 baseline, actual values for 2007, and projected 2010, 2015, and 2020 levels of CBNG development levels used to evaluate projected cumulative environmental impacts in the PRB Coal Review.

Table 4-7. Actual and Projected Wyoming PRB CBNG Development Scenario.

Production and Wells	Actual		Projected		
	2003	2007	2010	2015	2020
<b>Annual Production (bcf)</b>	338	432	708	1,005	1,026
<b>Active Wells</b>	14,758	20,408	31,943	42,980	42,108

Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

The amount of CBNG activity appears to be at a lower rate than was forecast by earlier projections in the Final EIS and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003), as well as in the 2005 version of the Task 2 report (BLM 2005a). New CBNG well numbers fell from a high of slightly more than 4,600 in 2001 to approximately 2,000 in 2004. It is anticipated that the number of new wells would increase so that between 2010 and 2020 the number of new wells drilled per year, basin-wide, would range between 2,892 to 3,943. As shown in Table 4-7, there would be 31,943 CBNG wells basin-wide by 2010, considerably lower than the over 40,000 wells predicted for the same time period in the Final EIS and Proposed Plan Amendment for the PRB Oil and Gas Project (BLM 2003). It is anticipated that production in the cumulative effects study area would increase from the 432 bcf per year observed in 2007 to approximately 1,026 bcf per year in 2020. These estimates are relatively aggressive related to actual activity from 2003 to 2007 (BLM 2009b), and it is likely that the Buffalo RMP revision, currently underway, will further refine these estimates.

4.1.2.3 Oil and Gas Related Development

Oil and gas related development activities considered in the PRB Coal Review include major transportation pipelines and refineries. Table 4-8 summarizes the net disturbance, reclamation, and water production associated with oil and gas activity (conventional oil and gas, CBNG, and major transportation pipelines) for 2003 (baseline year) and projects disturbance, reclamation, and water production for future years.

Table 4-8. Wyoming PRB Conventional Oil and Gas, CBNG, and Related Development Disturbance and Water Production.

Category	Actual			Projected	
	2003	2007	2010	2015	2020
<b>Cumulative Disturbed Area (acres)<sup>1</sup></b>	177,140	178,023	248,086	344,713	427,557
<b>Cumulative Permanently Reclaimed Area (acres)</b>	114,777	111,926	157,803	226,775	310,959
<b>Cumulative Unreclaimed Area (acres)</b>	62,363	66,097	90,283	117,959	116,598
<b>Annual Water Production (mmgpy)</b>	26,405	31,738	50,865	71,166	72,047

<sup>1</sup> Inclusive of conventional oil and gas and CBNG activities and major transportation pipelines. Disturbance associated with ancillary facilities (including gathering lines and distribution power lines) has been factored in a per well basis.

Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

4.1.2.3.1 Pipelines

Major transportation pipelines for the transport of product to outside markets are a key factor in the development of CBNG and conventional oil and gas resources in the Wyoming PRB study area. Major transportation pipelines also provide for transport of CO<sub>2</sub> to crude oil well fields, which depend somewhat on the availability of CO<sub>2</sub> for EOR. Currently, there are over 13 major transportation pipeline systems in the PRB that transport gas resources to markets outside of the basin (Flores et al. 2001, Wyoming Pipeline Authority 2008). The current capacity of these pipeline systems is approximately 2.1 bcf per day. Currently, the combined natural gas production (CBNG and conventional gas) in the Wyoming PRB study area is approximately 1.22 bcf per day.

Gathering lines and power lines associated with conventional oil and gas and CBNG development also occur within the study area; disturbance from these ancillary facilities were factored into the PRB Coal Review analysis on a per well basis.

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Currently, there are two proposed natural gas transportation pipeline projects that would cross the PRB study area:

- Bison Pipeline LLC (Bison), wholly owned by a subsidiary of TransCanada Corporation, is proposing to construct the Bison Pipeline Project, an interstate natural gas pipeline designed to transport gas from the PRB to the Midwest market. The Bison project will consist of approximately 302 miles of 30-inch diameter natural gas pipeline and related facilities that will extend from near Gillette through southeastern Montana and southwestern North Dakota where it will interconnect with the Northern Border Pipeline system in North Dakota. Approximately 53 miles of the proposed route is within the Wyoming PRB Coal Review study area. If constructed, the Bison project would have a 470 mmcfpd capacity with potential to expand to approximately 1,000 mmcfpd. Bison filed an application with the Federal Energy Regulatory Commission (FERC) for a certificate of public convenience and necessity to construct, own and operate the pipeline in April 2009 with an in-service estimate of 2010 (Bison Pipeline 2009).
- The proposed Pathfinder Pipeline Project, a 42-inch diameter, 500-mile long natural gas pipeline, would cross the Wyoming PRB study area; however, its main supply of gas would come from the Green River Basin, where it would originate. It is possible that an interconnect at Dead Horse Creek might provide an outlet for PRB-produced gas into Pathfinder. If constructed, the Pathfinder project would have a 1.2 to 2.0 bcf per day capacity. Submittal of an application with FERC is pending, with an in-service estimate of 2010.

Beyond the Wyoming PRB study area, these projects essentially would parallel one another to the interconnect with Northern Border's main pipeline in North Dakota. Since these projects would be interstate gas transportation pipelines, they would be regulated by the FERC. Although FERC lists these projects as "on the horizon" (FERC 2008), no formal applications have been filed with the regulatory agencies (FERC 2008, WDEQ/ISD 2008). Both of these projects are dependent upon acquisition of sufficient support in the open season process. Based on the lack of formal applications, their likelihood currently is considered low (BLM 2009b).

There currently are proposed and construction-in-progress natural gas transportation pipeline projects that would not cross the Wyoming PRB study area; however, they would influence the ability of PRB gas producers to access outside markets. These projects are the Alliance Pipeline (a 42-inch-diameter natural gas pipeline proposed from Wamsutter, Wyoming, to Emerson, Manitoba) and the Rockies Express (from Rio Blanco County, Colorado, to Monroe County, Ohio) (Rockies Express Pipeline LLC 2008, Wyoming Pipeline Authority 2008). The Alliance Pipeline is expected to commence construction in 2012, with a proposed in-service date sometime in 2013. Rockies Express Pipeline (western segment from western Colorado to Missouri) was in-service in

January 2008. The expected in-service date for the eastern segment (Missouri to Ohio) is October 2011. Although important to PRB gas producers, because these projects would not cross the Wyoming PRB study area, they are not considered further in this analysis.

The amount of available pipeline capacity could limit the amount of future CBNG development. In the original Task 2 Report (BLM 2003a), it was estimated that growth of Wyoming PRB CBNG production could rise from the 2003 level of 947 mmcf per day up to 3 to 4 bcf per day around 2007 and remain at or above those levels until 2015 (Holcomb 2003). However, production rates of 3 to 4 bcf per day were not realized by 2007, and the average daily production for all gas (conventional and CBNG) was approximately 1.22 bcf per day (WOGCC 2008). Average CBNG production in 2007 was approximately 1.24 bcf per day. The addition of the Bison Pipeline Project would increase the take-away capacity of the PRB by approximately 0.5 bcf per day, resulting in total take-away capacity for the PRB of approximately 2.55 bcf per day. The addition of the Pathfinder Pipeline Project would increase the take-away capacity by approximately an additional 1.6 bcf per day, for a total of approximately 4.15 bcf per day. Based on the assumptions in the Task 2 report, the projected total gas production (conventional and CBNG) would increase to 2.06 bcf per day in 2010, 2.86 bcf per day in 2015, and 2.91 bcf per day in 2020. Therefore, likelihood for additional new pipeline construction for 2010 is low, with a higher likelihood in subsequent years (BLM 2009b).

In the original Task 2 report (BLM 2005a), it was indicated that Anadarko Petroleum Corporation was planning to extend its CO<sub>2</sub> pipeline that runs between Bairoil, Wyoming, and Salt Creek, Wyoming, to the Sussex Field located in the southern Johnson County portion of the Wyoming PRB study area. However, more recent information indicates that this has not occurred (Anadarko Petroleum Corporation 2008). According to the Wyoming Enhanced Oil Recovery Institute, fields in the Wyoming PRB study area that would be good candidates for EOR using CO<sub>2</sub> include Hartzog Draw, Hilight, and House Creek (Boyles and vant Veld 2006). Since no CO<sub>2</sub> projects have been proposed for construction in the Wyoming PRB study area, they are not considered further in this analysis.

#### 4.1.2.3.2 Refineries

Construction of a new refinery was completed in the Wyoming PRB study area in 2008. The NorthCut Refinery, owned and operated by Interline Resources, is located in Converse County, approximately 20 miles north of the town of Douglas. Construction of the refinery, which was a conversion of the previously existing Well Draw Gas Plant, included installation of a crude oil pipeline between the company's existing crude gathering system and the refinery.

The NorthCut Refinery is a crude oil topping plant, specifically engineered to process 4,000 barrels per day of sweet crude produced in the PRB. Output

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from the refinery will include naphtha, off-road diesel, and reduced crude oil. The markets for the products include ethanol manufacturers, mines, and other refineries. The company-owned crude oil pipeline and third-party tanker trucks will be used for delivery of crude stocks. Tanker trucks also will be used to transport finished products from the facility (Interline Resources 2008).

The refinery is adjacent to and east of State Highway 59, with the joint BNSF&UP rail line located just to the west of the highway. The site previously had been the location of the Well Draw Gas Plant (approximately 20 acres), which shut down in 2002 following a fire. Interline has acquired an additional 12 acres bordering the original site for administrative, maintenance, and transportation-related uses (Interline Resources 2008).

The level and composition of outputs from the existing NorthCut Refinery would respond to various markets, potentially resulting in the construction of additional infrastructure and/or facilities in the future. Any future changes and associated disturbances would occur within the property currently owned by Interline Resources at the NorthCut site (Williams 2008). No specific plans for expansion currently have been identified. As a result, the likelihood for project expansion currently is considered speculative. Therefore, it has been eliminated from further analysis in this study.

No other reasonably foreseeable plans for construction and operation of new petroleum refineries in the Wyoming portion of the PRB have been identified.

### 4.1.3 Other Development Activity

#### 4.1.3.1 Other Mining

Uranium, sand, gravel, bentonite, and clinker (or scoria) have been and are being mined in the Wyoming PRB study area.

Wyoming has been the nation's leading producer of uranium ore since 1995, and also hosts the nation's largest uranium reserves (WSGS 2009). There are three primary uranium mining districts in the PRB: Pumpkin Buttes, Southern Powder River, and Kaycee (BLM 2003). Numerous uranium mining sites, both potential and existing, are present in these districts. Wyoming's only currently producing uranium mine, the Smith Ranch-Highland operation, is located in Converse County in the Southern Powder River District. The Smith Ranch-Highland operation is owned by Power Resources, Inc. (dba Cameco) and uses the in-situ recovery (or in-situ leach) method of mining. Aside from the Smith Ranch-Highland operation, the only other uranium mining operation in the PRB that is currently licensed by the U.S. Nuclear Regulatory Commission (USNRC) is the Christensen Ranch/Irigaray operation (owned by COGEMA Mining, Inc.) located in Johnson and Campbell counties (USNRC 2009). In-situ operations are expected to restart at the Christensen Ranch mine in the near future.

In the PRB Coal Review Task 2 report (BLM 2005a), reasonably foreseeable uranium development was eliminated from further consideration because: 1) there were no specific projects with pending applications and 2) no development was anticipated, based on market conditions. Based on commodity forecasts and uranium activity as of June 2004, the likelihood and potential timing of new uranium mining operations in the PRB was not known, and additional development was not projected in the PRB Coal Review analysis.

Due to increased overall demand for energy in recent years, uranium prices have increased from a low of \$7 a pound in 2001 to over \$138 a pound in 2007 (Barry 2008). The price fell to \$62 in 2008 and is currently in a range of \$40-\$50 per pound, which is expected to hold through 2010 because of stable demand and a growing supply. The recent upsurge in yellowcake spot prices has increased exploration and claim-staking activity in the PRB and is generating considerable interest in new development (WSGS 2009).

In response to the increased price of uranium, a number of uranium mine developments currently are proposed in the Wyoming PRB study area. The USNRC is currently reviewing applications for two new uranium recover facilities in the PRB: the Moore Ranch and the Nichols Ranch-Hank Unit (USNRC 2009). The Moore Ranch, owned by Energy Minerals Corporation (dba Uranium One), is located in Converse County, and the Nichols Ranch-Hank Unit, owned by Uranerz Energy Corporation, is located in Campbell and Johnson counties. Both of these projects submitted license applications in 2007, they are located in the Pumpkin Buttes District, and would use the in-situ recovery method of mining.

Over the next three years, the USNRC expects to receive additional applications for new uranium recovery facilities, as well as requests for restarts and expansions of existing facilities. Table 4-9 provides information on the three new projects and four expansion projects currently proposed in the PRB, all of which would use in-situ recovery. With the exception of the Ross Project, which is located in western Crook County, the proposed developments are all in the Pumpkin Buttes District in southwestern Campbell and northwestern Converse counties. The actual number of the proposed developments that would become operational would depend on several factors including uranium prices and approval of permits.

Bentonite is weathered volcanic ash that is used in a variety of products, including drilling mud and kitty litter, because of its absorbent properties. There are three major bentonite producing districts in and around the PRB: the Colony District in the Northern Black Hills, the Clay Spur District in the Southern Black Hills, and the Kaycee District west of Kaycee, Wyoming. Within the PRB Coal Review study area, bentonite is mined at Kaycee (WMA 2006). The PRB Coal Review assumed that bentonite mining would continue throughout the study period and that production would continue at existing active mines, with no new mines developed through 2020.

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Table 4-9. In-Situ Recovery Uranium Projects Currently Proposed in the Wyoming PRB Study Area.

<b>Project/ Company</b>	<b>County</b>	<b>Application Type</b>	<b>Watershed/ Mining District</b>	<b>Likelihood/ Rationale</b>
Ludeman Satellite Project/ Energy Metals Corp (dba Uranium One)	Converse	Expansion/ Amendment to Moore Ranch	Antelope Creek/ Pumpkin Buttes District	Moderate for 2012/ Letter of intent to USNRC February 2009, application expected 2009.
Allemand-Ross Satellite Project/ Energy Metals Corp (dba Uranium One)	Converse	Expansion/ Amendment to Moore Ranch	Antelope Creek/ Pumpkin Buttes District	Moderate for 2012/ Letter of intent to USNRC February 2009, application expected 2009.
Ross Project/ Peninsula Minerals, Ltd.	Crook	New	Little Missouri River/ Not in one of the three districts	Moderate for 2012/ Letter of intent to USNRC October 2009, application expected 2010.
Collins Draw Project/ Uranerz Energy Corporation	Campbell	New	Powder River/ Pumpkin Buttes District	Moderate for 2012/ Letter of intent to USNRC March 2008, application expected 2009.
North Butte-Ruth Project/ Power Resources, Inc. (dba Cameco)	Campbell and Johnson	Expansion/ Satellite to Smith Ranch	Powder River/ Pumpkin Buttes District	High probability for 2012/ Application for commercial operation filed March 2006.
Reno Creek Project/ Bayswater Uranium Corporation	Campbell	New	Belle Fourche River and Antelope Creek/ Pumpkin Buttes District	Moderate for 2015/ Letter of intent to USNRC March 2009, application expected 2010.
Ruby Ranch Project/ Power Resources, Inc. (dba Cameco)	Campbell	Expansion/ Satellite to Smith Ranch	Powder River and Belle Fourche River/ Pumpkin Buttes District	Moderate for 2015/ Letter of intent to USNRC March 2008, application expected 2009.

Sources: USNRC (2009), World Information Service on Energy (2009)

Aggregate, which is sand, gravel, and stone, is used for construction purposes. In the PRB, the more important aggregate mining localities are in Johnson and Sheridan counties (WSGS 2004). The largest identified aggregate operation is located in northern Converse County. It has an associated total disturbance area of approximately 67 acres, of which 4 acres have been reclaimed.

Clinker (which is formed when coal beds burn and the adjacent rocks become baked) is used as aggregate where alluvial terrace gravel or in-place granite/igneous rock is not available. Clinker generally is mined in the Converse and Campbell counties portion of the Wyoming PRB study area.

Increased sand, gravel, and clinker production and associated surface disturbance are anticipated in the Wyoming PRB study area in the future because aggregate would be required for road maintenance and new

construction activities as other primary resources, such as coal and oil and gas, continue to be developed. New operations and increased production from existing operations can be expected. These operations would vary in size based on the immediate need from the primary industries, but there is no specific information about these projected operations. As a result, new sand, gravel, or clinker operations were not analyzed in detail in the PRB Coal Review.

#### 4.1.3.2 Industrial Manufacturing

There are a number of existing industrial manufacturing establishments located in the Wyoming PRB Coal Review study area. Most are relatively small with fewer than 25 employees; they predominately serve regional and local markets, and most are directly or indirectly related to energy resource development and production. Over the years, some of these firms have expanded such that they now support activities and serve markets outside of the region, but those operations remain dependent upon the local and regional markets to sustain their existing operations.

The PRB Coal Review anticipates that increased coal production would result in an increased demand for fuels and explosives. This increased demand could result in the need for the development of new off-site chemical feedstock plants in the study area. Project-specific information is not available, however, and the potential development of new chemical feedstock plants was not considered in the PRB Coal Review.

Local economic development organizations, including CCEDC and CANDO, are continually engaged in efforts to recruit or assist new business formation in the PRB study area. For example, CANDO has pursued development of long-term potential projects; however, the outcomes of those projects are uncertain and little information and detail are available. As a result, they were not considered in the PRB Coal Review.

#### 4.1.3.3 Wind Power

Due to increasing concerns over global climate change, there is strong interest from consumers, investor-owned utilities, and environmental and economic sustainability interests in wind energy generating projects and other forms of renewable energy projects. The current development interest in wind energy generation is driven in part by mandates for many utilities to increase the use of renewables in their overall energy portfolio, decisions by environmentally conscious firms to use renewable energy sources, and also due to the development of wind energy manufacturing infrastructure in the region.

Wind power facilities have been proposed, are being constructed, and are providing energy at various sites in Wyoming, including the PRB region. There is good potential for wind power, and these facilities can contribute to meeting forecasted electric power demands; however, they are dependent on available transmission capacity to send power to users. Compared to the lower 48

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states, Wyoming currently ranks in eleventh place in terms of existing wind power capacity from projects currently in operation with 986 MW and 299 MW under construction. Texas ranks in first place with 8,797 MW in operation and 660 MW under construction. In terms of annual wind energy potential, Wyoming ranks seventh with 747 billion kilowatt-hours per year. North Dakota ranks first with 1,210 billion kilowatt-hours per year (AWEA 2010). Although many Wyoming locations having the highest potential are in the southern portion of the state, areas in both Converse and Campbell counties offer sufficient potential to support commercial-scale wind generation projects.

- One such project, the Glenrock Wind Farm, is currently providing power in the Wyoming PRB study area. PacifiCorp completed construction of this three-phase project in Converse County in 2009. The Glenrock Wind Farm is located approximately 15 miles north of the existing Dave Johnston Power Plant, on and near the site of the former Dave Johnston Coal Mine. This is the first wind energy project in the nation to be located at a reclaimed coal mine. The first phase, known as the Glenrock Wind Energy Project, went online in 2008. The second and third phases, the Rolling Hills Wind Energy Project and the Glenrock III Wind Energy Project, respectively, went online in 2009. The Glenrock and Rolling Hills phases each consist of 66 wind turbine generators (each rated at 1.5-MW [99-MW total]). The Glenrock III phase consists of 26, 1.5-MW wind turbines (39-MW total) (PacifiCorp 2009).
- Duke Energy (dba Three Buttes Windpower, LLC) completed the Campbell Hill Windpower Project and began commercial operations in December 2009. The Campbell Hill Windpower Project is located approximately 15 miles northeast of Casper in Converse County and consists of 66 wind turbines generating 99-MW. PacifiCorp will buy all of the output generated by the project.
- Duke Energy plans to build the Top of the World Wind Energy Project, a 200-MW wind farm located northeast of Glenrock in Converse County. Construction is expected to begin in early 2010 upon receipt of all necessary permits from the state. PacifiCorp will buy the power generated by the project (Duke Energy 2009).
- Third Planet Windpower is in the initial development phase of a wind energy project (Reno Junction Windfarm) in the Pumpkin Buttes area of southwestern Campbell County. Third Planet Windpower has acquired approximately 13,000 acres of land leases for the project, installed meteorological monitoring sites, and is currently doing environmental and feasibility studies. The company plans to install up to 133, 1.5-MW towers, yielding a total capacity of 200-MW, if fully constructed. The site for the Reno Junction Wind Farm is close to the Black Hills Power Pumpkin Buttes substation and the companies are seeking an agreement for interconnection. Third Planet Windpower plans to start construction in mid-2010 with an online date expected for the end of 2010 (Gillette

News-Record 2008c). This project is considered moderately likely to occur (BLM 2009b).

Land use disturbance for wind energy projects is associated with development of access roads, a turbine assembly pad, and foundation pad for each wind turbine tower. Additional land disturbance results from installation of transformers and substations, underground electric and fiber optic communications cables, one or more operations and maintenance facilities, meteorological towers, and a transmission line connecting the project to the regional grid. Much of the disturbance area is reclaimed immediately following construction, with long-term disturbance associated with permanent facilities (i.e., access roads, support facilities, and tower foundations).

Wind generating projects have an expected life of approximately 25 years, which could be extended based on market conditions and the overall condition of the infrastructure. Some redisturbance would occur at the time of decommissioning, followed by final reclamation.

According to the American Wind Energy Association (2010), transmission will be a key issue for the wind industry's future development over the next two decades.

#### 4.1.3.4 Solar Power

Although Wyoming has been given a rating of very good for Annual Solar Potential for Flat Plate Collectors, there currently are no utility-scale solar power collection facilities on federal, state, or private lands in Wyoming. Furthermore, no applications for the development of utility-scale solar energy projects have been filed as of January 1, 2010.

The BLM, the Office of Energy Efficiency and Renewable Energy (EERE), and the USDOE are jointly preparing a solar energy Programmatic Environmental Impact Statement (PEIS) which could facilitate future solar energy development application processes. Wyoming is not covered in the PEIS but still may be affected by it. Information on the PEIS can be found at: <http://solareis.anl.gov>. The BLM currently evaluates solar energy project proposals on a case by case basis.

Solar energy utilization in Wyoming is, as of January 1, 2010, limited to private residences and private commercial establishments. Current Wyoming solar energy incentives include a sales tax rebate on industrial or commercial solar energy generation equipment, a one-time grant of up to \$3,000 offered through lottery from the Wyoming Business Council, and the utility buy back of unused electricity at the wholesale price. Solar energy production equipment and installation at residential, commercial, and utility sites is expensive. Currently, the electric utility costs in Wyoming are such that the cost of installation does not favor solar energy development over existing forms of energy development.

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### 4.1.3.5 Reservoirs

Currently, there are five key water storage reservoirs in the Wyoming PRB Coal Review study area (Healy, Lake DeSmet, Muddy Guard No. 2, Gillette, and Betty No. 1) (HKM Engineering et al. 2002a and 2002b). The total disturbance associated with these five key water storage areas is 3,263 acres.

Based on the applicable water plans prepared for the Wyoming Water Development Commission for its Basin Planning Program (HKM Engineering et al. 2002a and 2002b), there are long range projections for development of additional reservoirs in the Wyoming PRB study area. However, none of these reservoirs have reached the planning stage; therefore, there was not enough information to analyze them in the PRB Coal Review.

### 4.1.3.6 Other Non-Energy Development

In addition to the specific projects and developments described above, a network of public and private physical infrastructure, private enterprises, and public activities has been developed in the PRB over time. Examples of infrastructure include the highway and road networks, airports, government offices, hospitals, public schools, municipal water systems, and extensive residential and commercial real estate development. Private enterprises include local retail and service establishments, newspaper publishing, and transportation and distribution firms.

There are a number of existing industrial manufacturing and service establishments located in the Wyoming PRB study area. Most are relatively small with fewer than 50 employees, and most serve local and regional markets, the majority of which are directly or indirectly related to energy resource development and production. Hettinger Welding and L&H Welding and Machine, both based in Gillette, are the largest industrial manufacturing firms in the region specializing in repairs, rebuilding, and manufacturing for the mining industry. Though classified as wholesalers and repair establishments, rather than as manufactures, firms such as Wyoming Machinery and P&H Mining Equipment also serve the mining and oil and gas industries. Other industrial manufacturing and service establishments in the region provide metal fabrication, metal plating, custom and precast concrete products, and specialized chemical products and services. Over the years, some of these firms have expanded such that they now support activities and serve markets outside the PRB region. However, they remain dependent upon the local and regional markets to sustain their existing operations (BLM 2009b).

Local economic development organizations, including Campbell County Economic Development Corporation (CCEDC) and Converse Area New Development Organization (CANDO) are continually engaged in efforts to recruit or assist new business formation in the PRB study area. For example, CANDO is pursuing development of an ammonium nitrate plant (using

methane as a feedstock) in the Bill, Wyoming, area, as well as location of an aluminum mill in the same general location. These and similar prospects are long-term potential whose outcomes are uncertain and for which little information and detail are available. As a result, they were eliminated from analysis in the PRB Coal Review (BLM 2009b).

Local governments, school districts, and other special service districts and public entities continually engage in long-term planning. Examples of some of the recently completed projects and developments, as well as anticipated plans or proposals for development in public, private, and commercial infrastructure within the city of Gillette and Campbell County, are included in the current city of Gillette development summary (City of Gillette 2009) and summarized below:

- The city of Gillette's Wastewater Treatment Plant was upgraded in 2007.
- An expansion and renovation of the county courthouse were completed in 2006, and a new public health building was completed in 2007.
- The Wyoming Center, a conference and multi-event facility expansion of the Gillette CAM-PLEX, was completed in 2008. The expansion includes more exhibit space, conference and indoor athletic facilities with seating for up to 9,000, an indoor ice rink, and various concession and support spaces.
- A new \$10 million headquarters for the Campbell County Fire Department providing administrative, training, storage space, and additional parking bays for firefighting equipment and vehicles was completed in 2008.
- A new Hospice Center, the Cummins Diesel Service Center, and the Hillcrest School were completed in 2008.
- Construction of the new Health Sciences Center at Gillette College was completed in 2008. The facility houses the school's nursing program, providing classrooms, labs, faculty offices, and other spaces. The nursing program functions in conjunction with the Campbell County Memorial Hospital
- Major infrastructure projects within and adjacent to the city limits in 2008 and 2009 included highway and roadway improvements, drainage system improvements, library renovations, subdivision developments, and expansion of the county landfill.
- Expansion of the Campbell County Detention Center and remodeling of the Sheriff's Office were completed in 2009.
- Construction of various commercial and residential housing developments is ongoing.

#### *4.0 Cumulative Environmental Consequences*

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- The new \$55 million Campbell County Recreation Center is currently under construction and scheduled for completion in 2010.
- The county, city, and Gillette College are partnering on a Campus Housing Complex and the Industrial Technical Education Center. Construction of these facilities is ongoing and part of a long-range master plan for the college that is designed to provide a broad college-level curriculum and provide more focused education and training to support local business and industry.
- Campbell County Memorial Hospital is undergoing a major expansion and renovation project that began in 2009.
- The city of Gillette is seeking state and local funding to construct an additional municipal water supply. Construction of a second Madison Formation well field in Crook County near the Keyhole Reservoir and a second water supply line from the well field to Gillette is expected to begin in 2011 or 2012.
- The Wyoming School Facilities Commission (WSFC) oversees all aspects of construction and maintenance of school facilities and physical plant. School districts submit 5-year plans for facilities spending, which are subject to approval and funding by the WSFC. Currently approved master plans for the seven school districts serving some portion of the Wyoming PRB study area include defined needs for more than \$115 million in capital construction, some of which have already been funded (WSFC 2008). The total includes approximately \$51 million for the Campbell County School District, the bulk of which would fund three new elementary schools and one new high school (WSFC 2008).

Additional private sector industrial and commercial development is expected to occur within the context of normal community and economic development. The strong economic base provided by the coal mines, oil and gas companies, and relatively high income of residents draws regional and national retailers (e.g., The Home Depot) to the area. Gillette's location on I-90 and the strong demand for lodging by energy workers, travelers, and visitors associated with events at the CAM-PLEX also have spurred construction of several new motels (CCEDC 2008, City of Gillette 2008a).

The 2010 Wyoming Department of Transportation (WYDOT) State Transportation Improvement Program (STIP) includes planned construction for the 2010 fiscal year and preliminary engineering estimates for projects with anticipated construction dates through 2015. In general, Wyoming transportation projects scheduled over the next 6 years include maintenance, reconstruction, and improvement projects. Airport improvement plans consist primarily of pavement rehabilitation and overlays, with some minor expansion of taxiways, aprons, and parking. Costs anticipated for 2010 through 2015 for highway and airport maintenance, reconstruction, and improvement projects in

the PRB Coal Review study area (Sheridan, Johnson and Campbell counties) are approximately \$190 million. No construction of new highways is scheduled and no new airports are proposed (WYDOT 2010).

In addition to highway projects included in WYDOT's 2008-2013 plan, the Eagle Butte Mine received approval from WYDOT to relocate a portion of U.S. Highway 14-16 in the vicinity of the Gillette-Campbell County Airport, north of the city of Gillette. The relocation will facilitate the recovery of approximately 40 million tons of additional coal recently acquired by the mine through the West Eagle Butte LBA Tract coal sale. Three alternative alignments, involving the construction of up to 6.8 centerline miles of new roadway, were identified and a preferred alternative was subsequently chosen and approved by WYDOT. Construction of the new highway segment is anticipated in 2011/2012 (WYDOT and Foundation Coal Company 2008).

There are numerous current and anticipated plans for future investment in public and private infrastructure in the PRB. Such investments would include state and local investment in transportation, administrative, and educational facilities. Given the timing, scale, year-to-year variability, relatively short construction timetables associated with such investments, the existence of a relatively large and diversified construction industry in the region and nearby areas, and the limited potential for these projects to alter long-term conditions in the PRB, they are not included in the PRB Coal Review analysis. However, one or more of these and similar projects could warrant consideration in a cumulative analysis for a site-specific project due to proximity or coincidental project schedules and timetables (BLM 2009b).

## **4.2 Cumulative Environmental Consequences**

Section 4.1 of this chapter discusses existing and projected levels of development in the Wyoming PRB, and includes summaries of the results of PRB Coal Review Task 2 studies. Task 2 was updated based on actual levels of development through 2007, and current development estimates available through year 2009. This section summarizes the existing conditions resulting from baseline year (2003) development and the cumulative environmental consequences of the projected development for 2010, 2015, and 2020 based on the results of the analyses conducted for PRB Coal Review Task 1 and 3 reports, respectively.

As discussed in Section 4.1, the Wyoming portion of the PRB is the primary focus of the PRB Coal Review analyses. For the majority of resources in the Task 1 analysis, the Wyoming PRB Coal Review study area encompasses all of Campbell County, all of Sheridan and Johnson counties outside of the Bighorn National Forest, and the northern portion of Converse County (Figure 4-1). The study areas for the Task 3 analyses are different. For the majority of the resources considered in the PRB Coal Review, the Task 3 study area is based on watershed boundaries in the PRB and includes the portions of the Upper Powder River, Little Powder River, Upper Belle Fourche River, Upper Cheyenne

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River, Antelope Creek, and Dry Fork Cheyenne River subwatersheds that lie within Sheridan, Johnson, Campbell and northern Converse counties (Figure 4-4). This study area includes over 4 million acres and is referred to below as the cumulative study area. Table 4-10 summarizes the total disturbance and reclamation acreages for the baseline year of 2003 and actual data for 2007, as well as the total projected disturbance and reclamation acreages for 2010, 2015, and 2020 within the cumulative study area described above.

A total of approximately 210,096 acres of this land area had been disturbed by development activities as of 2003. Based on the information in Appendices A and D of the Task 2 Update Report for the PRB Coal Review – Past, Present and Reasonably Foreseeable Development Activities (BLM 2009b), a total of approximately 222,568 acres (5 percent) of land area have been disturbed by development activities in the cumulative effects study area as of end of 2007. Of the 222,568 acres of total cumulative disturbance, approximately 83,593 acres of disturbance (37 percent) were associated with coal mine development.

Of the 222,568 acres of total cumulative disturbance, approximately 113,382 acres (51 percent) have been reclaimed. The remaining 132,645 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 83,593 total cumulative acres of disturbance directly associated with coal mine development, approximately 25,884 acres (31 percent) have been reclaimed (as of end of 2007). Of the remaining 57,709 acres of disturbance, approximately 24,338 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 each mine's life. Reclamation of the remaining 33,371 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 total cumulative disturbance is projected to increase to as much as 434,374 acres in 2020 under the upper coal production scenario, which would represent approximately 9.7 percent of the cumulative study area. This projected disturbance includes coal mining, coal-related development, and oil and gas and related development disturbance in the study area. Of the 434,374 acres, it is projected that 149,089 acres (34 percent) would be associated with coal mining activities. Areas reclaimed during each future time period shown in Table 4-10 reflect how much of the disturbed acreage is projected to be permanently reclaimed by that point in time.

Under the upper coal production scenario for 2020, of the 434,374 acres of total cumulative disturbance, approximately 296,670 (68 percent) would be reclaimed by 2020. The remaining 137,702 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 149,089 acres of disturbance associated with coal mining, it is projected that approximately

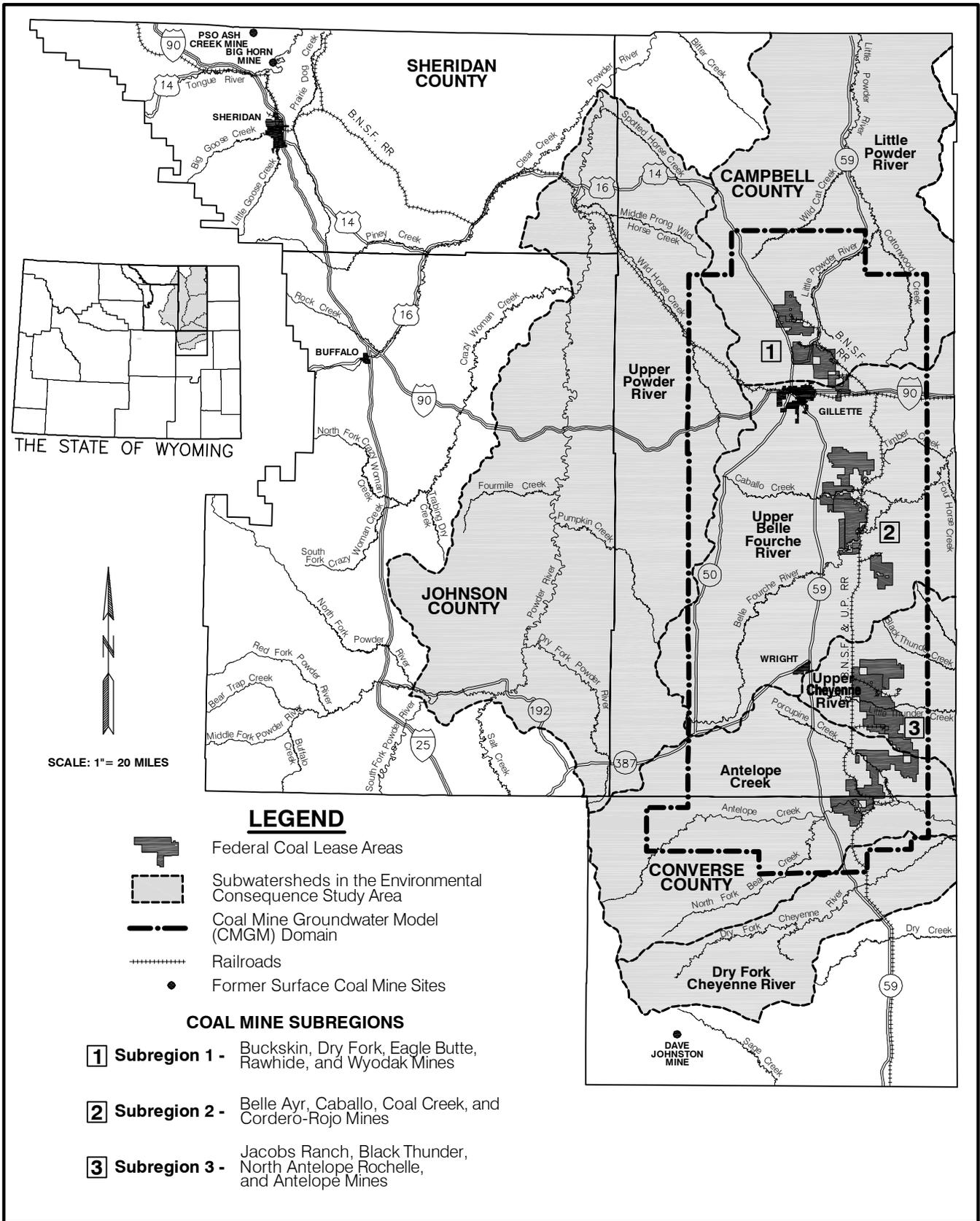


Figure 4-4. Wyoming Task 3 Study Area for PRB Coal Review Studies Evaluating Projected Environmental Consequences.

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Table 4-10. Actual and Projected Wyoming PRB Total Development Scenario, Task 3 Study Area.

Year	Total Acres Disturbed	Acres Reclaimed	Acres Unreclaimed	Acres	
				Unavailable for Reclamation <sup>1</sup>	Affected by Coal Development <sup>1</sup>
<b>Actual</b>					
2003	210,096	111,879	98,217	24,097	68,794
2007	222,568	113,382	132,645	24,338	83,593
<b>Projected Development - Lower Coal Production Scenario</b>					
2010	278,209	159,291	118,919	26,338	98,662
2015	354,148	219,816	134,334	27,549	117,236
2020	422,727	289,937	132,789	28,797	137,443
<b>Projected Development - Upper Coal Production Scenario</b>					
2010	281,996	161,124	120,872	25,688	102,448
2015	361,456	224,024	137,432	27,099	124,545
2020	434,374	296,670	137,702	28,345	149,089

<sup>1</sup> Includes coal mine and coal-related disturbance.  
Source: PRB Coal Review Task 2 Update Report (BLM 2009b)

86,196 (58 percent) would be reclaimed by 2020. Of the remaining 62,893 acres of coal mining-related disturbance, it is estimated that approximately 28,345 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 34,548 acres of disturbance would proceed concurrently with mining operations.

The acres of unreclaimed disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements. The acres currently not available for reclamation are occupied by long-term facilities that are needed to conduct mining operations or coal-related activities. These areas would be reclaimed near the end of each mine or facility's life.

Adjustments were made to the study area described above and shown in Figure 4-4 for several resources as described below:

- The potential air quality impacts were evaluated over a multi-state area (including most of Wyoming, southeastern Montana, southwestern North Dakota, western South Dakota, and northwestern Nebraska) because they would be expected to extend beyond the Wyoming and Montana PRB study area that was used to identify emissions sources for the air quality analysis.
- The socioeconomic impact analysis focused on Campbell County, but also considered Converse, Crook, Johnson, Sheridan, and Weston counties as directly affected and Niobrara and Natrona counties as indirectly affected.

The groundwater drawdown was evaluated in the area surrounding and extending west of the surface coal mines, shown in Figure 4-4, because that is the area where groundwater drawdown related to surface coal mining operations and CBNG production operations would overlap.

#### 4.2.1 Topography and Physiography

The PRB is located within the Upper Missouri Basin Broken Lands physiographic subprovince that includes northeastern Wyoming and eastern Montana to the Canadian border. The topography generally is of low to moderate relief with occasional buttes and mesas. The general topographic gradient slopes down gently from southwest to northeast with elevations ranging from 5,000 to 6,000 feet above sea level on the southern and western portions of the basin to less than 4,000 feet above sea level on the north and northeast along the Montana state line. The major drainages in the basin are the Tongue, Powder, Belle Fourche, and Cheyenne rivers. Most of the drainages in the area are intermittent and have flows during high precipitation events or during periods of snowmelt. The drainages are part of the upper Missouri River Valley drainage basin.

The disturbance associated with the majority of the past, present, and projected activities have resulted in or would result in the alteration of the surface topography. Surface coal mining, which is projected to continue in the area of the existing coal mines shown in Figure 4-4, permanently alters the topography by removing the overburden and coal and then replacing the overburden.

Recontouring during reclamation to match approximate original contours, as required by regulation, reduces the long-term impact to topography. After mined-out areas are reclaimed, the restored land surfaces are typically gentler, with more uniform slopes and restored basic drainage networks. Oil and gas exploration and development has occurred and is projected to continue throughout most of the Task 3 study area. It also results in the alteration of topography to accommodate facilities (e.g., well pads, power plants, etc.) and roads, but the disturbance tends to occur in smaller, more discrete areas than coal mining and the development is spread out over a larger area.

The disturbance and reclamation acreages associated with all existing and projected development in the Task 3 study area for the years 2003, 2007, 2010, 2015, and 2020 are given in Table 4-10.

#### 4.2.2 Geology, Mineral Resources, and Paleontology

The cumulative effects study area for geology, mineral resources, and paleontology is the PRB Coal Review Task 3 study area (Figure 4-4).

The PRB is one of a number of structural basins in Wyoming and the Rocky Mountain area that were formed during the Laramide Orogeny. The basin is

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asymmetric with a structural axis that generally trends northwest to southeast along the western side of the basin (Flores et al. 1999). Natural earthquakes, landslides, and subsidence do not present a hazard in the PRB based on the lack of active faults in the study area (USGS 2004); the low risk of ground shaking in the region if a maximum credible earthquake were to occur (Frankel et al. 1997); and the absence of evidence of subsidence, landslides, or other geologic hazards in association with CBNG production. USGS monitors the magnitude of blasting activity in the PRB under the Routine Mining Seismicity Earthquake Hazards Program (USGS 2008). Coal mine blasting operations induced seismic activity does occur throughout the PRB and has reached a USGS local magnitude rating of 3.6 (USGS 2004).

##### 4.2.2.1 Coal

Most of the coal resources of the basin are found in the Fort Union and Wasatch Formations. Although coals are present in the Wasatch, they are thinner and less continuous than the coals in the Fort Union and, therefore, they are not as economically important as the coals in the Fort Union for either coal mining or CBNG development. Projected levels of coal production and disturbance under the lower and upper coal production scenarios are shown in Tables 4-2 and 4-3.

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.

##### 4.2.2.2 Oil and Gas

Drilling for conventional oil and gas in the Wyoming PRB has declined considerably in the last 15 years. However, as discussed above, increasing prices have led to increased interest in drilling and there remains potential for finding and developing these resources in the deeper formations of the basin. Conversely, CBNG production increased rapidly from 1999 through 2002 but began to level off in 2003. Actual production rates for conventional oil and gas and CBNG in 2007 and projected rates for 2010, 2015, and 2020 are shown in Tables 4-6 and 4-7.

Oil and gas and related development accounts for most of the projected mineral disturbance outside of the coal mining areas. It generally would result in only shallow, discrete areas of surface disturbance, as discussed above. The acreages over which these impacts were occurring (as of 2003 and 2007) and are projected to occur in the years 2010, 2015, and 2020 are included in the totals shown in Table 4-10.

##### 4.2.2.3 Other Mineral Resources

As discussed in Section 4.1.3.1, other mineral resources that are being mined in the Wyoming PRB include uranium, bentonite, clinker, and aggregate.

Production of uranium and bentonite is not likely to be affected by development of coal or CBNG in the PRB. Aggregate and clinker production levels are more likely to be affected by other mineral development levels because these resources would be used in construction projects related to other mineral development.

#### 4.2.2.4 Paleontology

Scientifically significant paleontological resources, including vertebrate, invertebrate, plant, and trace fossils, are known to occur in many of the geologic formations within the Wyoming PRB. These fossils are documented in the scientific literature, in museum records, and are known by paleontologists and land managers familiar with the area.

The Wasatch Formation is the most geographically widespread unit exposed on the surface over most of the cumulative study area. It is underlain by the Fort Union Formation. The fossiliferous Morrison and Lance Formations crop out in the western portion of the basin but occur at depth in the vicinity of the coal mines and CBNG activity in the eastern portion of the basin. Within the cumulative study area, the highly fossiliferous White River Formation occurs only on Pumpkin Buttes in southwestern Campbell County.

As of 2007, no significant or unique paleontological localities had been recorded on federal lands in the PRB. However, the lack of localities in the PRB does not mean that scientifically significant fossils are not present, as much of the area within and surrounding the PRB has not been adequately explored for paleontological resources. As a result, development activities in the cumulative study area have the potential to adversely affect scientifically significant fossils, if they are present in or adjacent to disturbance areas.

The potential for impacts to scientifically significant fossils would be greatest in areas where Class 4 or 5 formations are present (see Section 3.3.3.1). The Wasatch Formation is classified as a Class 5 formation. The Fort Union Formation is classified as a Class 3 formation, which means that fossil content varies in significance, abundance, and predictable occurrence. The greatest potential impact to surface and subsurface fossils would result from disturbance of surface sediments and shallow bedrock during construction and/or operations, depending on the type of project. Potential subsurface disturbance of paleontological resources (e.g., during drilling operations) would not be visible or verifiable. The areas over which these impacts occurred as of 2003 and 2007, and are projected to occur as a result of all projected development in the years 2010, 2015, and 2020 are shown in Table 4-10. As only portions of the cumulative study area have been evaluated for the occurrence of paleontological resources, and discrete locations for development activities cannot be determined at this time, no accurate estimate can be made as to the number of paleontological sites that may be affected by cumulative development activities.

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Development activities which involve federally owned surface and/or minerals are 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 these activities.

##### 4.2.3 Air Quality

There is substantial scientific evidence that increased atmospheric concentrations of greenhouse gases (GHG) and land use changes are contributing to an increase in average global temperature (IPCC 2007). However, since these gases are not regulated pollutants, a discussion of this subject has been included in Section 4.2.14.

The Task 1A Report for the PRB Coal Review (BLM 2005b) documents the modeled air quality impacts of operations during a baseline year, 2002, using actual emissions and operations for that year. Emissions from permitted minor sources were estimated, due to unavailability of actual emissions data. The baseline year analysis evaluated impacts both within the PRB itself and at selected sensitive areas surrounding the region. The analysis specifically looked at impacts of coal mines, power plants, CBNG development, and other development activities. Results were provided for both Wyoming and Montana at the individual receptor areas. The Task 2 Report for the PRB Coal Review (BLM 2005a) identifies reasonably foreseeable development activities for the years 2010, 2015, and 2020.

The Task 3A Report for the PRB Coal Review (BLM 2006b) evaluates the impacts on air quality and air quality-related values for the year 2010 using the development levels projected for 2010 and the same model and meteorological data that were used for the baseline year study in the Task 1A Report. BLM updated the model and conducted impact analysis for the year 2015 (BLM 2008h). The updated Task 3A report for the PRB Coal Review Cumulative Air Quality Effects for 2015 uses a revised baseline year of 2004 with revised projected 2015 scenarios. BLM subsequently updated the model and conducted impact analysis for the year 2020 (BLM 2009c). The updated Task 3A report for the PRB Coal Review Cumulative Air Quality Effects for 2020 uses the same baseline year of 2004 with revised projected 2020 scenarios. The revised baseline year emissions inventory was developed using 2004 actual emissions data or emissions estimates and has incorporated the recent analyses of emissions in Wyoming and Montana, which were not available when the 2010 modeling study was done.

Existing and projected emissions sources for the baseline year (2004) and 2015 and 2020 analyses were identified within a study area comprised of the following counties in the PRB in Wyoming and Montana:

- Campbell County, all of Sheridan and Johnson counties except the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County, Wyoming.
- Rosebud, Custer, Powder River, Big Horn, and Treasure counties, Montana.

A state-of-the-art, guideline dispersion model was used to evaluate impacts of the existing and projected source emissions on several source groups, as follows:

- Near-field receptors in Wyoming and Montana covering the PRB Coal Review Task 1A and 3A study area in each state. Overall, the near-field receptor grid points were spaced at one kilometer intervals over the study area;
- Receptors in nearby federally designated pristine or “Class I” areas; and
- Receptors at other sensitive areas (Class II sensitive areas).

The EPA guideline CALPUFF model system version 5.8 (Scire et al. 1999a) was used for this study, which differs from the version used in the Task 1A and original Task 3A studies. The impacts for the baseline year (2004) and for 2015 and 2020 lower and upper coal production scenarios were directly modeled, and the criteria pollutants modeled were particulates (PM<sub>10</sub> and PM<sub>2.5</sub>), NO<sub>2</sub> and SO<sub>2</sub>. As discussed above, the modeling domain extends over most of Wyoming, southeastern Montana, southwestern North Dakota, western South Dakota, and western Nebraska. An interagency group participated in developing the modeling protocol and related domain that were used for this analysis.

The modeling approach for the updated Task 3A Report used actual emissions from existing sources representative of 2004 operations and projected those emissions for the expected level of development in 2015 and in 2020. Year 2004 emission inventory data were previously developed for the Montana Statewide Oil and Gas Supplemental Environmental Impact Statement. No specific emissions data were available for the projected levels of development. The baseline year emissions data were gathered from a variety of sources, but mainly relied on data collected by the WDEQ/AQD and the Montana Department of Environmental Quality (MDEQ). Only actual emission sources inside the study area described above were included in the modeling. Key major sources were included, such as the coal-fired power plants, gas-fired power plants, and sources that were included in the Title V (operating permit) program. The Dave Johnston power plant, which is located outside of but adjacent to the study area in Converse County, was included in the baseline year study and in the projected emissions. Some operational adjustments were made to accommodate small sources with air permits that were presumed to be operating at less than full capacity. Emissions from other sources, including

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estimated construction-related fugitive dust emissions, were computed based on EPA emission factors and on input data from WDEQ/AQD.

The existing regional air quality conditions generally are very good in the PRB Coal Review Task 1A and Task 3A study area. There are limited air pollution emissions sources (few industrial facilities, including the surface coal mines, and few residential emissions in relatively small communities and isolated ranches) and good atmospheric dispersion conditions. The available data show that the region is in compliance with the ambient air quality standards for nitrogen dioxide (NO<sub>2</sub>) and sulfur dioxide (SO<sub>2</sub>). There have been no monitored exceedances of the annual particulates (PM<sub>10</sub>) standard in the Wyoming PRB.

Air quality modeling indicates the projected mine activities at the three Wright area applicant mines will be in compliance with the PM<sub>10</sub> and PM<sub>2.5</sub> near-field and short-term NO<sub>2</sub> air standards for the 2015 and 2020 modeled air quality impacts at their currently permitted mining rates. All applicants have indicated that they propose to mine the respective LBA tracts at a rate equal to or below the mines' current air quality permit levels. Visibility data collected around the region indicate that, although there are some days with notable impacts at Class I areas, the general trend in the region shows little change in visibility impacts at the Badlands and Wind Cave National Parks and the Bridger/Fitzpatrick and Cloud Peak Wilderness Areas over the period from 1989 to 2008 (Figure 3-19).

Predicted impacts from baseline year (2004) and projected 2015 and 2020 emissions were modeled for four air quality criteria pollutants (NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>), along with changes in air quality-related values at Class I areas and at identified sensitive areas. For regulatory purposes, the Class I PSD (Prevention of Significant Deterioration) evaluations are not directly comparable to the air quality permitting requirements, because the modeling effort does not identify or separately evaluate increment consuming sources that would need to be evaluated under the PSD program. The cumulative impact analysis focuses on changes in cumulative impacts, but not on a comparison to PSD-related evaluations, which would apply to specific sources.

Table 4-11 presents the modeled impacts on ambient air quality at the near-field receptors in Montana and Wyoming. Results indicate the maximum impacts at any point in each receptor group, and data are provided for the baseline year (2004) analysis and for both coal production scenarios for 2015 and 2020. Peak impacts occur at isolated receptors and are likely due to unique source-receptor relationships. The model results should not be construed as predicting an actual exceedance of any standard, but are at best indicators of potential impacts.

The results of the modeling depict the anticipated changes under both development scenarios. For the Wyoming near-field receptors, the predicted impact of the 24-hour PM<sub>10</sub> and PM<sub>2.5</sub> concentrations show localized exceedances of the National Ambient Air Quality Standard (NAAQS) for the

Table 4-11. Projected Maximum Potential Near-field Impacts ( $\mu\text{g}/\text{m}^3$ ).

Pollutant	Averaging Time	Base Year (2004) Impacts	2020 Lower Coal Development Scenario Impacts	2020 Upper Coal Development Scenario Impacts	NAAQS	Wyoming AAQS	Montana AAQS	PSD Class II Increments
<b>Wyoming Near-field</b>								
NO <sub>2</sub>	Annual	31.3	30.5	30.6	100	100	--- <sup>1</sup>	25
SO <sub>2</sub>	Annual	15.3	16.4	16.5	80	60	---	20
	24-hour	112.3	143.3	143.3	365	260	---	91
	3-hour	462.0	936.7	936.7	1,300	1,300	---	512
PM <sub>2.5</sub>	Annual	13.4	<b>16.3</b>	<b>16.3</b>	15	15	---	---
	24-hour	<b>87.6</b>	<b>218.4</b>	<b>218.4</b>	35	35	---	---
PM <sub>10</sub>	Annual	38.4	46.6	46.6	---	50	---	17
	24-hour	<b>250.4</b>	<b>624.1</b>	<b>624.3</b>	150	150	---	30
<b>Montana Near-field</b>								
NO <sub>2</sub>	Annual	3.3	2.5	2.6	100	---	100	25
	1-hour	409.0	440.1	442.7	188.1	---	564	---
SO <sub>2</sub>	Annual	1.6	3.0	3.1	80	---	80	20
	24-hour	16.1	24.7	27.1	365	---	365	91
	3-hour	65.0	138.9	138.9	1,300	---	1,300	512
	1-hour	162.9	237.0	259.1	---	---	1,300	---
PM <sub>2.5</sub>	Annual	1.0	0.9	0.9	15	---	15	---
		10.2	10.2	10.2	35	---	35	---
PM <sub>10</sub>	Annual	2.8	2.5	2.6	---	---	50	17
	24-hour	29.1	29.3	29.3	150	---	150	30

<sup>1</sup> Indicates no value, standard, or increment

Value unit is microgram per cubic meter ( $\mu\text{g}/\text{m}^3$ )

**Bold values** indicate projected exceedance of AAQS

Source: PRB Coal Review Task 3A Update Report (BLM 2009c)

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baseline year (2004), as well as for both development scenarios for 2015 and 2020. The 2020 development scenarios show the concentration increases by a factor of 2.5 relative to the base year for these parameters. Additionally, while down about 10 percent from 2015, 2020 development scenarios show a 20 percent increase of annual PM<sub>10</sub> and PM<sub>2.5</sub> concentrations at peak Wyoming near-field receptors. This level of increase indicated modeled exceedances of annual standards for PM<sub>2.5</sub>. Impacts of NO<sub>2</sub> and SO<sub>2</sub> emissions are predicted to be below the NAAQS and Wyoming State Ambient Air Quality Standard (SAAQS) at the Wyoming near-field receptors.

Based on the modeling results, impacts at Montana near-field receptors would be in compliance with the Montana SAAQS for all pollutants and averaging periods. Importantly, the 1-hour NO<sub>2</sub> concentrations at Montana near-field receptors for 2015 were predicted to exceed the SAAQS at isolated locations due to CBNG development in Wyoming; however, with the anticipated southward progression of the CBNG wells, the 1-hour NO<sub>2</sub> concentrations in 2020 are predicted to remain below the SAAQS. However, the modeling results indicate that the 1-hour NO<sub>2</sub> concentrations at Montana near-field receptors for 2020 would exceed EPA's new 1-hour NAAQS (0.001 ppm or 188.1 µg/m<sup>3</sup>). The southward progression of the CBNG wells also contributes to a predicted decrease in impacts for annual NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub> relative to the baseline year. Although large percentage increases were predicted in SO<sub>2</sub> impacts, the levels would be below the ambient standards for all pollutants in the Montana near-field.

As discussed in Section 3.4.2.2.1, modeling tends to over-predict the 24-hour impacts of surface coal mining and, as a result, WDEQ/AQD does not consider short-term PM<sub>10</sub> modeling to be an accurate representation of short-term impacts. In view of this, a Memorandum of Agreement between WDEQ/AQD and EPA Region VIII, dated January 24, 1994, allows WDEQ/AQD to conduct monitoring in lieu of short-term modeling for assessing coal mining-related impacts in the PRB. This agreement also requires "Best Available Work Practice" mitigation measures in all coal mine permits. The monitored exceedances at surface coal mines in the Wyoming PRB and the measures that WDEQ/AQD has implemented or is proposing to implement to prevent future exceedances of the PM<sub>10</sub> NAAQS are discussed in Chapter 3, Sections 3.4.2.1 and 3.4.2.3.

The maximum modeled impacts on the annual PM<sub>2.5</sub> level is projected to be above the standard (15 µg/m<sup>3</sup>) at near-field receptors in Wyoming for the 2015 and 2020 lower and upper coal production scenarios. Annual PM<sub>10</sub> levels are projected to be above the standard (50 µg/m<sup>3</sup>) at near-field receptors in Wyoming for 2015, and then to fall back below the standard for the 2020 lower and upper coal production scenarios. EPA has revoked the NAAQS annual PM<sub>10</sub> standard of 50 µg/m<sup>3</sup>, but until Wyoming enters into rule making to revise the WAAQS, that standard is still effective. WDEQ/AQD issues air quality permits for coal mining. AQD cannot issue any permit that violates Ambient Air Quality Standards. Impacts of NO<sub>2</sub> and SO<sub>2</sub> emissions are

predicted to be below the NAAQS and Wyoming AAQS at all Wyoming near-field receptors. A large portion of the impacts for all scenarios would be associated with coal-related sources, although non-coal sources would contribute a notable portion of the impact.

Table 4-12 lists the three Class I areas and two Class II areas where the modeled impacts are the greatest. Table 4-12 includes a comparison to ambient air quality standards and PSD increments; however, it must be noted that this modeling analysis did not separate PSD increment-consuming sources from those that do not consume increment. The PSD-increment comparison is provided for informational purposes only and cannot be directly related to a regulatory interpretation of PSD increment consumption.

None of the modeled Class I areas currently have, or are predicted to have, NAAQS or SAAQS exceedances. Table 4-12 compares the modeled impacts to the PSD Class I and sensitive Class II increment levels. At the Northern Cheyenne Indian Reservation (IR), Badlands National Park (NP) and Wind Cave NP base year impacts are slightly above the Class I comparative levels for 24-hour PM<sub>10</sub> in 2020. Additionally, the SO<sub>2</sub> impacts at the Northern Cheyenne IR for the 3-hour and 24-hour averaging period exceed the Class I PSD increment levels. In the other Class I areas, only the modeled 24-hour SO<sub>2</sub> impacts at Theodore Roosevelt NP and Fort Peck IR, and 3-hour SO<sub>2</sub> impacts at Theodore Roosevelt NP, are above the PSD increment levels for the 2020 development scenarios; the predicted exceedances for these areas are due to sources outside the PRB study area. In the sensitive Class II areas, there are no modeled exceedances of the Class II PSD Increments. The modeled annual NO<sub>2</sub> impacts at the Cloud Peak Wilderness Area (WA) and Crow IR are projected to increase by a factor of 2 to 4, respectively, in 2020 as a result of projected CBNG and coal hauling activities. For comparison purposes, modeling results for all sensitive Class II areas are below PSD increment levels for both 2020 development scenarios.

The projected modeled visibility impacts for the baseline year (2004) and for the lower and upper coal production scenarios for 2020 for all analyzed Class I and sensitive Class II areas are listed in Table 4-13. For the baseline year, the maximum visibility impacts at Class I areas were determined to be at the Northern Cheyenne Indian Reservation in Montana and at Wind Cave and Badlands National Parks in South Dakota. For these locations, modeling showed more than 200 days of impacts with a change of 10 percent or more in extinction. A 10 percent change in extinction corresponds to 1.0 deciview (dv).

Table 4-13 provides a detailed listing of visibility impacts for all analyzed Class I and sensitive Class II areas. As with the 2015 modeling results, 2020 modeled visibility impacts at the identified Class I areas continue to show a similar pattern as exhibited for the base year (2004), with a high number of days with a greater than 10 percent change in visibility at the most impacted Class I areas. Visibility impacts at Badlands NP, Northern Cheyenne IR, and Wind Cave NP all have greater than 10 percent change for more than 200 days

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Table 4-12. Maximum Predicted PSD Class I and Sensitive Class II Area Impacts ( $\mu\text{g}/\text{m}^3$ ).

Location	Pollutant	Averaging Period	Base Year (2004) Impacts	2020 Lower Coal Development Scenario	2020 Upper Coal Development Scenario	PSD Class I/II Increments
<b>Class I Areas</b>						
<b>Northern Cheyenne Indian Reservation</b>	NO <sub>2</sub>	Annual	0.4	0.8	1.1	2.5
		24-hour	0.5	1.1	1.3	2
	SO <sub>2</sub>	24-hour	3.1	<b>7.1</b>	<b>12.8</b>	5
		3-hour	9.4	23.6	<b>39.7</b>	25
	PM <sub>2.5</sub>	Annual	0.3	0.4	0.5	--- <sup>1</sup>
		24-hour	3.4	4.5	4.6	---
PM <sub>10</sub>	Annual	0.9	1.2	1.5	4	
	24-hour	<b>9.6</b>	<b>12.9</b>	<b>13.2</b>	8	
<b>Badlands National Park</b>	NO <sub>2</sub>	Annual	0.1	0.2	0.2	2.5
		24-hour	0.5	0.6	0.2	2
	SO <sub>2</sub>	24-hour	3.6	4.0	4.0	5
		3-hour	8.1	8.2	8.2	25
	PM <sub>2.5</sub>	Annual	0.2	0.3	0.3	---
		24-hour	2.1	3.0	3.1	---
PM <sub>10</sub>	Annual	0.7	0.9	1.0	4	
	24-hour	5.9	<b>8.5</b>	<b>8.8</b>	8	
<b>Wind Cave National Park</b>	NO <sub>2</sub>	Annual	0.2	0.3	0.3	2.5
		24-hour	0.7	0.8	0.8	2
	SO <sub>2</sub>	24-hour	3.7	4.6	4.7	5
		3-hour	7.0	7.5	7.7	25
	PM <sub>2.5</sub>	Annual	0.4	0.5	0.5	---
		24-hour	3.8	4.6	4.7	---
PM <sub>10</sub>	Annual	1.0	1.4	1.4	4	
	24-hour	<b>10.9</b>	<b>13.0</b>	<b>13.3</b>	8	
<b>Sensitive Class II Areas</b>						
<b>Cloud Peak Wilderness Area</b>	NO <sub>2</sub>	Annual	0.06	0.12	0.12	25
		24-hour	0.2	0.3	0.3	20
	SO <sub>2</sub>	24-hour	2.0	2.5	2.5	91
		3-hour	8.0	8.9	9.0	512
	PM <sub>2.5</sub>	Annual	0.2	0.2	0.2	---
		24-hour	2.6	3.2	3.39	---
PM <sub>10</sub>	Annual	0.5	0.7	0.7	17	
	24-hour	7.4	9.1	9.3	30	
<b>Crow Indian Reservation</b>	NO <sub>2</sub>	Annual	0.9	3.6	4.2	25
		24-hour	2.3	2.4	2.7	20
	SO <sub>2</sub>	24-hour	14.4	14.8	14.8	91
		3-hour	76.8	77.0	77.0	512
	PM <sub>2.5</sub>	Annual	0.8	0.8	0.8	---
		24-hour	7.2	7.2	7.2	---
PM <sub>10</sub>	Annual	2.2	2.3	2.4	17	
	24-hour	20.5	20.6	20.6	30	

<sup>1</sup> Indicates no increment

Value units are micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ )

**Bold values** indicate exceedance of PSD increment

Source: PRB Coal Review Task 3A Update Report (BLM 2009c)

Table 4-13. Modeled Change in Visibility Impacts at Class I and Sensitive Class II Areas.

Location	Base Year (2004)	2020 Lower Coal Development Scenario	2020 Upper Coal Development Scenario
	No. of Days >10%	Change in No. of Days >10%	Change in No. of Days >10%
<b>Class I Areas</b>			
Badlands National Park	218	44	44
Bob Marshall WA	8	0	0
Bridger WA	144	5	5
Fitzpatrick WA	91	6	6
Fort Peck Indian Reservation	105	20	21
Gates of the Mountain WA	55	4	4
Grand Teton National Park	70	6	6
North Absaroka WA	61	8	8
North Cheyenne Indian Reservation	243	59	60
Red Rock Lakes	42	3	3
Scapegoat WA	27	2	2
Teton WA	57	8	8
Theodore Roosevelt National Park	178	24	24
UL Bend WA	77	18	18
Washakie WA	83	8	8
Wind Cave National Park	262	28	31
Yellowstone National Park	84	5	5
<b>Sensitive Class II Areas</b>			
Absaroka Beartooth WA	101	10	10
Agate Fossil Beds National Monument	251	26	26
Big Horn Canyon National Rec. Area	331	1	1
Black Elk WA	236	47	47
Cloud Peak WA	126	29	30
Crow Indian Reservation	360	3	3
Devils Tower National Monument	274	31	32
Fort Belknap Indian Reservation	66	14	15
Fort Laramie National Historic Site	260	15	16
Jedediah Smith WA	79	3	5
Jewel Cave National Monument	261	36	37
Lee Metcalf WA	97	2	2
Mount Naomi WA	51	1	1
Mount Rushmore National Monument	222	49	52
Popo Agie WA	139	6	6
Soldier Creek WA	268	19	19
Wellsville Mountain WA	130	17	17
Wind River Indian Reservation	217	9	10

Source: PRB Coal Review Task 3A Update Report (BLM 2009c)

#### *4.0 Cumulative Environmental Consequences*

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a year during the base year. These Class I areas are the top three Class I areas with the highest predicted change in light extinction in 2020. All but four of the sensitive Class II areas have more than 100 days per year with greater than a 10 percent change during the base year. The most significant visibility change to sensitive Class II areas in 2020 is predicted for Black Elk WA and Mount Rushmore National Monument. Class II areas do not have any visibility protection under federal or state law. To provide a basis for discussing the modeled visibility impacts resulting from the projected increased production under the lower and upper coal production scenarios for 2020, the modeled visibility impacts for 2004 were subtracted from the model results for 2020. Table 4-13 shows the number of additional days that the projected impacts were greater than 1.0 dv (10 percent in extinction) for each site for the upper and lower coal production scenarios. Using Badlands Park as an example, the modeling analysis showed 218 days with impacts greater than 1.0 dv in 2004. Under the 2020 lower coal production scenario, the modeling analysis projects an additional 44 days with impacts greater than 1.0 dv, or a total of 262 days with impacts greater than 1.0 dv.

For acid deposition, all predicted impacts are below the deposition threshold values for both nitrogen and sulfur compounds. There are substantial percentage increases in deposition under the lower and upper coal production scenarios for 2015; however, impacts remain well below the nitrogen and sulfur levels of concern (1.5 and 5.0 kilograms per hectare per year, respectively).

The acid neutralizing capacity (ANC) of sensitive lakes also was analyzed, and results are summarized in Table 4-14. The base year study indicated that none of the lakes had predicted significant impacts except Upper Frozen Lake; however, the lower and upper development scenarios for 2020 show an increased impact at Florence Lake, leading to an impact above the 10 percent change in acid neutralizing capacity. Impacts also are predicted to be above 1 microequivalent per liter ( $\mu\text{eq}/\text{L}$ ) for Upper Frozen Lake.

The study also modeled impacts of selected hazardous air pollutant emissions (benzene, ethyl benzene, formaldehyde, n-hexane, toluene, and xylene) on the receptors with the highest ambient impacts. The near-field receptors in Wyoming and Montana were analyzed for annual (chronic) and 1-hour (acute) impacts. Model results for the base year (2004) and 2020 development scenarios show that impacts are predicted to be well below the acute Reference Exposure Levels, non-carcinogenic Reference Concentrations for Chronic Inhalation, and carcinogenic risk threshold for all hazardous air pollutants. The maximally exposed individual's carcinogenic risk factor due to benzene exposure is predicted to increase 50 percent as a result of projected development in the PRB, however, even with this substantial increase, the predicted risk is well below U.S. Environmental Protection Agency (EPA) carcinogenic risk thresholds.

Comparing the PRB Coal Review updated Task 3A Report for 2020 (BLM 2009c) to the earlier update for 2015 shows a similar general increase in air quality

Table 4-14. Predicted Total Cumulative Change in Acid Neutralizing Capacity of Sensitive Lakes.

Location	Lake	Background ANC (µeq/L)	Area (hectares)	Base Year 2004 Change (percent)	2020 Lower Coal Development Scenario Change (percent)	2020 Upper Coal Development Scenario Change (percent)	Thresholds (percent)
<b>Bridger Wilderness Area</b>	Black Joe	67.0	890	4.00	4.26	4.27	10
	Deep	60.0	205	4.70	4.98	4.99	10
	Hobbs	70.0	293	3.95	4.14	4.15	10
	Upper Frozen	5.0	64.8	2.42	2.55	2.56	1 <sup>1</sup>
<b>Cloud Peak Wilderness Area</b>	Emerald	55.3	293	5.24	6.69	6.30	10
	Florence	32.7	417	9.09	11.79	11.99	10
<b>Fitzpatrick Wilderness Area</b>	Ross	53.5	4,455	2.72	2.89	2.90	10
<b>Popo Agie Wilderness Area</b>	Lower Saddlebag	55.5	155	6.28	6.65	6.67	10

<sup>1</sup> Data for Upper Frozen Lake presented in changes in µeq/L rather than percent change. (For lakes with less than 25 µeq/L background ANC.)  
Source: PRB Coal Review Task 3A Update Report (BLM 2009c)

#### *4.0 Cumulative Environmental Consequences*

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effects over time compared to the base year. The production from conventional oil and gas activities is projected to peak at 2010, with slight declines predicted over the following decade. The production from CBNG activities was projected to peak at 2015, with slight declines predicted over the following decade; however the actual development has been slower than predicted and therefore the peak year has been shifted later. Therefore, from these sources, expected impacts have increased slightly from 2015 to 2020. The coal mining and CBNG sources would be the major contributors to PM<sub>10</sub> and PM<sub>2.5</sub> impacts in the near-field between 2015 and 2020, and these impacts would result from the proximity of the receptors to the coal mining operations. As noted above, the general south and westward trend of CBNG activity has lowered NO<sub>2</sub> and particulate air quality effects projected in Montana by 2020.

Power plants currently are the major contributors to all SO<sub>2</sub> impacts in the near-field in both states. However, the projected impacts are well below any ambient standard or PSD increment. According to the PRB Coal Review Air Quality modeling analysis, predicted future expansion modeled to the year 2020 should not jeopardize the attainment of those standards. Impacts on NO<sub>2</sub> concentrations are the result of emissions from all the source groups. No one source group dominates the NO<sub>2</sub> impacts in the near-field.

A pattern that is similar to the near-field receptors holds true for the Class I and sensitive Class II receptor groups. Essentially, the mine operations would continue to dominate the PM<sub>10</sub> and PM<sub>2.5</sub> impacts, the power plants would continue to dominate the SO<sub>2</sub> impacts (although they would continue to be below the standards), and the overall source groups would continue to contribute to NO<sub>2</sub> impacts. Impacts should remain below the annual NO<sub>2</sub> standard for 2015 and 2020 in Wyoming and Montana.

Based on modeling results, one of the lakes (Florence) in the Cloud Peak Class I area and one lake (Upper Frozen Lake) in the Bridger Class I area exceeded the acid deposition thresholds for both the lower and upper coal production scenarios for 2015. With the exception of Florence and Upper Frozen lakes, the projected increases in coal development (and power plants) are not expected to raise the deposition levels above the thresholds extended into 2020. The model results showed that the increased deposition, largely from SO<sub>2</sub> emissions from power plants, exceeded the thresholds of significance for the ANC at sensitive (high alpine) lakes. The results indicate that with increased growth in power plant operations, the reduced ANC of the sensitive lakes would need to be addressed carefully for each proposed major development project.

WDEQ/AQD and WDEQ/LQD mitigation and monitoring requirements for coal mine emissions are discussed in Sections 3.4.2.3 and 3.4.3.3. The discussion in these sections includes the operational control measures that are currently in place and would be required for mining operations on LBAs that are issued in the future, as well as measures that may be required to avoid future exceedances of the WAAQS and NAAQS and/or future mine-related impacts to the public.

#### 4.2.4 Water Resources

Surface and groundwater are used extensively throughout the PRB for agricultural water supply, municipal water supply, and both domestic and industrial water supply. Surface water use is limited to major perennial drainages and agricultural areas within the basin are found mainly along these drainages. Reservoirs are also used throughout the basin for agricultural water supply. Municipal water supply comes from a combination of surface and groundwater. Domestic and industrial water supply primarily is from groundwater.

The PRB Coal Review Task 1B Report (BLM 2009d) describes the base year (2002) water resource conditions in the PRB study area, which 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 (Figure 4-4). The Task 3B Report for the PRB Coal Review (BLM 2009e) presents potential future cumulative groundwater impacts in the area of CBNG development and coal mine expansion in the eastern PRB (Figure 4-4), and provides a cumulative impact assessment of surface water quality and channel stability from surface discharge of groundwater from CBNG development.

##### 4.2.4.1 Groundwater

There are five main aquifers in the PRB Coal Review Task 1 and 3 study area (Figure 4-4) that can be used for water supply:

- Madison Aquifer System;
- Dakota Aquifer System;
- Fox Hills/Lance Aquifer System;
- Fort Union/Wasatch Aquifer System; and
- Quaternary Alluvial Aquifer System.

The Fort Union/Wasatch Aquifer System includes the coal and overburden aquifers that are directly affected by surface coal mining and CBNG development. It is also a major source of local water supply for domestic and stock water use. Table 4-15 shows the recoverable groundwater in the components of the Fort Union/Wasatch Aquifer System. The Wasatch Formation is more of a local aquifer, while the Fort Union Formation is a regional aquifer. The volumes of recoverable groundwater from the sandstones within the Wasatch/Tongue River Aquifer, the Lebo Confining Layer, and the Tullock Aquifer were determined from the volume of sandstone in each of these units multiplied by the 13 percent specific yield value for sandstone. Similarly, the volume of recoverable groundwater from the coals within the Wasatch/Tongue River was calculated from the volume of coal multiplied by the 0.4 percent specific yield value for coal.

#### 4.0 Cumulative Environmental Consequences

Table 4-15. Recoverable Groundwater in the Fort Union/Wasatch Aquifer System in the PRB.

<b>Hydrogeologic Unit</b>	<b>Surface Area (acres)</b>	<b>Average Formation Thickness (ft)</b>	<b>Percentage of Sand/Coal</b>	<b>Average Sand/Coal Thickness (ft)</b>	<b>Specific Yield (percent)</b>	<b>Recoverable Groundwater (acre-feet)<sup>1</sup></b>
Wasatch-Tongue River Aquifer Sandstones	5,615,609	2,035	50.0	1,018	13.0	743,121,790
Wasatch-Tongue River Aquifer Coals	4,988,873	2,035	6.2	126	0.4	2,516,519
Lebo Confining Layer Sandstones	6,992,929	1,009	33.0	250	13.0	227,137,339
Tulloch Aquifer Sandstones	7,999,682	1,110	52.0	430	13.0	447,246,784

<sup>1</sup> Calculated by multiplying Surface Area × Average Sand/Coal Thickness × Specific Yield. These numbers vary slightly from the numbers presented in Table 3-5 of the Final Environmental Impact Statement and Proposed Plan Amendment for the PRB Oil and Gas Project.  
Source: BLM 2003

As a result of statutory requirements and concerns, several studies and a number of modeling analyses have been conducted to help predict the impacts of surface coal mining on groundwater resources in the Wyoming portion of the PRB. Some of these studies and modeling analyses are discussed below.

In 1987, the U.S. Geological Survey (USGS), in cooperation with the WDEQ and Office of Surface Mining Reclamation and Enforcement (OSM), conducted a study of the hydrology of the eastern PRB. The resulting description of the cumulative hydrologic effects of all current and anticipated surface coal mining (as of 1987) was published in 1988 in the USGS Water-Resources Investigation Report entitled “*Cumulative Potential Hydrologic Impacts of Surface Coal Mining in the Eastern Powder River Structural Basin, Northeastern Wyoming*,” also known as the “USGS CHIA” (Martin et al. 1988). This report evaluates the potential cumulative groundwater impacts of surface coal mining in the area and is incorporated by reference into this EIS. The USGS CHIA analysis considered the proposed mining at the three applicant mines in the Wright area. It did not, however, evaluate potential groundwater impacts related to additional coal leasing in this area and it did not consider the potential for overlapping groundwater impacts from coal mining and CBNG development.

Each mine must assess the probable hydrologic consequences of mining as part of the mine permitting process. The WDEQ/LQD must evaluate the cumulative hydrologic impacts associated with each proposed mining operation before approving the mining and reclamation plan for each mine, and they must find that the cumulative hydrologic impacts of all anticipated mining would not cause material damage to the hydrologic balance outside of the permit area for each mine. As a result of these requirements, each existing

approved mining permit includes an analysis of the hydrologic impacts of the surface coal mining proposed at that mine. If major amendments to mining and reclamation permits are proposed, then the potential cumulative impacts of the revisions must also be evaluated. If the six WAC LBA tracts are leased to the respective applicants, the existing mining and reclamation permits for each current mine must be revised and approved to include the new lease before it can be mined.

The PRB Oil and Gas Project FEIS (BLM 2003) includes a modeling analysis of the groundwater impacts if an additional 39,000 new CBNG wells are drilled in the PRB by the end of 2011. The project area for this EIS, which covers all of Campbell, Sheridan, and Johnson counties, as well as the northern portion of Converse County, is similar to the study area for the PRB Coal Review Task 1 and Task 2 study area (Figure 4-4).

The coal mine groundwater monitoring data are published each year by the Gillette Area Groundwater Monitoring Organization (GAGMO), a voluntary group formed in 1980. Members of GAGMO include most of the companies with operating or proposed mines in the Wyoming PRB, WDEQ, Wyoming State Engineer's Office (SEO), BLM, USGS, and OSM. GAGMO contracts with an independent firm each year to publish the annual monitoring results. GAGMO also periodically publishes reports summarizing the water monitoring data collected since 1980 in the Wyoming PRB (e.g., Hydro-Engineering 1991, 1996, 2001, and 2007).

Another source of data on the impacts of surface coal mining on groundwater is the monitoring that is required by WDEQ/LQD and administered by the mining operators. Each mine is required to monitor groundwater levels and quality in the affected coal aquifers, in the shallower aquifers (overburden and alluvium), and in the subcoal aquifers in the area surrounding their operations. Monitoring wells are also required to record water levels and water quality in reclaimed areas. Hydrologic monitoring data and analyses are submitted to the WDEQ/LQD annually.

The cumulative impacts to groundwater resources associated with large scale surface coal mining in the eastern PRB have been identified as five major issues:

1. The extent of the temporary lowering of static water levels in the aquifers around the mines due to dewatering associated with removal of aquifers within the mine boundaries.
2. Potential overlapping drawdown due to proximity of coal mining and CBNG development.
3. The effect of the removal of the coal aquifer and any overburden aquifers within the mine area and replacement of these aquifers with backfill material.

#### *4.0 Cumulative Environmental Consequences*

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4. Changes in groundwater quality as a result of mining.
5. The effects of the use of water from the subcoal Fort Union Formation by the mines.

The first major issue is the extent of water level drawdown in the coal and shallower aquifers in the area surrounding the mines. In general, the saturated sand aquifers in the Wasatch Formation overburden have limited extent and, as a result, the drawdowns in the Wasatch Formation are much smaller and cover much less area than the coal drawdowns.

The GAGMO 25-year report provides actual groundwater drawdown information after 25 years of mining (Hydro-Engineering 2007). Of the 530 monitoring wells included in the GAGMO 25-year report, 195 are completed in the Upper Fort Union (or Wyodak) coal beds and 193 are completed in the overlying sediments or interburden between the coal beds located within and near the mine sites in the eastern PRB. The balance of the monitoring wells are completed in local alluvial aquifers or in strata below the lowest coal seam mined. Since 1996, some BLM monitor wells have been included in the GAGMO reports.

The USGS CHIA predicted the approximate area of 5 feet or more water level decline in the Wyodak coal aquifer which would result from “all anticipated coal mining.” “All anticipated coal mining” included 16 surface coal mines operating at the time the report was prepared and six additional mines proposed at that time. All of the currently producing mines, including the three applicant mines in the Wright area, were considered in the USGS CHIA analysis (Martin et al. 1988). The study predicted that water supply wells completed in the coal may be affected as far away as 8 miles from mine pits, although the effects at that distance were predicted to be minimal.

As drawdown propagates to the west, available drawdown in the coal aquifer increases. Available drawdown is defined as the elevation difference between the potentiometric surface (elevation to which water will rise in a well bore) and the bottom of the aquifer. Proceeding west, the coal depth increases faster than the potentiometric surface declines, so available drawdown in the coal increases. Since the depth to coal increases, most stock and domestic wells are completed in units above the coal. Consequently, with the exception of CBNG wells, few wells are completed in the coal in the areas west of the mines. Those wells completed in the coal have considerable available drawdown, so it is unlikely that surface coal mining would cause adverse impacts to wells outside the immediate mine area.

Wells in the Wasatch Formation were predicted to be impacted by drawdown only if they were within 2,000 feet of a mine pit (Martin et al. 1988). Drawdown occurs farther from the mine pits in the coal than in the shallower aquifers because the coal is a confined aquifer that is areally extensive. The area in which the shallower aquifers (Wasatch Formation, alluvium, and clinker)

experience a 5-foot drawdown would be much smaller than the area of drawdown in the coal because the shallower aquifers are generally discontinuous, of limited areal extent, and often unconfined.

When the USGS CHIA was prepared in 1988 there were about 1,200 water supply wells within the maximum impact area defined in that study. Of those wells, about 580 were completed in Wasatch aquifers, about 100 in the Upper Fort Union (or Wyodak coal) aquifer, and about 280 in strata below the coal. There were no completion data available for the remainder of the wells (about 240) at that time.

The WDEQ/LQD Cumulative Hydrologic Impact Assessment of Coal Mining in the Southern Powder River Basin (WDEQ-CHIA-19) (Ogle and Calle 2006) examined the cumulative hydrologic impact of coal mining in the Wright subregion to determine the potential for material damage to the hydrologic system. Analysis of the cumulative impacts as a result of mining was performed by qualitatively assessing the additive impacts of these mines. Each mine is required by WDEQ/LQD to evaluate the impacts to the hydrologic resources and will typically model groundwater level drawdown using the most conservative, worst-case scenario. The extent of the 5-foot drawdown contour is used by WDEQ/LQD to assess the extent of the impact to the groundwater system caused by mining operations. The predicted maximum 5-foot drawdown contour for the Wyodak coal aquifer from all four Wright area coal mines (Jacobs Ranch, Black Thunder, North Antelope Rochelle, and Antelope) was superimposed by Ogle and Calle (2006) to generate the 5-foot cumulative estimate. The areal extent of cumulative drawdown within the Wyodak coal aquifer with the addition of the six WAC LBA tracts to the Jacobs Ranch, Black Thunder and North Antelope Rochelle mines, as defined by the 5-foot drawdown contour, was extrapolated using the WDEQ-CHIA-19 prediction and is depicted in Figure 4-5.

If the six WAC LBA tracts are leased and mined, the groundwater drawdown would be extended into the area surrounding the proposed new leases. When a lease is issued to an existing mine for a maintenance tract, the mine must revise its existing mining permit to include the new tract in its mine and reclamation plans. In order to do that, the lessee would be required to conduct a detailed groundwater analysis to predict the extent of drawdown in the coal and overburden aquifers caused by mining the new lease. WDEQ/LQD would use the revised drawdown predictions to update their cumulative hydrologic impact analysis (WDEQ-CHIA) for this portion of the PRB. The applicants have installed monitoring wells that would be used to confirm or refute drawdown predicted by analysis. These analyses would be required as part of the WDEQ mine permitting procedure, which is discussed in Chapter 1 of this EIS.

The PRB Coal Review Task 2 Report (BLM 2009b) defines the past and present development actions in the PRB study area, which comprises all of Campbell County, all of Sheridan and Johnson counties less the Bighorn National Forest lands, and the northern portion of Converse County (Figure 4-4). The Task 2

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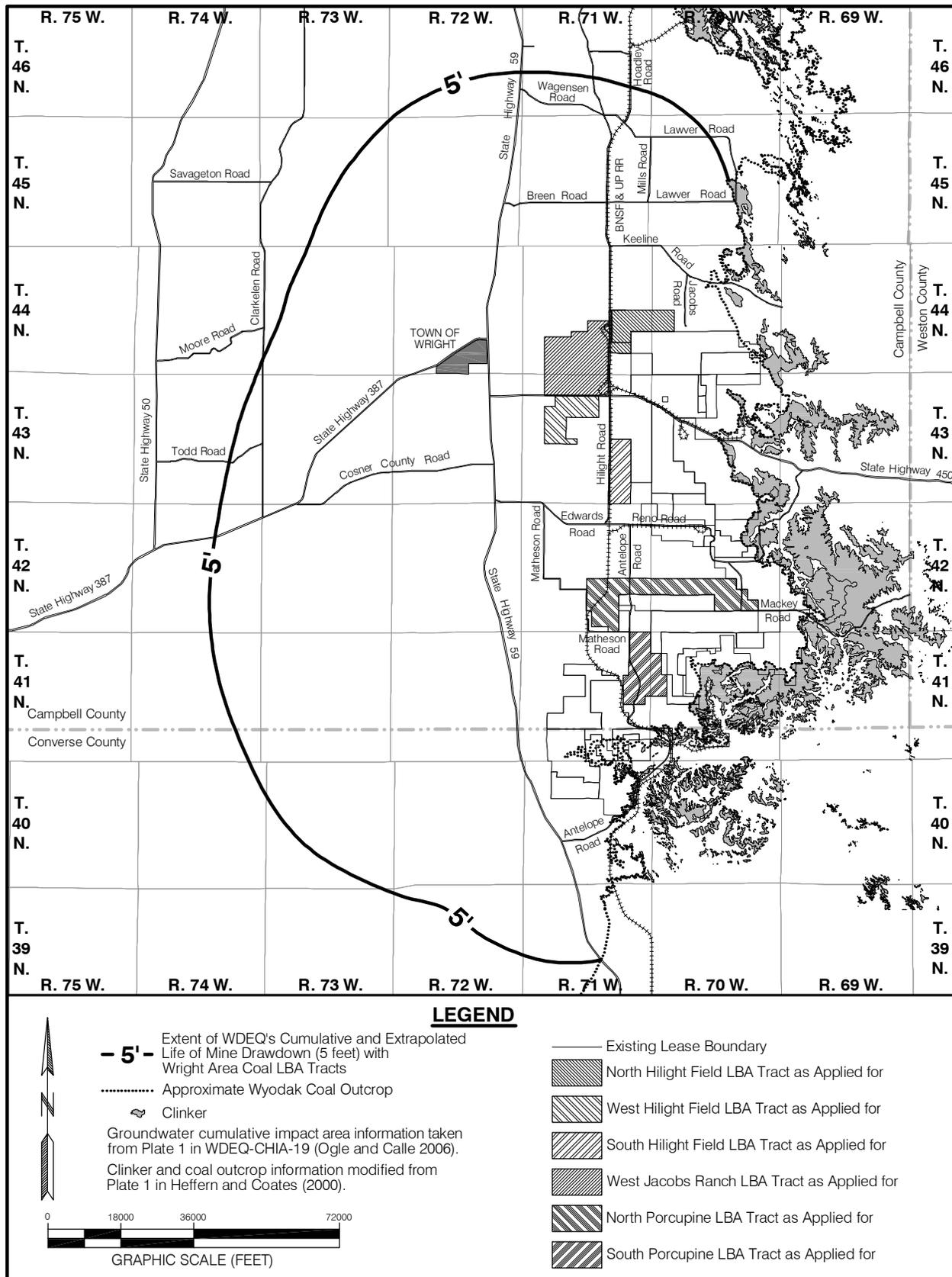


Figure 4-5. Extrapolated Extent of Life of Mine Cumulative Drawdown Within the Wyodak Coal Aquifer With the Addition of Wright Area Coal LBA Tracts.

report also defines the projected reasonably foreseeable development (RFD) scenarios in the PRB for years 2010, 2015, and 2020, and provides the basis for the analysis of potential cumulative impacts in the Task 3 component of the study.

The PRB Coal Review Task 3B Report (BLM 2009e) summarizes the modeled changes in groundwater levels projected for 2010, 2015, and 2020 in the eastern PRB within approximately 25 miles of the coal mines. The cumulative effects study area for water resources encompasses the groundwater model domain (Figure 4-4), with emphasis placed on the overlap in the coal mine- and CBNG-related groundwater drawdown area. Projected groundwater level changes primarily are due to CBNG groundwater withdrawal in the Upper Fort Union Formation and to both CBNG pumping and discharge along with coal mine pit dewatering in the Wasatch Formation. Near the coal mines, coal mine dewatering of the Upper Fort Union also has affected groundwater levels in that formation. Groundwater level recovery in the eastern PRB after the cessation of both CBNG development and coal mining, and the effect on groundwater flow paths associated with coal mine pit backfill and reclamation after the cessation of coal mining in the eastern PRB also were modeled and the results are included in the Task 3B report. For purposes of modeling groundwater recovery, it was assumed that CBNG development in the eastern PRB would cease by 2030 and surface coal mining would cease by 2050 (BLM 2009e).

The Task 3B report describes the modeled cumulative groundwater impacts associated with ongoing coal mine-related groundwater withdrawal in the eastern PRB for the time periods of 2010, 2015, and 2020, and the base years used for comparison of groundwater impacts were 2002 (the year used for calibration of the groundwater model) and 1990 (a time period prior to CBNG pumpage and before major expansion by the eastern PRB coal mines). The eastern PRB cumulative effects study area for water resources comprises the Coal Mine Groundwater Model (CMGM) domain as shown in Figure 4-4 (BLM 2009e). The CMGM was developed specifically for the PRB Coal Review study. The GAGMO databases for 1990 to 2002 were used to calibrate the groundwater model to best reflect conditions in the basin.

The primary objective of the Task 3B report is to provide an estimate of potential future cumulative impacts to water resources in the eastern PRB of Wyoming due to CBNG development and coal mining for the target years 2010, 2015, and 2020. To accomplish that objective, the Task 3B report evaluated the potential groundwater impacts due only to coal mine dewatering. The projected locations of coal mine pits from 2002 to 2020 were used for placement of drain cells in the groundwater model that represent pumpage of groundwater by the mines. The amount of water removed by the drain cells reflects calibration to GAGMO monitoring wells surrounding each mine, rather than estimated or recorded discharge rates (BLM 2009e).

Projected groundwater level changes in the Wasatch generally are due to coal mine dewatering and CBNG pumping and discharge, which generally result in

#### *4.0 Cumulative Environmental Consequences*

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local mounding of groundwater in the Wasatch near CBNG fields and drawdown near the coal mines (BLM 2009e). The Wasatch Formation is not a true aquifer in that it has only discontinuous water-bearing sand units not consistent and uniform groundwater level over the eastern PRB; therefore, groundwater level drawdowns due to mining are very localized and in close proximity to the mine operation. For the Upper Fort Union, groundwater level changes are due to CBNG pumpage and coal mine dewatering. Between 2002 and 2020, the projected reduction in coal mine dewatering and the expected reduction in CBNG pumpage from Wright northward toward Gillette are projected to result in a rebound of groundwater levels both within the coal mine boundaries and especially within the basin west of the coal mines (BLM 2009e).

Based on the results of the CMGM, the effect of coal mine dewatering on the Upper Fort Union from 1990 to 2010 in Subregion 3 is a cumulative drawdown ranging from approximately 50 to 250 feet in the vicinity of the Antelope and North Antelope Rochelle mines, and from 50 to 150 feet in the vicinity of the Black Thunder and Jacobs Ranch mines. The 25-foot drawdown contour was projected to be less than 3 miles west of the four Wright area mines' westernmost boundaries (Figure 4-6). The modeled drawdown in the Upper Fort Union due to coal mine dewatering from 1990 to 2020 in Subregion 3 indicated there is approximately 50 to 100 feet of groundwater rebound in area of the Subregion 3 mines due to a reduction in coal mine dewatering and ongoing reclamation. Drawdown in the Upper Fort Union attributable to mining only from 1990 to 2020 ranges from 25 to 125 feet in the active mine areas with up to 125 feet of rebound in the reclaimed areas. The location of the 25-foot drawdown contour was projected to be essentially the same as the 25-foot drawdown limit in 2010; 3 miles or less west of the Subregion 3 mines (Figure 4-7) (BLM 2009e).

The second issue of concern is the potential for cumulative impacts to groundwater resources due to the proximity of coal mining and CBNG development. The Upper Fort Union (Wyodak) coal is being developed by mining and CBNG production in the same general area. Dewatering activities associated with CBNG development have overlapped with and expanded the area of groundwater drawdown in the coal aquifer in the PRB over what would occur due to coal mining development alone, and this would be expected to continue.

Numerical groundwater flow modeling was used to predict the impacts of the cumulative stresses imposed by mining and CBNG development on the Upper Fort Union Formation coal aquifer in the PRB Oil and Gas Project EIS (BLM 2003). Modeling was necessary because of the large areal extent, variability, and cumulative stresses imposed by mining and CBNG development on the Fort Union coal aquifers. Information from earlier studies was incorporated into the modeling effort for this analysis. As expected, the modeling indicated that the groundwater impacts from CBNG development and surface coal mining would be additive in nature and that the addition of CBNG development

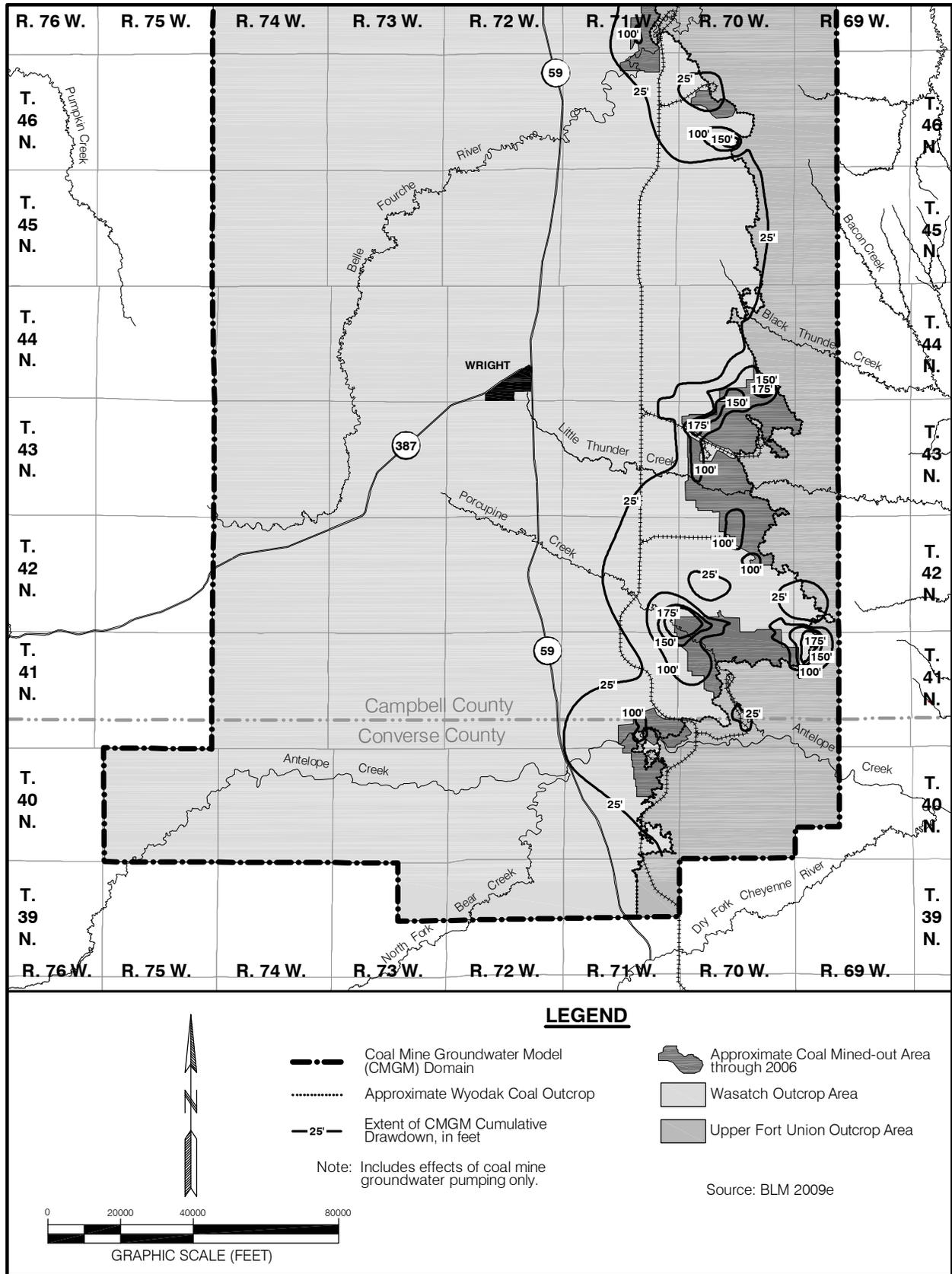


Figure 4-6. Coal Mine Groundwater Model, Upper Fort Union Formation, 1990-2010 Coal Mine-related Groundwater Level Drawdown.

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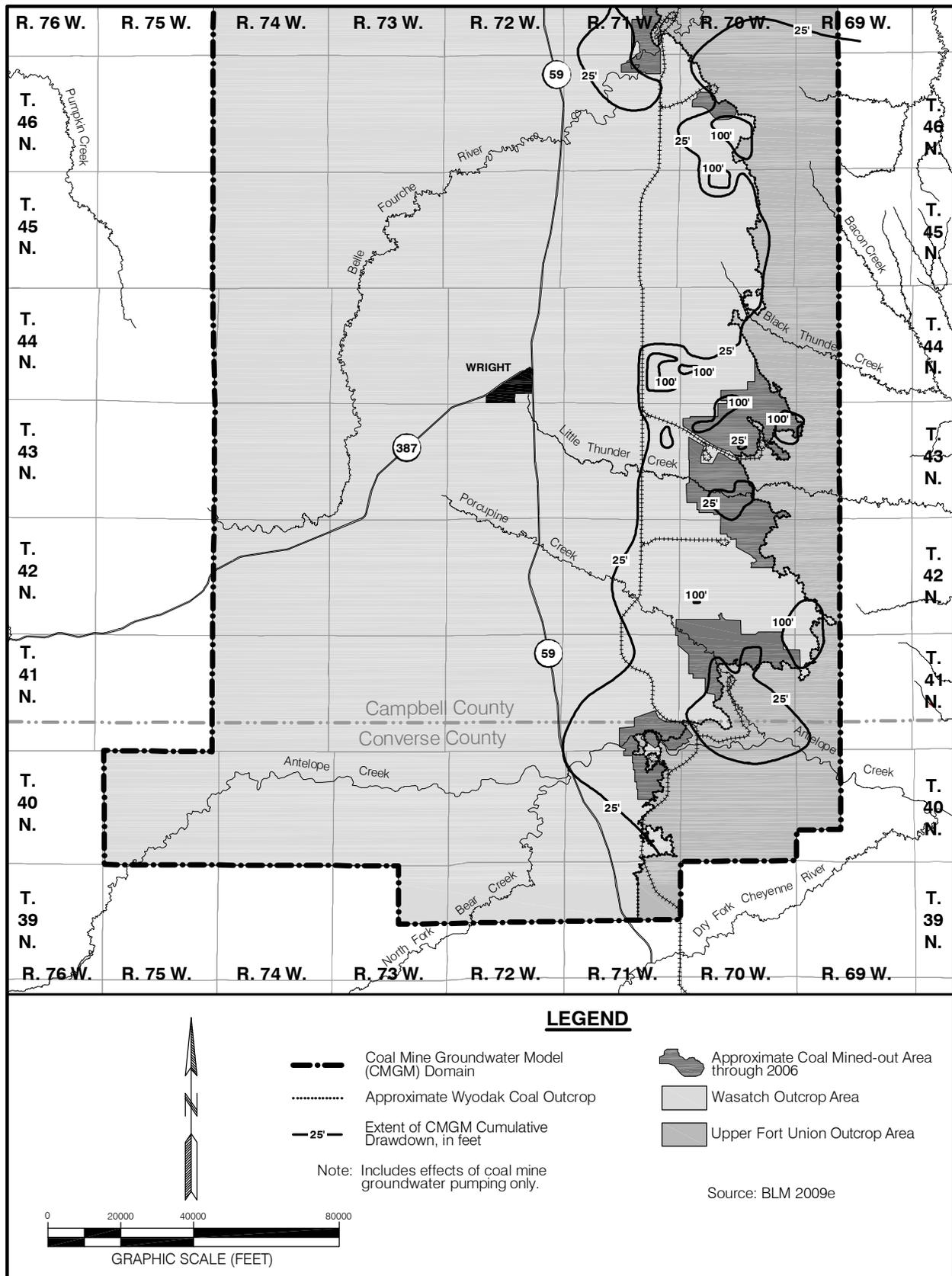


Figure 4-7. Coal Mine Groundwater Model, Upper Fort Union Formation, 1990-2020 Coal Mine-related Groundwater Level Drawdown.

would extend the area experiencing a loss in hydraulic head to the west of the mining area. The GAGMO 25-year Report stated that drawdowns in all areas have greatly increased due to the water production from the Wyodak coal aquifer by CBNG producers (Hydro-Engineering 2007).

As previously stated, the PRB Coal Review Task 2 Report (BLM 2009b) defines the projected RFD scenarios in the PRB for years 2010, 2015, and 2020, and provides the basis for the analysis of potential cumulative impacts in the Task 3 component of the study. The Task 3B Report (BLM 2009e) summarizes the modeled changes in groundwater levels projected for 2010, 2015, and 2020 in the eastern PRB within approximately 25 miles of the coal mines. Projected groundwater level changes primarily are due to CBNG groundwater withdrawal in the Upper Fort Union Formation and to both CBNG pumping and discharge along with coal mine pit dewatering in the Wasatch Formation. Groundwater level recovery in the eastern PRB after the cessation of both CBNG development and coal mining, and the effect on groundwater flow paths associated with coal mine pit backfill and reclamation after the cessation of coal mining in the eastern PRB also were modeled and the results are included in the Task 3B report. For purposes of modeling groundwater recovery, it was assumed that CBNG development in the eastern PRB would cease by 2030 and surface coal mining would cease by 2050 (BLM 2009e).

The Task 3B report describes the modeled cumulative groundwater impacts associated with ongoing CBNG-related groundwater withdrawal in the eastern PRB for the time periods of 2010, 2015, and 2020, and the base years used for comparison of groundwater impacts were 2002 (the year used for calibration of the groundwater model) and 1990 (a time period prior to CBNG pumpage and before major expansion by the eastern PRB coal mines).

The primary objective of the Task 3B report is to provide an estimate of potential future cumulative impacts to water resources in the eastern PRB of Wyoming due to CBNG development and coal mining for the target years 2010, 2015, and 2020. To accomplish that objective, the Task 3B report evaluated the potential groundwater impacts due only to CBNG development by estimating groundwater pumpage rates through analysis of past patterns in CBNG development and groundwater pumpage in the eastern PRB. The locations of surface discharge of groundwater (outfalls) were represented in the CMGM as recharge cells to allow for infiltration of discharge water into the Wasatch Formation (BLM 2009e).

Projected groundwater level changes in the Wasatch generally are due to coal mine dewatering and CBNG pumping and discharge, which generally result in local mounding of groundwater in the Wasatch near CBNG fields and drawdown near the coal mines (BLM 2009e). For the Upper Fort Union, groundwater level changes are due to CBNG pumpage and coal mine dewatering. Between 2002 and 2020, the expected reduction in coal mine dewatering and CBNG pumpage from Wright northward toward Gillette are projected to result in a rebound of groundwater levels both within the coal

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mine boundaries and especially within the basin west of the coal mines (BLM 2009e).

Based on the results of the CMGM, the effect of CBNG pumpage on the Upper Fort Union from 1990 to 2010 in Subregion 3 results in an extensive area of drawdown centered just southwest of Wright, covering nearly 15 townships and drawdowns range from 25 feet on the southern margin to 575 feet in the center of the depression (Figure 4-8). The modeled drawdown in the Upper Fort Union due to CBNG pumpage from 1990 to 2020 in Subregion 3 is projected to primarily be located southwest of Wright, producing a groundwater depression of between 25 to 425 feet that covers roughly eight to nine townships (Figure 4-9) (BLM 2009e).

There is a potential for conflicts to occur over who (coal mining or CBNG operators) is responsible for replacing or repairing private wells that are adversely affected by the drawdowns; however, the number of potentially affected wells completed in the coal is not large. As discussed previously, coal companies are required by state and federal law to mitigate any water rights that are interrupted, discontinued, or diminished by coal mining. In response to concerns about the potential impacts of CBNG development on water rights, a group of CBNG operators and local landowners developed a standard water well monitoring and mitigation agreement that can be used on a case-by-case basis as development proceeds. All CBNG operators on federal oil and gas leases are required to offer this water well agreement to the surface landowners (BLM 2003).

The effect of replacing the coal and overburden with backfill is the third major groundwater issue of concern. The following discussion of recharge, movement, and discharge of water in the backfill aquifer is excerpted from the USGS CHIA (Martin et al. 1988):

Postmining recharge, movement, and discharge of groundwater in the Wasatch aquifer and Wyodak coal aquifer will probably not be substantially different from premining conditions. Recharge rates and mechanisms will not change substantially. Hydraulic conductivity of the spoil aquifer will be approximately the same as in the Wyodak coal aquifer allowing groundwater to move from recharge areas where clinker is present east of mine areas through the spoil aquifer to the undisturbed Wasatch aquifer and Wyodak coal aquifer to the west.

Monitoring data verify that recharge has occurred and is continuing in the backfill (Hydro-Engineering 1991, 1996, 2001, and 2007). The water monitoring summary reports prepared each year by GAGMO list current water levels in the monitoring wells completed in the backfill and compare them with the 1980 water levels, as estimated from the 1980 coal water-level contour maps. In the 1991 GAGMO 10-year report, some recharge had occurred in 88 percent of the 51 backfill wells reported at that time (Hydro-Engineering 1991). In the GAGMO 20-year report, 79 percent of the 82 backfill wells measured

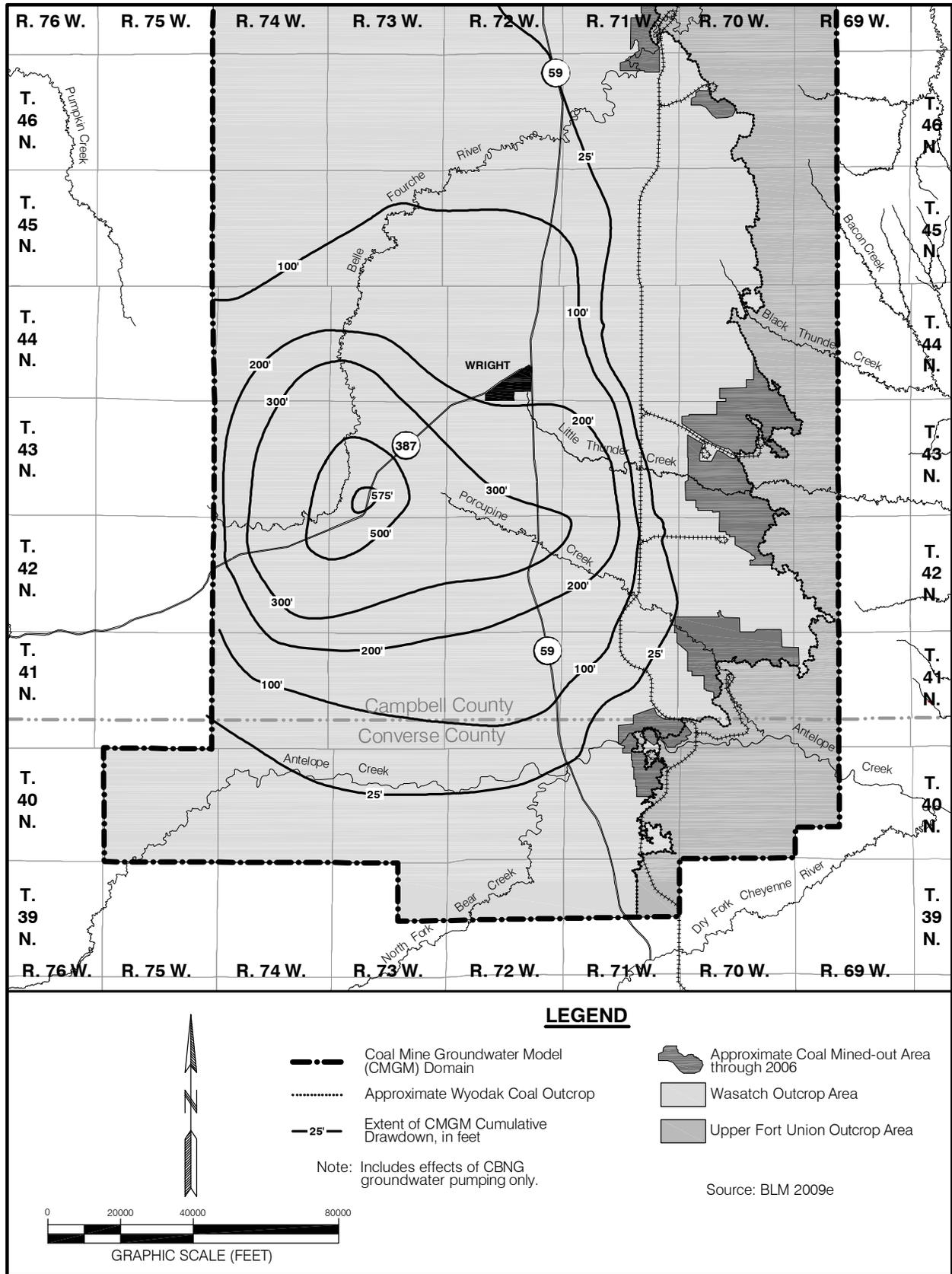


Figure 4-8. Coal Mine Groundwater Model, Upper Fort Union Formation, 1990-2010 Coal Bed Natural Gas-related Groundwater Level Drawdown.

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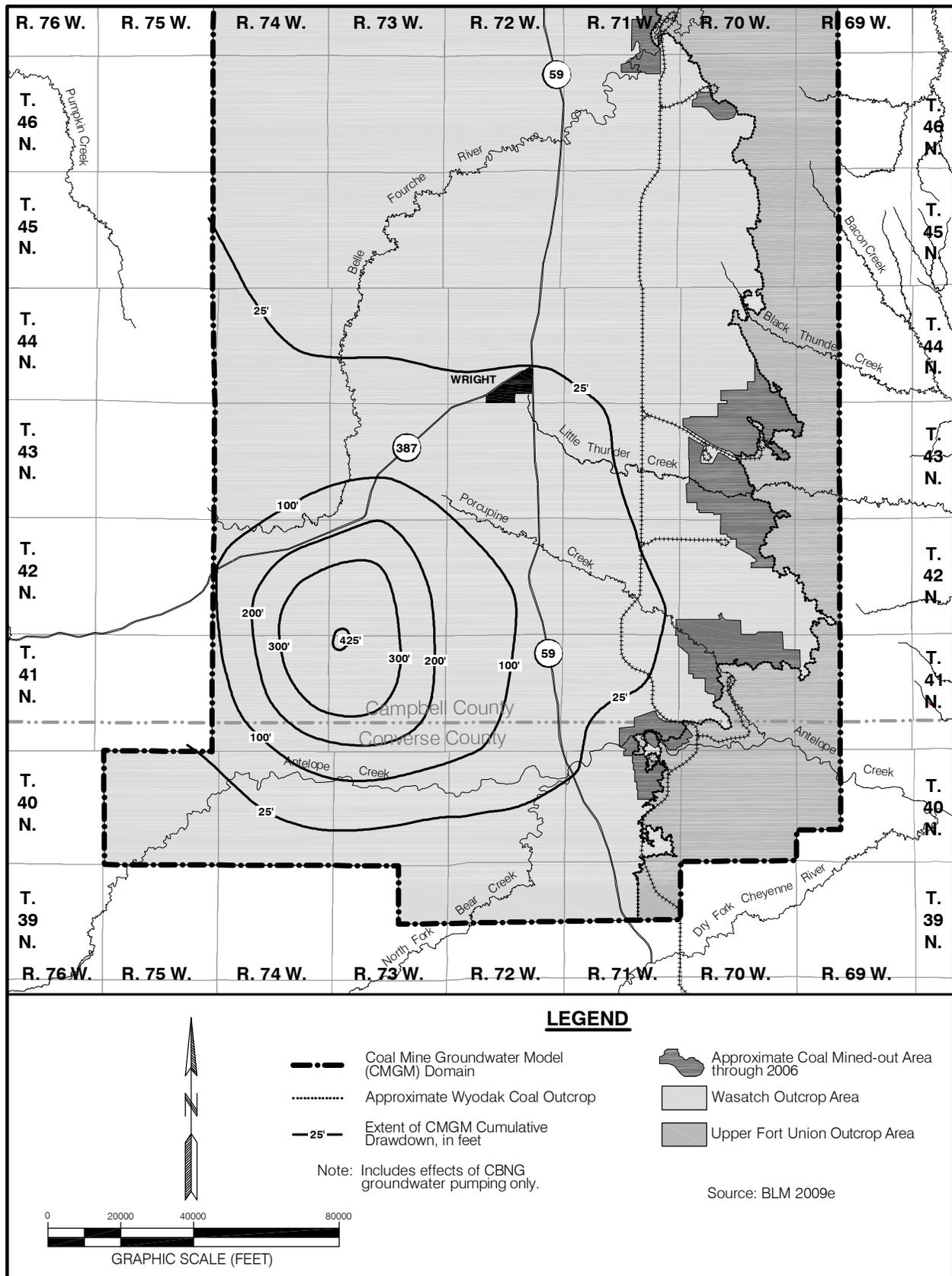


Figure 4-9. Coal Mine Groundwater Model, Upper Fort Union Formation, 1990-2020 Coal Bed Natural Gas-related Groundwater Level Drawdown.

contained water (Hydro-Engineering 2001). In the GAGMO 25-year report, 8.6 percent of the 101 backfill wells measured contained water (Hydro-Engineering 2007).

The outcrop areas of the Fort Union coal seams are zones of burned coal referred to as clinker (or scoria). These are zones of high secondary permeability and are the main recharge zones for the Fort Union Formation (BLM 2009d). Clinker occurs all along the coal outcrop at the eastern edge of the PRB study area, and is a major groundwater recharge source for the backfill just as it is for the coal aquifer. Some clinker is mined for road-surfacing material, but saturated clinker is not generally mined since abundant clinker exists above the water table and does not present the mining problems that would result from mining saturated clinker. Therefore, the major recharge source for the backfill aquifer is not being disturbed by current mining. Clinker occurs in localized areas on only the North Hilight Field and North Porcupine LBA Tracts configured under Alternative 2, BLM's preferred alternative.

The cumulative size of the backfill area in the PRB and the duration of mining activity would be increased by mining the currently pending LBA tracts, including the six WAC LBA tracts. Because the mined-out areas are being backfilled and the monitoring data demonstrate that recharge of the backfill is occurring, substantial additional cumulative impacts are not anticipated as a result of the pending leasing actions.

The PRB Coal Review Task 3B Report (BLM 2009e) summarizes the modeled recovery of groundwater levels once the CBNG development and coal mining operations have ceased. For CBNG development, it was assumed that groundwater pumping in the eastern PRB would end in 2030. For coal mining, it was assumed that open-pit dewatering in advance of mining, as well as mine reclamation, would end in 2050. Groundwater recovery related to the cessation of coal mining started in year 2050, with groundwater discharge rates remaining constant at the projected 2020 rate from year 2020 to 2050. The Upper Fort Union shows recovery after 50 to 100 years (2100 to 2150) and substantial recovery after 200 years (year 2250). Both the Wasatch and Upper Fort Union are projected to rebound and reach approximately 80 percent of steady-state after 300 to 500 years, or between years 2350 and 2550. When the Fort Union and Wasatch formations of the eastern PRB recover to near steady-state conditions, based on the resaturation modeling, groundwater will flow through the coal mine backfill aquifers and westward into the PRB (BLM 2009e).

The fourth issue of concern with respect to cumulative groundwater impacts is the effect of mining on water quality. Specifically, what effect does mining have on the water quality in the surrounding area, and what are the potential water quality problems in the backfill aquifer following mining?

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In the Wyoming PRB, the backfill material gradually resaturates with water as groundwater from the Wasatch Aquifer and the Fort Union coal bed aquifers enters the backfill material. In a regional study of the cumulative impacts of coal mining, the median concentrations of dissolved solids and sulfates were found to be higher in water from backfill aquifers than in water from either the Wasatch Formation overburden or the Wyodak coal aquifer (Martin et al. 1988). This is expected because blasting and movement of the overburden materials exposes more surface area to water, increasing dissolution of soluble materials, particularly from the overburden materials that were situated above the saturated zone in the premining environment.

One pore volume of water is the volume of water that would be required to saturate the backfill following reclamation. The time required for one pore volume of water to pass through the backfill aquifer is greater than the time required for the postmining groundwater system to reestablish equilibrium. According to the USGS CHIA, estimates of the time required to reestablish equilibrium range from tens to hundreds of years (Martin et al. 1988).

The major current use of water from the aquifers being replaced by the backfill (the Wasatch Formation overburden and Fort Union coal aquifers) is for livestock because these aquifers are typically too high in dissolved solids for domestic use and well yields are typically too low for irrigation (Martin et al. 1988). Chemical analyses of 336 samples collected between 1981 and 1986 from 45 wells completed in backfill aquifers at 10 mines indicated that the quality of water in the backfill will, in general, meet the state standard for livestock use of 5,000 milligrams per liter (mg/L) for total dissolved solids (TDS) when recharge occurs (Martin et al. 1988).

Water quality samples from coal mine backfill monitor wells in along the eastern PRB typically have a pH between 6.0 and 7.8, TDS in the range of 1,000 to 4,000 mg/L, bicarbonate values ranging from 500 to 1,300 mg/L, sodium in the range of 200 to 800 mg/L, high sulfate values ranging from 1,000 to 3,500 mg/L, and SAR values in the range of 2.0 to 7.0 (Hydro-Engineering 2001). The 2000 Annual GAGMO report (Hydro-Engineering 2001) evaluated samples from 48 backfill wells in 1999 and found that the TDS in 75 percent were less than 5,000 mg/L, TDS in 23 percent were between 5,000 and 10,000 mg/L, and TDS in one well was above 10,000 mg/L. An analysis of about 2,000 samples collected from 95 backfill monitoring wells between 1986 and 2002 found that the water quality in 75 percent of the wells were within the acceptable range for the Wyoming livestock standard, with 25 percent exceeding that standard (Ogle 2004).

WDEQ/LQD calculated a median TDS concentration of 3,293 mg/L for the backfill aquifer in the east-central area of the PRB, which includes the four mines located immediately south of Gillette, based on 1,384 samples (Ogle et al. 2005). These results suggest that the TDS in the backfill aquifer in the middle group of mines meets the requirements for livestock use and is similar to TDS found in the undisturbed Wasatch Formation overburden but typically

larger than TDS found in the Wyodak coal aquifer. The 2005 Annual GAGMO report (Hydro-Engineering 2006) indicates that TDS concentrations in 2005 ranged from 656 mg/L at well RW2804 (at the Belle Ayr Mine) to 12,409 mg/L at well SP-4-NA (at the North Antelope Rochelle Mine). The GAGMO 25-Year Report (Hydro-Engineering 2007) reported samples collected from 57 backfill monitoring wells, and of the last samples that were collected from those wells in 2005, the TDS concentrations ranged from a low of 656 mg/L to and high of 12,409 mg/L, with an average of 3,800 mg/L and a median of 3,670 mg/L. WDEQ/LQD calculated a median TDS concentration of 3,670 mg/L based on 869 samples collected from monitoring wells with at least 15 years of data that are completed in the backfill at the three applicant mines included in this analysis, and concluded that the recovered concentrations will be suitable for post-mining land use (Ogle and Calle 2006). The incremental effect on groundwater quality due to leasing and mining the six WAC LBA tracts would be to increase the total volume of backfill and, thus, the time for equilibrium to reestablish.

The PRB Coal Review Task 3B Report (BLM 2009e) predicts that resaturation of coal mine pit backfill to form backfill aquifers may take approximately 100 years after cessation of mining and is projected to result in the westward migration of groundwater with elevated TDS levels. Modeling of this westward migration indicates that TDS levels should be down to the average background value of 1,000 mg/L within 2,000 feet of the final westward extent of the coal mine boundaries. Thus, no impact to groundwater quality in either the Wasatch or Upper Fort Union aquifers is expected beyond approximately 2,000 feet west of the final coal mine boundaries (BLM 2009e).

Potential water-level decline in the subcoal Fort Union Formation is the fifth major groundwater issue. Water level declines in the Tullock Aquifer have been documented in the Gillette area. According to Crist (1991), these declines are most likely attributable to pumpage for municipal use by Gillette and for use at subdivisions and trailer parks in and near the city of Gillette. Most of the water-level declines in the subcoal Fort Union wells occur within one mile of the pumped wells (Crist 1991, Martin et al. 1988). Most of the mines have water supply wells completed in zones below the lowest coal seam mined (e.g., subcoal Fort Union Formation and the underlying Lance-Fox Hills aquifer), but the mine facilities in the PRB are separated by a distance of one mile or more, so little interference between mine supply wells would be expected (refer to Section 3.5.1.2).

In response to concerns voiced by regulatory personnel, several mines have conducted impact studies of the subcoal Fort Union Formation. The OSM also commissioned a cumulative impact study of the subcoal Fort Union Formation to address the effects of mine facility wells on this aquifer (OSM 1984). Conclusions from these studies are similar and may be summarized as follows:

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- Because of the discontinuous nature of the sands in this formation and because most large-yield wells are completed in several different sands, it is difficult to correlate completion intervals between wells.
- In the Gillette area, water levels in this aquifer have probably declined because the city of Gillette and several subdivisions have utilized water from the formation (Crist 1991). (Note: Gillette is mixing Fort Union Formation water with water from wells completed in the Madison Formation. Also, because drawdown has occurred, some operators are able to dispose of CBNG water by injecting it into the subcoal Fort Union Formation near the city of Gillette.)
- Because large saturated thicknesses are available (locally) in this aquifer unit, generally 500 feet or more, a drawdown of 100 to 200 feet in the vicinity of a pumped well would not dewater the aquifer.

Most of the existing coal mines in the PRB have permits from the Wyoming SEO for subcoal Fort Union Formation water supply wells. Four industrial water supply wells are completed in the Fort Union Formation and one industrial supply well is completed in the underlying Lance-Fox Hills aquifer within Black Thunder Mine's existing permit area. The Jacobs Ranch Mine uses five wells completed in the subcoal Fort Union Formation for industrial water supply. The North Antelope Rochelle Mine uses four wells completed in the subcoal Fort Union Formation and one well completed in the Lance-Fox Hills aquifer for industrial water supply. Locations of the three applicant mines' water supply wells are shown on Figures 3-20, 3-21, and 3-22, respectively. Extending the life of the three WAC mines by issuing new leases would result in additional water being withdrawn from the subcoal Fort Union Formation and Lance-Fox Hills aquifer systems, but no new subcoal water supply wells would be required. The additional water withdrawal would not be expected to extend the area of water level drawdown over a substantially larger area due to the discontinuous nature of the sands in the Tullock Member and the fact that drawdown and yield reach equilibrium in a well due to recharge effects. Due to the distances separating subcoal Fort Union Formation and Lance-Fox Hills aquifer wells used for mine water supply, these wells have not experienced interference and are not likely to in the future.

Water requirements and sources for proposed power plants are not currently known, however, there are no proposed power plants in the immediate vicinity of the three WAC mines. The Wyoming SEO is discouraging further development of the lower Fort Union Formation aquifers, so the most likely groundwater source for future power plants is the Lance-Fox Hills aquifer system. This would reduce the chances that the power plants would add to cumulative hydrologic impacts of mining and CBNG production.

## 4.2.4.2 Surface Water

The Powder River structural basin of Wyoming, often referred to as the PRB, encompasses five major drainages. The drainages in the northern portion of the basin include the Powder River, Tongue River, and Little Powder River. In the central and southern parts of the basin, the major drainages are the Belle Fourche and Cheyenne rivers. Surface water flows to the north into Montana in the northern part of the basin and to the east-northeast into South Dakota in the southern and central parts of the basin. The discussion of water resources in the PRB focuses on two main issues: 1) current water use in the basin, and 2) industrial use of water resources by the coal mines and CBNG industries. The discussion of water use in Wyoming PRB study area is divided into two major water planning areas: the Powder/Tongue River Basin and the Northeast Wyoming River Basins (BLM 2009d).

The main rivers in the Powder/Tongue River Basin are the Tongue River and the Powder River. The Powder/Tongue River Basin receives substantial surface water runoff from the Big Horn Mountains, leading to major agricultural development along drainages in the Tongue River and Powder River basins. Reservoirs are used throughout the basin for agricultural water supply and for municipal water supply in the Powder/Tongue River Basin. Water use in the Powder/Tongue River Basin as of 2002 is summarized in Table 4-16.

Table 4-16. Water Use as of 2002 in the Powder/Tongue River Basins (acre-feet per year).

Water Use Categories	Dry Year		Normal Year		Wet Year	
	Surface Water	Ground-water	Surface Water	Ground-water	Surface Water	Ground-water
Agricultural	178,000	200	184,000	200	194,000	300
Municipal	2,700	500	2,700	500	2,700	500
Domestic	---	4,400	---	4,400	---	4,400
Industrial <sup>1</sup>	---	68,000	---	68,000	---	68,000
Recreation			Non-consumptive			
Environmental			Non-consumptive			
Evaporation	11,300	--	11,300	--	11,300	--
<b>Total</b>	<b>192,000</b>	<b>73,100</b>	<b>198,000</b>	<b>73,100</b>	<b>208,000</b>	<b>73,200</b>

<sup>1</sup> Includes conventional oil and gas production water and CBNG production water.

Source: HKM Engineering et al. 2002a

The Little Bighorn River, Tongue River, Powder River, Crazy Woman Creek, and Piney Creek carry the largest natural flows in the Powder/Tongue River Basin. Many of the other major drainages are affected by irrigation practices to the extent that their flows are not natural (HKM Engineering et al. 2002a). Water availability in the major sub-basins of the Powder/Tongue River Basin is summarized in Table 4-17. This table presents the amount of surface water in acre-feet that is physically available above and beyond allocated surface water in these drainages. As a result of the Yellowstone River Compact, Wyoming

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Table 4-17. Surface Water Availability in the Powder/Tongue River Basins.

Sub-basin	Surface Water Availability (acre-feet per year)		
	Wet Years	Normal Years	Dry Years
Little Bighorn River	152,000	113,000	81,000
Tongue River	473,000	326,000	218,000
Clear Creek	213,000	124,000	80,000
Crazy Woman Creek	69,000	32,000	16,000
Powder River	547,000	324,000	16,000
Little Powder River	48,000	12,000	3,000
<b>Total</b>	<b>1,502,000</b>	<b>931,000</b>	<b>414,000</b>

Source: HKM Engineering et al. 2002a

must share some of the physically available surface water in the Powder/Tongue River Basin with Montana.

The main rivers in the Northeast Wyoming River Basins are the Belle Fourche in Campbell and Crook counties and the Cheyenne River in Converse, Weston, and Niobrara counties. Water in these rivers and their tributaries comes from groundwater baseline flow and from precipitation, especially from heavy storms during the summer months. Most surface flow in Northeast Wyoming River Basins is intermittent to ephemeral and streamflows are typically dominated by irrigation practices to the extent that their flows are unnatural (HKM Engineering et al. 2002a). Water use in the Northeast Wyoming River Basins as of 2002 is summarized in Table 4-18.

Table 4-18. Water Use as of 2002 in the Northeast Wyoming River Basins (acre-feet per year).

Water Use Categories	Dry Year		Normal Year		Wet Year	
	Surface Water	Ground-water	Surface Water	Ground-water	Surface Water	Ground-water
Agricultural	65,000	11,000	69,000	17,000	71,000	17,000
Municipal	---	9,100	---	9,100	---	9,100
Domestic	---	3,600	---	3,600	---	3,600
Industrial <sup>1</sup>	---	46,000	---	46,000	---	46,000
Industrial (Other) <sup>2</sup>	---	4,700	---	4,700	---	4,700
Recreation			Non-consumptive			
Environmental			Non-consumptive			
Evaporation (Key Reservoirs)	14,000	---	14,000	---	14,000	---
Evaporation (Stock Ponds)	6,300	---	6,300	---	6,300	---
<b>Total</b>	<b>85,300</b>	<b>74,400</b>	<b>89,300</b>	<b>80,400</b>	<b>91,300</b>	<b>80,400</b>

<sup>1</sup> Includes conventional oil and gas production water and CBNG production water.

<sup>2</sup> Includes electricity generation, coal mining, and oil refining.

Source: HKM Engineering et al. 2002b

Stream flow in the major drainages of the Northeast Wyoming River Basins is much less than in the Powder/Tongue River Basin, due to the absence of a major mountain range to provide snow melt runoff. Water availability in the

major sub-basins of the Northeast Wyoming Rivers Basin is summarized in Table 4-19.

Table 4-19. Surface Water Availability in the Northeast Wyoming River Basins.

Sub-basin	Surface Water Availability (acre-feet per year)		
	Wet Years	Normal Years	Dry Years
Redwater Creek	34,000	26,000	17,000
Beaver Creek	30,000	20,000	14,000
Cheyenne River	103,000	31,000	5,000
Belle Fourche River	151,000	71,000	13,000
<b>Total</b>	<b>318,000</b>	<b>148,000</b>	<b>49,000</b>

Source: HKM Engineering et al. 2002b

The PRB Coal Review Task 3B Report (BLM 2009e) summarizes the modeled changes in surface water quality as a result of CBNG, conventional oil and gas, and surface coal mining development projected for 2010, 2015, and 2020 in the eastern PRB within approximately 25 miles of the coal mines. The base year used for comparison of surface water quality impacts was 2003. A stream channel stability analysis was also conducted to evaluate the potential effects to stream channels due to projected CBNG production water discharge. The surface water resources in the cumulative study area consist primarily of intermittent and ephemeral streams and scattered ponds and reservoirs. A major impact of the projected development activities would be direct surface disturbance of these surface water features. Projected cumulative surface water impacts primarily include the impacts of CBNG production water discharge to ephemeral drainages and the surface disturbance and subsequent reclamation of drainages that result from coal mine expansion.

Surface water quality impacts for target years 2010, 2015, and 2020 were estimated using a linear model developed by ACE (2009) and the projected water discharge volumes presented in the PRB Coal Review Task 2 Report (BLM 2009b). Projected changes in surface water quality are due to mixing of predicted CBNG production water discharge with natural flow in the modeled drainages. For CBNG discharge, the direct discharge to ephemeral drainages for each drainage basin was used as a guide for modeling water quality or estimating impacts to channel stability and channel properties. For the coal mines, most of the water produced was expected to be consumed, according to estimates provided by the mine operators and included in the Task 2 report. Where production exceeded estimated consumption for the coal mines in any given drainage basin, it was assumed that the discharged water would go first to holding ponds and then to nearby ephemeral drainages in accordance with Wyoming Pollution Discharge Elimination System (WYPDES) permits, thereby minimizing the potential for degradation of water quality and impacts to channel stability.

Table 4-10 summarizes the cumulative baseline (2003), actual (2007), and projected (in 2010, 2015, and 2020) acres of surface disturbance and

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reclamation. The projected activities would result in surface disturbance in each of the six subwatersheds in the cumulative study area (Figure 4-4). Discrete locations for development disturbance and reclamation areas cannot be determined based on existing information. However, the projected disturbance would primarily involve the construction of additional linear facilities, product gathering lines, and road systems associated with conventional oil and gas and CBNG activities, plus additional disturbance associated with extending coal mining operations onto lands adjacent to the existing mines.

Surface disturbing activities can result in sediment input to water bodies, which affects water quality parameters such as turbidity and bottom substrate composition. Contaminants also can be introduced into water bodies through chemical characteristics of the sediment. 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 or development activities have been completed. It is anticipated that sediment input associated with development disturbance areas would be minimized by implementation of appropriate erosion control measures, as would be determined during future permitting.

Future coal mining 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 Section 3.5.2, the WAC mines are in the Cheyenne River subwatershed. 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).

Coal mining-related surface water would be discharged into intermittent and ephemeral streams in four subwatersheds (Antelope Creek, Little Powder River, Upper Belle Fourche River, and Upper Cheyenne River). Based on current trends, it is assumed that most, if not all, of the coal mine-produced water would be consumed during operation. As discussed in Section 3.5.2.2, changes in surface runoff would occur as a result of the destruction and reconstruction of drainage channels as mining progresses. Sediment control structures would be used to manage discharges of surface water from the mine permit areas. State and federal regulations require treatment of surface runoff from mined lands to meet effluent standards.

Of particular importance is the amount of production water that is directly conveyed to the receiving drainages. Based on information and data presented in the PRB Coal Review Task 1B and Task 2 reports (BLM 2009d and 2009b, respectively), it is assumed that the production water discharged directly to the receiving drainages would be limited to CBNG water discharge. The PRB Coal Review assumes that future permitting would allow a portion of CBNG-

produced water to be discharged to intermittent and ephemeral drainages as is currently allowed in the six subwatersheds in the cumulative study area (Antelope Creek, Dry Fork Cheyenne River, Upper Cheyenne River, Upper Belle Fourche River, Upper Powder River, and Little Powder River) (Figure 4-4).

The PRB Coal Review Task 3B Report utilizes the surface water model described in the Surface Water Quality Analysis Technical Report (Greystone and ALL Consulting 2003), which was prepared in support of the PRB Oil and Gas Project EIS (BLM 2003), to evaluate the cumulative impacts to surface water quality from surface discharge of CBNG development. The linear model used by ACE (2009) to predicted future cumulative surface water quality impacts combined stream flows and stream water quality with the predicted CBNG discharge water quantity and quality for each subwatershed for 2010, 2015, and 2020, and the base year for comparison for surface water quality impacts was 2003.

Based on past monitoring in receiving streams, most (70 to 90 percent) CBNG discharge water either infiltrates or evaporates within a few miles of the discharge points and generally is not recorded at USGS stream gaging stations. Impacts to surface water flow and quality are therefore generally limited to within a few miles of the discharge point. In view of this, the PRB Coal Review Task 3B water quality impact analysis assumes a conveyance loss of 70 percent for the water quality assessment and modeling analysis.

Key water quality parameters for predicting the potential effects of CBNG development in the surface water quality impact analysis focused on the suitability of surface water for agricultural irrigation. Consequently, the sodium adsorption ratio (SAR) and salinity, measured by electrical conductivity (EC), were utilized for the prediction. SAR is a measure of the amount of sodium in the water that can react with clays and, thus, reduce infiltration into soils and the ultimate use of the soil for growing crops. EC is a measure of the total dissolved solids. The most restrictive proposed limit (MRPL) and least restrictive proposed limit (LRPL) regulatory standards for EC and SAR are set for each subwatershed by the WDEQ in conjunction with neighboring states that receive flow across state boundaries from the specified stream in the watershed. These limits refer to the desired concentrations for SAR and EC and are used as guidelines for evaluating potential impacts to water quality. The limits presented in Table 4-20 were used during the comparison of EC and SAR values for resulting mixtures of existing streamflows and discharges from CBNG wells under various flow conditions and reasonably foreseeable development (RFD) projections for 2010, 2015, and 2020.

The cumulative impacts to surface water quality focused on RFD scenarios for normal and dry year conditions to show the difference based on streamflow and climate. Wet years were not analyzed because increased runoff and stream flow would result in potential water quality impacts considerably less than normal and dry year RFD scenarios. The impact analysis, conducted using monthly flows, comparatively evaluated the water quality parameters (SAR and

#### 4.0 Cumulative Environmental Consequences

Table 4-20. Summary of Proposed Limits for SAR and EC.

Subwatershed	Most Restrictive Proposed Limit (MRPL)		Least Restrictive Proposed Limit (LRPL)	
	SAR	EC ( $\mu\text{S}/\text{cm}^1$ )	SAR	EC ( $\mu\text{S}/\text{cm}^1$ )
Little Powder	5	2,000	9.75	2,500
Upper Powder	2	2,000	9.75	2,500
Belle Fourche	6	2,000	10	2,500
Cheyenne River & Antelope Creek	10	2,000	10	2,500

<sup>1</sup>  $\mu\text{S}/\text{cm}$  = microsiemens per centimeter

Source: Wyoming DEQ, Montana DEQ, and South Dakota Legislative Council

EC) of the receiving drainage before and after mixing with discharge water generated by the CBNG wells within that drainage. In general, the water discharged from the CBNG wells reflected increased levels of SAR and reduced levels of EC compared to the water quality of the receiving drainages. Impacts to water quality are likely to be maximized during the low flow months; consequently, the comparative evaluation of water quality focused on the minimum monthly flow associated with the dry year and normal year conditions.

The water quality impact analysis made several observations regarding the overall effects of mixing CBNG well production water with surface water in the cumulative study area. These general observations are summarized below.

#### Normal Year Conditions

Antelope Creek: Before mixing, the SAR values are relatively low and do not exceed the MRPL. The EC values exceed the MRPL during the low-flow months, but are typically less than the LRPL all year. After mixing, from 2003 to 2020, EC is projected to decline, and SAR values are projected to increase. The data indicate that the MRPL and LRPL would not be exceeded for either EC or SAR after mixing or CBNG production waters. Based on the data, surface water is projected to be suitable for irrigation use in all months.

Dry Fork of the Cheyenne River: Before mixing, the SAR values are relatively low and do not exceed the MRPL. The EC values exceed the MRPL during the low-flow months, but are typically less than the LRPL all year. There is no projected discharge of CBNG production water to the drainage through 2020. Therefore, surface water quality conditions for 2010, 2015, and 2020 would be the same as for the base year (2003).

Upper Cheyenne River: Before mixing, the SAR levels do not exceed the MRPL and the EC levels exceed the MRPL for 11 months of the year and the LRPL for 9 months of the year. After mixing, from 2003 to 2010, EC is projected to decrease, and SAR values would not change. There is no projected discharge of CBNG production water to the drainage in 2015 and 2020. Based on the data, EC values would exceed the MRPL, except for August 2010, and exceed the LRPL, except for July through September 2010. SAR values would not exceed

the MRPL and LRPL. Based on the data, surface water would remain suitable for irrigation from 2010 to 2020.

Upper Belle Fourche: Before mixing, the SAR levels exceed the MRPL from November through January while meeting the LRPL throughout the year. The EC levels exceed the MRPL from September through January and exceed the LRPL from November through January. After mixing, from 2003 to 2015, EC is projected to decline and SAR is projected to increase slightly. There is no projected discharge of CBNG production water to the drainage in 2020; therefore, EC and SAR values for this time period would be the same as projected for the base year (2003). The data indicate that EC would not exceed the MRPL, except for October in 2010 and October through January in 2015, and would not exceed the LRPL. The projected SAR values would exceed the MRPL from August to January in 2010 and from September to January of 2015, and would not exceed the LRPL for all months. Based on the data, surface water is projected to be suitable for irrigation to 2020.

Upper Powder River: Before mixing, surface water in the Upper Powder River exceeds the MRPL for both EC and SAR throughout the majority of the year. Levels of SAR are less than the LRPL while EC values generally exceed the LRPL from July through December. After mixing, from 2003 to 2015, EC is projected to decrease slightly, and SAR values would increase slightly. There is no projected discharge of CBNG production water to the drainage in 2020; therefore, EC and SAR values for this time period would be the same as projected for the base year (2003). The data indicate that EC values would exceed the MRPL, except for May and June for 2010 and 2015, and would exceed the LRPL during July through December from 2010 to 2015. SAR values would exceed the MRPL, except for March in 2010 and 2015 and May in 2015, and would not exceed the LRPL. Based on the data, surface water is projected to remain suitable for irrigation from 2010 to 2010.

Little Powder River: Before mixing, the surface water in the Little Powder River exceeds the MRPL for EC and SAR throughout the majority of the year. SAR levels remain below the LRPL throughout the year, but EC levels exceed the LRPL during the low flow months. After mixing, from 2003 to 2020, EC is projected to increase slightly. The data indicate that EC values would exceed the MRPL except for March and May during 2010, and March during 2015 and 2020; however, it would not exceed the LRPL except for January and August from 2010 to 2020, and also in September, November, and December from 2015 to 2020. SAR values are projected to exceed the MRPL and not exceed the LRPL. Based on the data, surface water is projected to remain suitable for irrigation to 2020.

#### Dry Year Conditions

Antelope Creek: After mixing, from 2003 to 2020, EC values would be reduced due to mixing with CBNG waters and SAR values would increase. The data indicate that the MRPL and LRPL would not be exceeded from either EC or SAR

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for all years. Based on the data, surface water would remain suitable for irrigation except for June and August from 2010 to 2020.

Dry Fork of the Cheyenne River: There is no projected discharge of CBNG production water to the drainage through 2020. Therefore, surface water quality conditions would be the same as for the base year (2003), for all years to 2020.

Upper Cheyenne River: After mixing, from 2003 to 2010, EC values would decline, and SAR values would increase slightly. There is no projected discharge of CBNG production water to the drainage in 2015 and 2020. EC values would exceed the MRPL except for August 2010; the LRPL would be exceeded except for July to September 2010. For SAR, neither the MRPL nor the LRPL would be exceeded. Based on the data, surface water would remain suitable for irrigation to 2020.

Upper Belle Fourche: After mixing, from 2003 to 2015, EC values would decline, and SAR values would increase slightly. There is no projected discharge of CBNG production water to the drainage in 2020. EC values would not exceed the MRPL or LRPL from 2010 to 2015. SAR values would exceed the MRPL in 2010, except for March and July, and also would exceed the MRPL from August to January 2015. Based on the data, surface water would be unsuitable for irrigation from August to October during 2010 and in October 2015.

Upper Powder River: After mixing, from 2003 to 2015, EC values would decrease slightly, and SAR values would increase slightly. There is no projected discharge of CBNG production water to the drainage in 2020. EC values would exceed the MRPL except for the months of May and June 2010 and 2015, and the LRPL would be exceeded July through December for 2010 and 2015. SAR values would exceed the MRPL, except for May and June 2015, and would not exceed the LRPL for all years. Based on the data, surface water would remain suitable for irrigation to 2020.

Little Powder River: After mixing, from 2003 to 2020, the EC would be reduced and the SAR would increase. The MRPL would be exceeded for all years for EC during the months of February, April, June, and August in 2010; during November through February and during April, June, and August in 2015; and all months except March in 2020. EC values would exceed the LRPL in September 2010; August 2015; and January, August November, and December 2020. SAR values would exceed the MRPL in all months and years except March 2015 and March and May 2020. The LRPL for SAR would be exceeded in September 2010. The water would remain suitable for irrigation from 2010 to 2020 except for September and October 2010.

In summary, the suitability of the mixed water for irrigation purposes is related to EC and SAR. In general, the water most suitable for irrigation has a relatively low SAR and a relatively high EC. Elevated SAR values may reduce

permeability in clayey soils, which reduces the rate of water infiltration. As discussed above, the water discharged from the CBNG wells is generally characterized by higher levels of SAR and reduced levels of EC compared to the water quality of the receiving drainages. In those cases where mixing results in a significant increase in SAR and the EC is moderately low, the water was considered unsuitable. For these six drainages, the projected water quality after mixing demonstrated adequate suitability for irrigation in most months during normal year conditions. The MRPL and LRPL may be exceeded for EC and SAR in 1 or more years and in any given year for 1 or more months, but not for all months in the year. During dry year conditions, the suitability of surface waters in the six drainages for irrigation generally would be reduced due to the greater percentages of CBNG water in the drainage after mixing. Both the EC and SAR values would exceed the MRPL and LRPL more frequently compared to normal year flows. Even though the waters' suitability for irrigation would be reduced (except for the Belle Fourche River) surface water generally would remain suitable for irrigation during the majority of months of the irrigation season.

#### 4.2.5 Channel Stability

In general, cumulative impacts to channel stability largely relate to changes in water quantity associated with discharges from existing and projected development activities as compared to the natural runoff characteristics of the receiving drainages. For this evaluation, ACE (2009) assumed that water discharged directly to the receiving drainages would be limited to CBNG activities, which are projected to be the primary source of discharge water in the PRB study area through 2020.

To the extent possible, the impact to perennial drainages was addressed quantitatively at the subwatershed level using regression equations related to discharge and channel width. Geomorphic relationships between mean annual discharge, channel gradient and geometry, bed load, and median sediment size also were used to provide a qualitative assessment of potential impacts associated with the discharge of CBNG production water.

To have an impact on channel stability that is manifested in active channel erosion, CBNG production water discharge likely would have to represent a substantial portion of the channel-forming discharge in watersheds where the channel slope is steep enough and the width, depth, and sinuosity low enough to impact channel morphology. Channel-forming discharge was estimated using the peak annual discharge recurrence interval and the common range for channel-forming discharge between the 1.5- to 2.0-year recurrence interval. Based on the magnitude of the projected CBNG production water discharges compared to the channel-forming discharge (1.5- to 2.0-year recurrence interval), the impact more likely would be evident in small ephemeral drainages that are characterized by steep channel gradients, lower sinuosity, and smaller widths and depths. Overall, as the drainage area increases, the channel slope

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typically decreases along with an increase in sinuosity, thereby reducing the impact of CBNG production water discharge on channel stability.

The channel-forming discharge for both the Little Powder River and Belle Fourche River is given in Table 4-21. The perennial stream evaluation calculated the change in channel width for the Little Powder River as less than 0.3 percent. For the Belle Fourche River, it was calculated to be less than 0.2 percent (Table 4-21) (ACE 2009). Given the low increase in mean annual discharge from introduced CBNG water, changes in channel geomorphology (width, depth, gradient, bed material transport and meander wavelength) are considered imperceptible. These results suggest that for the larger perennial streams the effect of CBNG production water discharge would be minimal.

Table 4-21. Projected Impact of CBNG Production Water Discharge on Perennial Streams.

Location	Channel Forming Discharge <sup>1</sup> (cfs)	CBNG Discharge		Estimated Width		Potential Impact [Increased Channel Width]	
		(cfs)	(%)	Existing Conditions (ft)	Combined Discharge (ft)	(ft)	(%)
Little Powder River above Dry Creek near Weston, Wyoming (USGS Gage 06324970)	270 to 420	2.2	0.5 to 0.8	47.3 to 56.3	47.4 to 56.4	0.15 to 0.12	0.3
Belle Fourche River below Moorcroft, Wyoming (USGS Gage 06426500)	652 to 789	3.9	0.5 to 0.6	66.9 to 72.1	67.0 to 72.2	0.16 to 0.14	0.2

<sup>1</sup> Discharge associated with the 1.5- to 2-year recurrence interval.

Discharge of CBNG well production water into ephemeral drainages may start or exacerbate erosion in the ephemeral stream channel. Given the potentially greater increase in stream flow due to a lower natural flow, channel geomorphology is more likely to be perceptible. Smaller drainages may be more likely to exhibit channel erosion depending on the magnitude of the flow contribution from CBNG water production compared to the channel-forming discharge. However, field observations in these watersheds found an increase in vegetation diversity and density along the channel.

According to the BLM Task 3B Report (BLM 2009e), a special study was done of the Caballo Creek drainage in the Belle Ayr Mine permit area, to see how reclaimed drainages were impacted by increased CBNG discharges. It was determined that CBNG discharge represented less than 1 percent of the 2-year peak discharge. No active erosion was noted in the natural or diverted portions of the Caballo Creek channel, while an increase in vegetative diversity and density was noted. Based on the relative magnitude of the flow contribution from CBNG production water discharge to the flow in Caballo Creek, the minor amount of flow increase would not likely result in increased erosion to its

channel or in streams similar to Caballo Creek. While it is more likely that creeks with smaller drainage areas, like Duck Nest or Bone Pile Creeks may experience more erosion due to relatively larger flow increases due to CBNG discharge, such effects were not observed in the field (BLM 2009e).

#### 4.2.6 Alluvial Valley Floors

The identified AVFs for all coal mines in the PRB Coal Review study area are described in the PRB Coal Review Task 1D Report (BLM 2005d), based on individual mine State Decision Documents. Regulatory determinations of AVF occurrence and location are completed as part of the permitting process for coal mining operations, because their presence can restrict mining activities under SMCRA and Wyoming laws. The WDEQ/LQD administers the AVF regulations for coal mining activities in Wyoming. Coal mine-related impacts to designated AVFs generally are not permitted if the AVF is determined to be significant to agriculture. If an AVF is determined not to be significant to agriculture or if the permit to affect the AVF was approved prior to the effective date of SMCRA, the AVF can be disturbed during mining but must be restored to essential hydrologic function during reclamation.

The formal AVF designation and related regulatory programs described above are specific to coal mining operations; however, other development-related activities in the study area would potentially impact AVF resources. The portions of the cumulative study area that lie outside of the mine permit areas have generally not been surveyed for the presence of AVFs; therefore, the locations and extent of the AVFs outside of the mine permit areas have not been determined.

#### 4.2.7 Soils

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to soils as a result of projected development activities in the PRB Coal Review Task 3 study area. The area of actual surface coal mining disturbance and reclamation for the years 2003 and 2007, and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual disturbance and reclamation for all development in 2003 and 2007, and the projected cumulative total areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

Development activities such as increased vehicle traffic, vegetation removal, soil salvage and redistribution, discharge of CBNG produced groundwater, and construction and maintenance of project-specific components (e.g., roads, ROWs, well pads, industrial sites, and associated ancillary facilities) would result in cumulative impacts to soils in the study area. In general, soil disturbance and handling from these activities would generate both long-term and short-term impacts to soil resources through accelerated wind or water

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erosion, declining soil quality factors, compaction, and the removal and replacement of soil resources at mining sites.

Of the types of development 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 tendency of mining operations to occur in contiguous blocks. These factors would encourage widespread accelerated wind and water erosion. Extensive soil handling would cause compaction and a corresponding loss of permeability to water and air; a decline in microbial populations, fertility, and organic matter; and potential mixing of saline and/or alkaline soil zones into seedbeds, which would reduce soil quality. There would be a limited availability of suitable soil resources for reclamation uses in some areas.

However, for surface coal mining operations, there are measures that are either routinely required or can be specifically required as necessary to reduce impacts to soil resources and to identify overburden material that may be unsuitable for use in reestablishing vegetation, as discussed in Sections 3.3.1.3, 3.4.2.3, and 3.8.3.

As described in Appendix E of the PRB Coal Review Task 2 Report (BLM 2009b), a variety of CBNG water disposal methods may be employed in the cumulative study area. The potential impacts to soils would depend on the water treatment method, if any, and the nature of the disposal method. As discussed in the PRB Coal Review Task 3D Report (BLM 2005e), due to elevated SAR levels in water produced from the Wyodak-Anderson coal zone in the Upper Powder River and Little Powder River subwatersheds, land applications of CBNG-produced water in those areas could increase soil alkalinity. As discussed above in Section 4.2.4.2, the SAR values are generally low for the Upper Belle Fourche subwatershed and tend to exceed the MRPL after mixing with discharged CBNG water during six months of the year while meeting the LRPL throughout the year. Land application of CBNG-produced water is not anticipated in this area. The specific approaches to CBNG water discharges, the resource conditions and locations in which they occur, the timing of discharges, and the discharge permit stipulations from regulatory and land management agencies would determine the extent and degree of potential impacts to soils.

#### 4.2.8 Vegetation, Wetlands and Riparian Areas

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to vegetation, wetlands, and riparian areas as a result of projected development activities in the cumulative study area. The area of actual surface coal mining disturbance and reclamation for the years 2003 and 2007, and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual disturbance and reclamation for all development in 2003 and 2007, and the

projected cumulative total areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

#### 4.2.8.1 Vegetation

The PRB is characterized as a mosaic of general vegetation types, which include prairie grasslands, shrublands, forested areas, and riparian areas. These broad categories often represent several vegetation types that are similar in terms of dominant species and ecological importance. Fourteen vegetation types were identified within the PRB Coal Review Task 1 study area, of which 10 primarily consist of native vegetation and are collectively classified as rangeland. These vegetation types include short-grass prairie, mixed-grass prairie, sagebrush shrubland, other shrubland, coniferous forest, aspen, forested riparian, shrubby riparian, herbaceous riparian, and wet meadow. The remaining vegetation types support limited or non-native vegetation and include cropland, urban/disturbed, barren, and open water. The vegetation types are described in more detail in the Task 1D Report for the PRB Coal Review (BLM 2005d).

Impacts to vegetation can be classified as short-term and long-term. Potential short-term impacts arise from the removal and disturbance of herbaceous species during a project's development and operation (e.g., coal mining, CBNG drilling and production, etc.), which would cease upon project completion and successful reclamation in a given area. Reclaimed mine land is defined by WDEQ/LQD as affected land that has been backfilled, graded, topsoiled, and permanently seeded in accordance with the approved practices specified in the reclamation plan (Christensen 2002). Species composition on the reclaimed lands may be different than on the surrounding undisturbed lands. The removal of woody species would be considered a long-term impact since these species take approximately 25 years or longer to attain a size comparable to woody species present within proposed disturbance areas. Potential long-term impacts would also include permanent loss of vegetation and vegetative productivity in areas that would not be reclaimed in the near term (e.g., power plant sites, etc.).

#### 4.2.8.2 Special Status Plant Species

Special status plant 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 (species that are protected under the ESA), BLM Sensitive Species, U.S. Department of Agriculture-Forest Service (USFS) Sensitive Species, and Wyoming Game and Fish Department (WGFD) Species of Special Concern in Wyoming. Further discussions of species that are protected under the ESA, BLM Sensitive Species, and USFS Sensitive Species are included in Appendix H of this EIS. Two federally listed species (Ute ladies'-tresses orchid and blowout penstemon) and three USFS sensitive species (Barr's milkvetch, Rosy palafox, and Lemonscent) are known to occur or may have potentially suitable habitat

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in the cumulative study area. Three BLM sensitive species (Nelson's milkvetch and Laramie columbine [Casper Field Office] and William's wafer-parsnip [Buffalo Field Office]) may occur in the cumulative 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, associated with past and projected activities. Direct impacts also could include the direct loss of individual plants within the cumulative study area, depending on their location in relation to development 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.

#### 4.2.8.3 Noxious and Invasive Weed Species

Once established, invasive and non-native plant species can out-compete and eventually replace native species, thereby reducing forage productivity and the overall vigor and diversity of existing native plant communities. The state of Wyoming has currently designated the following 25 plant species as noxious weeds:

- Field bindweed (*Convolvulus arvensis*)
- Canada thistle (*Cirsium arvense*)
- Leafy spurge (*Euphorbia esula*)
- Perennial sowthistle (*Sonchus arvensis*)
- Quackgrass (*Agropyron repens*)
- Hoary cress (*Cardaria draba*)
- Perennial pepperweed (giant whitetop) (*Lepidium latifolium*)
- Ox-eye daisy (*Chrysanthemum leucanthemum*)
- Skeletonleaf bursage (*Franseria discolor* Nutt.)
- Russian knapweed (*Centaurea repens* L.)
- Yellow toadflax (*Linaria vulgaris*)
- Dalmatian toadflax (*Linaria dalmatica*)
- Scotch thistle (*Onopordum acanthium*)
- Musk thistle (*Carduus nutans*)
- Common burdock (*Arctium minus*)
- Plumeless thistle (*Carduus acanthoides*)
- Dyers woad (*Isatis tinctoria*)
- Houndstongue (*Cynoglossum officinale*)
- Spotted knapweed (*Centaurea maculosa* Lam.)
- Diffuse knapweed (*Centaurea diffusa* Lam.)
- Purple loosestrife (*Lythrum salicaria* L.)
- Saltcedar (*Tamarix spp.*)
- Common St. Johnswort (*Hypericum perforatum*)
- Common Tansy (*Tanacetum vulgare*)
- Russian olive (*Elaeagnus angustifolia* L.)

Campbell County does not have a declared list of weeds.

Development-related construction and operation activities would potentially 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.

Chapter 4, Section 2(d)(xiv) of the WDEQ/LQD rules and regulations requires that surface coal mines address weed control on reclaimed areas as follows:

The operator must control and minimize the introduction of noxious weeds in accordance with federal and state requirements until bond release.

Accordingly, the reclamation plans for all surface coal mines in the Wyoming PRB include steps to control invasion by weedy (invasive nonnative) plant species. As discussed in Chapter 3, Section 3.9.4, the WAC mines work with the Campbell County Weed and Pest Department and conduct an active noxious weed control program on their existing coal leases. Similar measures to identify and control noxious weeds are used at all of the surface coal mines in the Wyoming PRB as a result of the WDEQ/LQD regulatory requirements.

Mitigation to control invasion by noxious weeds for CBNG developers is determined on a site-specific basis and may include spraying herbicides before entering areas and washing vehicles before leaving infested areas. BLM reviews weed educational material during preconstruction on-site meetings with CBNG operators, subcontractors, and landowners. BLM also attaches this educational information to approved Applications for Permit to Drill (APDs) or Plans of Development (PODs) (BLM 2003). BLM also participates in a collaborative effort with the South Goshen Cooperative Extension Conservation District, the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), private surface owners, WGFD, and the Weed and Pest District in a prevention program that includes a long-term integrated weed management plan, public awareness and prevention programs, and a common inventory (BLM 2003).

#### 4.2.8.4 Wetland and Riparian Species

Operations associated with development activities in the study area would result in the use of groundwater. Annually, during 2010-2020, from 30,000-42,000 mmgpy of CBNG-produced water would be discharged to impoundments or intermittent and ephemeral streams or reinjected. The discharge of produced water could result in the creation of wetlands in containment ponds, landscape depressions, and riparian areas along segments of 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 in

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the long term. 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 for the PRB Coal Review (BLM 2005d). For agricultural uses, the current Wyoming water quality standard for SAR is 8.0 (WDEQ/WQD 2009). SARs of 5 to 10 have been observed in discharge waters in the study area (BLM 2003). Once water discharges have peaked and subsequently decrease in the long term, the extent of wetlands and riparian areas and species diversity would decrease accordingly. After the complete cessation of water discharges, artificially-created wetland and riparian areas once again would support upland species and previously existing wetland and riparian areas would decrease in areal extent.

##### 4.2.9 Wildlife and Fisheries

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to wildlife as a result of projected development activities in the cumulative study area. The area of habitat disturbance and reclamation for the years 2003 and 2007, and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual habitat disturbance and reclamation for all development in 2003 and 2007, and the projected cumulative total habitat disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

Impacts to wildlife can be classified as short-term and long-term. Potential short-term impacts arise from habitat 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 long-term or 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. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities.

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 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, and climate).

#### 4.2.9.1 Game Species

Big game species that are present within the cumulative study area include pronghorn, white-tailed deer, mule deer, and elk. Potential direct impacts to these species would include the incremental loss or alteration of potential forage and ground cover associated with construction and operation of the past, present and reasonably foreseeable future development discussed in Section 4.1. Development associated with coal mining, drilling for CBNG, ancillary facilities, agricultural operations, urban areas, and transportation and utility corridors result in vegetation removal. Assuming that adjacent habitats would be at or near carrying capacity and considering the variabilities associated with drought conditions and human activities in the study area, the PRB Coal Review Task 3D study concluded that displacement of wildlife species (e.g., big game) as a result of development activities would create some unquantifiable reduction in wildlife populations.

There are a number of big game habitat ranges within the cumulative study area. In Wyoming, the WGF and the BLM have established habitat classifications based on seasonal use. Classification types include crucial winter, severe winter, winter yearlong, and yearlong. 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. As discussed in the PRB Coal Review Task 2 Report, discrete locations for most of the disturbance related to the projected development could not be determined based on the available information. However, identified future coal reserves were used for the Task 3D Report to provide some level of quantification of potential future impacts to big game ranges. Tables 4-22 through 4-25 summarize the effects on pronghorn, deer, and elk game ranges as a result of the predicted lower and upper levels of coal production through 2020.

Table 4-22. Potential Cumulative Disturbance to Pronghorn Ranges from Development Activities—Lower and Upper Coal Production Scenarios (acres/percent affected).

Time Period/Scenario	Pronghorn Ranges <sup>1</sup>			
	Crucial Winter	Severe Winter	Winter Yearlong	Yearlong
2010/Lower	N/A	1,472 / 3%	33,196 / 2%	32,099 / 1%
2010/Upper	N/A	1,472 / 3%	34,760 / 2%	33,172 / 1%
2015/Lower	N/A	1,460 / 3%	32,649 / 2%	34,828 / 1%
2015 Upper	N/A	1,460 / 3%	34,177 / 2%	36,999 / 1%
2020/Lower	N/A	1,422 / 3%	33,637 / 2%	35,714 / 1%
2020/Upper	N/A	1,422 / 3%	33,580 / 2%	37,437 / 2%

<sup>1</sup> Potential coal mine related impacts to big game ranges were determined based on GIS information as follows: the total acres of a big game range (e.g., crucial winter, severe winter, winter yearlong, and yearlong) within the PRB Coal Review Task 3 study area was divided by the sum of the potential disturbance acreage for the time period (based on GIS mapping of coal reserves for the lower coal production scenario) and 2006 disturbance from coal mine development.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

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Table 4-23. Potential Cumulative Disturbance to White-tailed Deer Ranges from Development Activities—Lower and Upper Coal Production Scenarios (acres/percent affected).

<b>White-tailed Deer Ranges<sup>1</sup></b>				
<b>Time</b>				
<b>Period/Scenario</b>	<b>Crucial Winter</b>	<b>Severe Winter</b>	<b>Winter Yearlong</b>	<b>Yearlong</b>
2010/Lower	N/A	N/A	N/A	1,411 / 0.6%
2010/Upper	N/A	N/A	N/A	1,411 / 0.6%
2015/Lower	N/A	N/A	N/A	1,497 / 0.7%
2015 Upper	N/A	N/A	N/A	1,495 / 0.7%
2020/Lower	N/A	N/A	N/A	1,704 / 0.7%
2020/Upper	N/A	N/A	N/A	1,707 / 0.8%

1 Potential coal mine-related impacts to big game ranges were determined based on GIS information as follows: the total acres of a big game range (e.g., crucial winter, severe winter, winter yearlong, and yearlong) within the PRB Coal Review Task 3 study area was divided by the sum of the potential disturbance acreage for the time period (based on GIS mapping of coal reserves for the lower coal production scenario) and 2006 disturbance from coal mine development.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

Table 4-24. Potential Cumulative Disturbance to Mule Deer Ranges from Development Activities—Lower and Upper Coal Production Scenarios (acres/percent affected).

<b>Mule Deer Ranges<sup>1</sup></b>				
<b>Time</b>				
<b>Period/Scenario</b>	<b>Crucial Winter</b>	<b>Severe Winter</b>	<b>Winter Yearlong</b>	<b>Yearlong</b>
2010/Lower	N/A	N/A	6,808 / 0.4%	25,390 / 1%
2010/Upper	N/A	N/A	6,924 / 0.4%	26,641 / 1%
2015/Lower	N/A	N/A	6,956 / 0.4%	26,420 / 1%
2015 Upper	N/A	N/A	7,285 / 0.5%	27,205 / 1%
2020/Lower	N/A	N/A	6,958 / 0.4%	27,004 / 1%
2020/Upper	N/A	N/A	7,413 / 0.5%	27,990 / 1%

1 Potential coal mine-related impacts to big game ranges were determined based on GIS information as follows: the total acres of a big game range (e.g., crucial winter, severe winter, winter yearlong, and yearlong) within the PRB Coal Review Task 3 study area was divided by the sum of the potential disturbance acreage for the time period (based on GIS mapping of coal reserves for the lower coal production scenario) and 2006 disturbance from coal mine development.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

Table 4-25. Potential Cumulative Disturbance to Elk Ranges from Development Activities—Lower and Upper Coal Production Scenarios (acres/percent affected).

<b>Elk Ranges<sup>1</sup></b>				
<b>Time</b>				
<b>Period/Scenario</b>	<b>Crucial Winter</b>	<b>Severe Winter</b>	<b>Winter Yearlong</b>	<b>Yearlong</b>
2010/Lower	24 / 0.4%	N/A	375 / 1%	1,444 / 0.9%
2010/Upper	24 / 0.4%	N/A	375 / 1%	1,444 / 0.9%
2015/Lower	24 / 0.4%	N/A	351 / 1%	1,161 / 0.7%
2015 Upper	24 / 0.4%	N/A	351 / 1%	1,162 / 0.7%
2020/Lower	24 / 0.4%	N/A	351 / 1%	1,121 / 0.7%
2020/Upper	24 / 0.4%	N/A	351 / 1%	1,168 / 0.7%

1 Potential coal mine-related impacts to big game ranges were determined based on GIS information as follows: the total acres of a big game range (e.g., crucial winter, severe winter, winter yearlong, and yearlong) within the PRB Coal Review Task 3 study area was divided by the sum of the potential disturbance acreage for the time period (based on GIS mapping of coal reserves for the lower coal production scenario) and 2006 disturbance from coal mine development.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

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

Operations associated with development activities in the cumulative study area would result in the use of groundwater. The PRB Coal Review assumes that most, if not all, of the coal mine-produced water would be consumed during operation and anticipates that up to approximately 31,000 mmgpy of water would be produced in association with oil and gas production in 2010, increasing to about 42,000 mmgpy by 2020. The portion of the water that is produced in association with the CBNG and discharged to impoundments or intermittent and ephemeral streams 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. 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 evaporation ponds, the potential adverse effects to waterfowl would be minimal.

#### 4.2.9.2 Non-game Species

Potential direct impacts to non-game species (e.g., small mammals, raptors, passerines, amphibians, and reptiles) would include the incremental loss or alteration of existing or potential foraging and breeding habitats from construction and operation of past, present and reasonably foreseeable future development activities (e.g., vegetation removal for coal mines and CBNG wells, ancillary facilities, and transportation and utility corridors). 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 in the path of vehicles and heavy equipment. Indirect impacts would include increased noise levels and human presence, dispersal and invasion of noxious weeds, and dust effects from unpaved road traffic. Assuming that adjacent habitats would be at or near carrying capacity, and considering variable factors such as drought conditions and human activities in the study area, the PRB Coal Review concluded that displacement of wildlife species from the cumulative study area would result in an unquantifiable reduction in wildlife populations.

Numerous migratory bird species have been documented within the PRB over the last two to three decades of wildlife monitoring. Development activities that occur during the migratory bird breeding season (April 1 through July 31) could cause the abandonment of a nest site or territory or the loss of eggs or

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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 and could potentially affect populations of important migratory bird species that may occur in the PRB.

Breeding raptor species that occur within the cumulative study area include the bald eagle, golden eagle, ferruginous hawk, red-tailed hawk, rough-legged hawk, Swainson's hawk, American kestrel, prairie falcon, northern harrier, great horned owl, short-eared owl, burrowing owl, and long-eared owl (*Asio otus*). Bald eagles and long-eared owls are rare nesters in the area.

One potential direct impact to raptors is habitat (nesting and foraging) loss due to additional surface disturbance within the cumulative study area. In the event that development activities were to occur during the breeding season (February 1 through July 31), these activities could result in nest or territory abandonment, or loss of eggs or young. Such losses would reduce productivity for the affected species during that breeding season. As discussed above, loss of an active nest site, incubating adults, eggs, or young would not comply with the intent of several laws, including the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Additional direct impacts could result from construction of new overhead power lines in the region. New power line segments in the study area would incrementally increase the collision and/or electrocution potential for migrating and foraging bird species (e.g., raptors and waterfowl) (APLIC 1994). However, the potential for avian collisions with overhead power lines is typically dependent on variables such as the location of the structures relative to high-use areas (e.g., nesting, foraging, staging, and roosting habitats), the orientation of the power line to flight patterns and movement corridors, species composition, line visibility, and structure design.

In addition, new power lines could pose an electrocution hazard for raptor species attempting to perch on the structure. Configurations greater than 69 kV typically do not present an electrocution potential, based on conductor placement and orientation (APLIC 2006). It is assumed that future permitting for power lines would require the use of appropriate raptor-detering designs, thereby minimizing potential impacts. For example, SMCRA requires that surface coal mine operators use the best technology available to ensure that electric power lines are designed and constructed to minimize electrocution hazards to raptors. Power line impacts to raptors can be reduced with the increased use of underground power lines wherever possible. Many of the power lines for CBNG development currently are being constructed underground.

##### 4.2.9.3 Fisheries

Potential cumulative effects on fisheries as a result of development activities in the cumulative study area would be closely related to impacts on ground and

surface water resources. In general, development 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. The potential effects of development activities on aquatic communities are discussed below for each of these impact topics.

The predominant aquatic habitat type in the cumulative study area consists of intermittent and ephemeral streams and scattered ponds and reservoirs. In general, perennial streams within the study area are limited to the Little Powder River and Belle Fourche River. Warm water game fish and non-game species are present in some perennial stream segments and numerous scattered reservoirs and ponds. However, the latter features are typically stocked artificially either following construction or annually, depending on the depth of the water body. Due to the lack of constant water in most of the potentially affected streams and static water bodies, existing aquatic communities are mainly 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. This loss would be temporary if the stock ponds are replaced during reclamation.

Development activities could result in the loss of aquatic habitat as a result of direct surface disturbance. Table 4-10 summarizes the cumulative acres of surface disturbance and reclamation as of 2003 and 2007, and projects cumulative acres of surface disturbance and reclamation in 2010, 2015, and 2020. Discrete locations for development disturbance and reclamation areas cannot be determined based on existing information. However, projected development that could result in the loss of aquatic habitat would involve the construction of additional linear facilities, product gathering lines and road systems associated with conventional oil and gas and CBNG activities, as well as any additional disturbance that would be associated with extending coal mine operations onto lands adjacent to the existing mines. The removal of aquatic habitat eliminates existing and potential habitat for invertebrates and some fish species. This loss would be temporary if such ponds are reconstructed and recharged as part of the reclamation process.

Projected activities would result in surface disturbance in each of the six cumulative study area sub-watersheds. Information relative to the stream crossing locations for the majority of the linear facilities is not available at this time. The initial phases of the proposed Bison Pipeline Project commenced in April 2008 and is projected to be completed by November 2010. If the project is constructed as planned, it would cross Cottonwood Creek, a tributary of the Little Powder River. Typically, the associated disturbance corridor would consist of a 100-foot-wide construction ROW; however, site-specific stream crossing methods and reclamation would be determined at the time of project permitting.

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Future coal mining also could remove intermittent or ephemeral streams and stock ponds in the Antelope Creek, Upper Cheyenne River, Upper Belle Fourche River, and Little Powder River sub-watersheds. 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). As discussed in Section 3.5.2, the Cheyenne River and its tributaries drain the general Wright analysis area. All streams within the LBA tracts and adjacent applicant mine permit areas are typical for the region, in that flow events are ephemeral. Under natural conditions, aquatic habitat is limited by the ephemeral nature of surface waters in the general Wright analysis area. The results of fish surveys conducted in the Belle Fourche River, Caballo Creek, Antelope Creek, and various area stock ponds during baseline studies for the mines in the South Gillette and Wright subregions that started in the mid-1970s were discussed in Section 3.10.7.1; no uncommon species were documented during those efforts.

The PRB Coal Review assumes that surface disturbing activities would not be allowed in perennial stream segments or reservoirs on public lands that contain game fish species. It also assumes that other types of development operations would not occur within stream channels nor would they remove ponds or reservoirs as part of construction or operation and, therefore, would not result in the direct loss of habitat for these species.

Water quality parameters such as turbidity and bottom substrate composition can be impacted by surface disturbing activities through erosion of sediment into water bodies. Contaminants can also be introduced into those systems through the chemical characteristics of the eroded sediment. Potential related effects on aquatic biota could include physiological stress, movement to avoid affected areas, or alterations of spawning or rearing areas (Waters 1995). Studies have shown that TDS levels in streams near reclaimed coal lands have increased from one percent to seven percent (Martin et al. 1988). Typically, sedimentation effects are short-term in duration and localized in terms of the affected area. TDS concentrations would stabilize and return to more typical concentrations after construction or development activities have been completed. The PRB Coal Review anticipated that the use of appropriate erosion and spill control measures during both development and reclamation activities, as determined during the permitting process, would minimize the introduction of additional sediments into the sub-watershed.

The removal of streamside vegetation would impact both riparian vegetation and stream parameters in those locations. Loss of vegetation along stream channels would reduce the shade and increase bank erosion, both of which would degrade aquatic habitats. Effects on aquatic habitats from linear projects, such as ROWs, would be limited to a relatively small portion of the stream (generally no more than 100 feet in width), whereas mine-related disturbance could affect considerably larger stretches. Because perennial streams are protected from development by a buffer zone on either side of

center, these types of impacts would presumably be limited to intermittent and ephemeral creeks. It is anticipated that reclamation practices to restore riparian vegetation would be required during future project permitting, thereby minimizing such impacts.

CBNG and coal mining are the primary types of development activities that use or manage water as part of their operations. Based on current trends, the PRB Coal Review assumes that most, if not all, of the water produced during coal mining would be consumed during operation. As discussed in Section 3.5.2.2, changes in surface runoff characteristics and sediment discharges would occur during surface coal mining as a result of the destruction and reconstruction of drainage channels as mining progresses, and the use of sediment control structures to manage discharges of surface water from the mine permit area. State and federal regulations require treatment of surface runoff from mined lands to meet effluent standards. After treatment, coal mine-related surface water in the region would ultimately be discharged into intermittent and ephemeral streams in four sub-watersheds (Antelope Creek, Upper Cheyenne River, Belle Fourche River, and Little Powder River). The PRB Coal Review assumes that most, if not all, of the coal mine-produced water would be consumed during operation and anticipates that approximately 31,000 mmgpy of water would be produced in association with oil and gas production in 2010, increasing to about 42,000 mmgpy by 2020, and assumes that a portion of the water that is produced in association with the CBNG would be discharged to intermittent and ephemeral drainages in the general analysis area, much as is currently allowed in the six sub-watersheds in the study area. Based on past monitoring in receiving streams, no change in surface flows would be expected beyond approximately two miles from the discharge points (BLM 2003). Water discharged from CBNG wells has supplied some drainages and water bodies in the PRB nearly continuously for several years. Within the general analysis area, Spring Creek has experienced an influx of CBNG water in recent years, but has not become perennial. The same is true for other streams elsewhere in the PRB that receive CBNG discharge water.

#### 4.2.9.4 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 (species that are protected under the ESA), BLM Sensitive Species, USFS Sensitive Species, and WGFD Species of Special Concern in Wyoming. Further discussions of species that are protected under the Endangered Species Act (ESA), as well as BLM and USFS Sensitive Species, are included in Appendices G and H, respectively, of this EIS. The U.S. Fish and Wildlife Service (USFWS) also has a list of Migratory Bird Species of Management Concern in Wyoming, which is discussed in Section 3.10.6. Special status species potentially occurring in the Task 1 study area are identified in Section 2.4.3.5 of the PRB Coal Review Task 1D Report (BLM 2005d). Additional information about the occurrence of these species in the general Wright analysis area can be found in the Annual Wildlife

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Reports for the Black Thunder, Jacobs Ranch and North Antelope Rochelle mines, which are on file with the WDEQ/LQD in Cheyenne, Wyoming.

Potential impacts to special status terrestrial species would be similar to those discussed above for non-game wildlife (e.g., small mammals, birds, amphibians, and reptiles). Potential direct impacts would include the incremental loss or alteration of potential habitat (native vegetation and previously disturbed vegetation) from construction and operation of development activities (e.g., vegetation removal for coal mines and CBNG wells, ancillary facilities, and transportation and utility corridors). Impacts could also result in mortalities of less mobile species (e.g., small mammals, reptiles, and amphibians), nest or burrow abandonment, and loss of eggs or young in the path of vehicles and heavy equipment. Indirect impacts would include increased noise levels and human presence, introduction and 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 for species currently inhabiting the cumulative study area. Development within potential habitat for special status species likely would decrease its overall suitability, and potentially would reduce or preclude use by some species due to increased activity and noise. Future use by a special status species of habitats subject to development would be strongly influenced by the quality and composition of remaining habitat, with the degree of impact dependent on variables such as breeding phenology, nest and den site preferences, the species' relative sensitivity to disturbance, and possibly the presence of visual barriers (e.g., topographic shielding) between nesting efforts and disturbance activities.

Bird species that have been identified as occurring within the PRB and are on two or more of the special status species lists include common loon, American bittern, white-faced ibis, trumpeter swan, Greater sandhill crane, mountain plover, upland sandpiper, long-billed curlew, black tern, yellow-billed cuckoo, Lewis' woodpecker, pygmy nuthatch, sage thrasher, loggerhead shrike, Baird's sparrow, sage sparrow, Brewers sparrow, and Greater sage-grouse. Any development activities (oil and gas, coal mining, other operations and associated infrastructure) that occur during the breeding season (April 1 through July 31) could result in the abandonment of a nest site or territory, or the loss of eggs or young. As discussed previously, loss of an active nest site, incubating adults, eggs, or young as a result of any of these development activities would not comply with the intent of the Migratory Bird Treaty Act and could potentially impact populations of important migratory bird species that are known to or may occur in the PRB.

A number of raptor species have been documented in the PRB and are on two or more of the special status species lists including bald eagle, ferruginous hawk, northern goshawk, merlin, peregrine falcon, western burrowing owl, and short-eared owl. Those species that have been documented in the general Wright analysis area are discussed at length in Appendices G and H of this

EIS. Potential direct impacts to raptors would result from the surface disturbance of nesting and foraging habitat, as well as injury or mortalities due to collisions with vehicles and equipment. Breeding raptors in or adjacent to development activities could abandon their nest sites or territories, or lose eggs or young. As previously described, such losses would constitute non-compliance with the intent of several laws including the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act, and could potentially affect populations of important migratory bird species that are known to or may occur within the region. Incremental construction of new overhead power lines in the area to support energy industries would increase risks of electrocution and collision for perching, migrating, and foraging bird species such as the larger raptors. Use of current APLIC guidelines for construction designs and retrofitting measures for new and existing utility structures would help mitigate these impacts.

The USFWS announced on March 5, 2010 its decision to classify the Greater sage-grouse as a candidate species under the Endangered Species Act. Candidate species receive no statutory protection under the ESA, but the USFWS encourages voluntary cooperative conservation efforts for these species because they are, by definition, species that warrant future protection under the ESA (USFWS 2010). A total of 239 sage-grouse strutting grounds (leks) were identified in the six sub-watersheds in the cumulative study area as of 2003, though that study did not evaluate the status (i.e., active or inactive) of those leks. As discussed in Section 3.10.5 and in the PRB Coal Review Task 1D Report, the trend in the sage-grouse population for the Sheridan Region suggests about a 10-year cycle with periodic highs and lows. More recent population peaks have been lower than previous highs, suggesting a steadily declining sage-grouse population with the Sheridan Region (Oedekoven 2001). Direct and indirect impacts to sage-grouse as a result of development activities would result from the incremental surface disturbance of existing and potential habitat, increased levels of noise and human presence, introduction or dispersal of noxious and invasive weed species, and effects of dust from increased traffic on unpaved roads. In addition to disturbance-related impacts, sage-grouse are susceptible to infection with West Nile Virus, and the incidence of infection is much higher in northeastern Wyoming than the rest of the state.

As discussed in Section 3.10.5.1, ten sage-grouse leks have been documented within the six combined general analysis areas for the six LBA tracts analyzed in this EIS. Four of the leks have been active during recent survey years and are classified as occupied (Hansen Lakes, Payne, and Kort I and Kort II leks; Kort leks likely represent a shift in lekking activity rather than two distinct leks). Two of the leks have not been attended by displaying grouse for at least the last 10 years and are classified as unoccupied/abandoned (Butch and Wilson leks). There is insufficient data on two leks, therefore they have been classified as undetermined (Stuart I and Stuart II). Two leks have been eclipsed by mining activities at the adjacent Black Thunder and North Antelope Rochelle mines (Black Thunder and Rochelle leks, respectively).

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The occupied leks, Hansen Lakes and Payne, are within the BLM study areas for the North Hilight Field and North Porcupine LBA Tracts, respectively, and are therefore likely to be directly impacted if these two tracts are leased and mined under the Proposed Action and/or Alternative 2, BLM's preferred alternative. The 3-mile radii of concern for the two other occupied leks (Kort I and Kort II leks, which are likely only one strutting ground that has been relocated slightly), overlap the North Porcupine LBA Tract. If the North Porcupine LBA Tracts as applied for and/or the additional areas evaluated by BLM under Alternative 2, the BLM's preferred alternative, is leased and mined, potential nesting habitat for grouse that were bred at the Kort I and II leks would likely be affected by mining activity in those areas.

Stuart II, one of the two undetermined leks, is within the West Hilight Field LBA Tract as applied for, and the 3-mile radii of both undetermined leks (Stuart I and Stuart II) overlap both the West Hilight Field and West Jacobs Ranch LBA Tracts as applied for. The 3-mile radius is the area in which two-thirds of the hens that were bred at those leks would be expected to nest. As previously discussed, the Stuart I and Stuart II leks are classified undetermined, but they are likely unoccupied/abandoned and will probably not be re-occupied in the near future due to the presence of nearby CBNG development activities and facilities. Therefore, if the West Hilight Field and West Jacobs Ranch LBA Tracts as applied for and the additional areas evaluated by BLM under Alternative 2 are leased and mined, it is unlikely that those two undetermined leks would be affected. However, as also previously discussed, no sage-grouse nests or broods have been recorded on any of the six LBA tracts as applied for or on lands added under Alternative 2, BLM's preferred alternative for each tract, during specific surveys or incidental to other wildlife surveys conducted in those areas annually since at least 1994. The noise associated with mining operations may disrupt sage-grouse breeding and nesting activities that might occur in those areas. Direct and indirect effects to Greater sage-grouse within the general Wright analysis area as a result of development activities are outlined in Appendix H.

Based on existing information, the spatial relationship between projected future disturbance and reclamation areas for the coal production scenarios and the resource-specific information in the Geographic Information Systems (GIS) layers could not be determined for the PRB Coal Review. However, the analysis did use GIS layers for future coal reserves to provide some quantification of potential future coal mining-related impacts to Greater sage-grouse. The results of this analysis are summarized in Table 4-26. The difference in the number of lek sites that would occur within 2 miles of coal mining activities under the lower coal production scenario versus the upper coal production scenario is due to slight variations in the projected disturbance areas. An unquantifiable number of lek sites initially could be impacted by CBNG activity, which would occur in advance of coal mine development. Potential direct impacts to sage-grouse, if present, could include loss of foraging areas, abandonment of a lek site, or loss of eggs or young as a result of development activities.

Table 4-26. Potential Cumulative Impacts to Greater Sage-grouse Leaks from Coal Mine Development - Upper and Lower Coal Production Scenarios.

<b>Lek Categories</b>	<b>2010/ Lower</b>	<b>2010/ Upper</b>	<b>2015/ Lower</b>	<b>2015/ Upper</b>	<b>2020/ Lower</b>	<b>2020/ Upper</b>
Number of Directly Affected Leaks	3	3	4	4	1	4
Number of Leaks within 2 Miles of Coal Mining Activity	30	30	31	35	28	27

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

Seven special status fish species potentially occur in the cumulative study area sub-watersheds: the flathead chub (*Platygobio gracilis*) (Antelope Creek, Upper Cheyenne River, and Little Powder River sub-watersheds), plains topminnow (*Fundulus sciadicus*) (Upper Cheyenne River), goldeye (*Hiodon alosoides*) (Little Powder River), lake chub (*Couesius plumbeus*) (Little Powder River), mountain sucker (*Catostomus platyrhynchus*) (Little Powder River), silvery minnow (*Hybognathus argyritis*) (Little Powder River), and plains minnow (Upper Cheyenne River, Upper Belle Fourche River, and Little Powder River). Potential impacts to special status fish species as a result of development activities would be similar to effects discussed above for fisheries. Surface disturbance in three sub-watersheds (Upper Cheyenne River, Upper Belle Fourche River, Little Powder River) could alter habitat or affect water quality conditions for special status fish species. Erosion control measures, as required by existing (2003) and future permits, and National Pollution Discharge Elimination System (NPDES) permit requirements would be implemented for each project. These efforts would help decrease disturbance-related sediment input into stream segments that may contain one or more of the special status fish species. Therefore, it is anticipated that impacts to special status fish species would be low.

#### 4.2.10 Land Use and Recreation

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to land use and recreation as a result of projected development activities in the PRB Coal Review Task 3 study area (Figure 4-4). The area of actual surface coal mining disturbance and reclamation for the years 2003 and 2007, and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual disturbance and reclamation for all development in 2003 and 2007, and the projected cumulative total areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

The PRB is a predominantly rural, wide open landscape. With little rainfall and limited alternative sources of water, the primary land use is grazing. Nevertheless, there is a range of other land uses. The major categories include agriculture, forested, mixed rangeland, urban, water, wetlands, coal mines,

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and barren land. The relative amounts of these lands in the PRB Coal Review Task 1 and Task 2 study area (Figure 4-1) is tabulated in Table 4-27.

Table 4-27. Land Use by Surface Ownership.

Use Category	Surface Ownership (acres)				Total	
	BLM	USFS	State	Private	Acres	Percent
Agriculture	2,627	14,197	13,770	472,811	503,405	6.3
Barren	165	205	187	9,396	9,953	0.1
Forested	137,555	14,604	48,645	332,062	532,866	6.7
Mixed Rangeland	732,014	218,156	561,363	5,271,644	6,783,177	86.0
Urban	893	17	1,039	25,469	27,418	0.3
Water	35	73	334	4,773	5,215	<0.1
Wetlands	0	104	559	1,566	2,229	<0.1
Coal Mines	149	7,236	2,805	40,917	51,107	0.6
<b>Total</b>	<b>873,438</b>	<b>254,592</b>	<b>628,702</b>	<b>6,158,638</b>	<b>7,915,370</b>	<b>100.0</b>

Source: PRB Coal Review Task 1D Report (BLM 2005d)

A large part of the PRB consists of split estate lands (privately owned surface lands underlain by federally owned minerals). This results in conflicts between surface users, which are mainly ranching interests, and mineral developers. There also may be conflicts with some dispersed rural residences, although specific locations cannot be identified until development is proposed.

Much of the study area is also used for dispersed recreational activities such as hunting. The study area includes surface lands that are federally, state, and privately owned. With nearly 80 percent of the area privately owned, public lands provide important open space and recreation resources including both developed recreation facilities and areas to pursue dispersed recreation activities. The private sector contributes the elements of commercial recreation opportunities and tourism services such as motels and restaurants. Some private land owners also allow hunting with specific permission, sometimes for a fee.

##### 4.2.10.1 Grazing and Agriculture

Potential impacts to grazing in the cumulative study area as a result of development 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 AUMs;
- temporary loss of water-related range improvements, such as improved springs, water pipelines, and stock ponds;
- temporary loss of other range improvements, such as fences and cattle guards; and

- restricted movement of livestock within an allotment due to the development and operation of projects like surface coal mines, which would cease after successful reclamation had been achieved and replacement of water-related and other range improvements had been completed.

The discharge of produced water could increase the availability of water to livestock, which may offset the temporary loss of water-related range improvements. Potential long-term impacts consist of permanent loss of forage and forage productivity in areas, such as power plants, that would not be reclaimed in the near term. Indirect impacts may include dispersal of noxious and invasive weed species within and beyond the surface disturbance boundaries, which decreases the amount of desirable forage available for livestock grazing in the long term.

Development 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 the projects. Long-term impacts would result from the permanent loss of agricultural land due the development of permanent facilities such as power plants and railroads.

Table 4-28 contains an estimate of the number of AUMs unavailable on lands disturbed and not yet reclaimed through 2020 for the high and low levels of predicted development activity, along with the acreage of cropland estimated to be affected.

Table 4-28. AUMs and Acres of Cropland Estimated Unavailable on Lands Disturbed and Not Yet Reclaimed as a Result of Development Activities.

<b>Category</b>	<b>2003/ Baseline</b>	<b>2007/ Actual</b>	<b>2010/ Lower</b>	<b>2010/ Upper</b>	<b>2015/ Lower</b>	<b>2015/ Upper</b>	<b>2020/ Lower</b>	<b>2020/ Upper</b>
Unavailable AUMs <sup>1</sup>	18,150	22,108	19,820	20,145	22,389	22,905	22,131	22,950
Unavailable Crop Land (acres)	48	--- <sup>2</sup>	59	60	134	139	206	289

<sup>1</sup> Based on an average stocking rate of 6 acres per AUM.

<sup>2</sup> Not reported.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

#### 4.2.10.2 Urban Use

It is expected that there would be additional expansion of urban residential and commercial development as a result of the projected 48 percent growth in population (between 2003 and 2020) in Campbell County. Section 4.2.12 and the Task 3C Report of the PRB Coal Review (BLM 2005f) contain 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, primarily Gillette, which accounts for approximately 60

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percent of the Campbell County population and, to a lesser extent, Wright and other small communities. Most of this development would occur on land that is currently in use for grazing or agriculture.

##### 4.2.10.3 Recreation

Accessible public lands provide diverse opportunities for recreation, including hunting, fishing, off road vehicle (ORV) use, sightseeing, and wildlife observation. The National System of Public Lands generally provides dispersed recreational uses in the study area. Some developed recreational facilities occur in special management areas, including recreation areas. While opportunities are available on public lands throughout the PRB, the majority of dispersed recreational uses occur in the western part of the PRB Coal Review Task 1 and Task 2 study area, including the south Big Horn Mountains area and along the Powder River. Public lands elsewhere consist mainly of isolated tracts of land that are too small to provide a quality recreational experience. Larger parcels of public lands occur in the southwest part of Johnson County and along the Powder River (administered by BLM) and in the Thunder Basin National Grassland (administered by the USFS). Public lands are accessible via public roads or across private land with the landowner's permission.

Hunting is a major recreation use of state and federal lands in the study area. Various big game and upland game bird species are hunted in the region. Fishing is a popular year-round activity for residents of the study area.

Mule deer and pronghorn hunting are by far the most popular hunting activities in the Task 1 study area, accounting for 35,529 and 21,304 hunter days, respectively, in 2003 (Stratham 2005). The next highest were cottontail rabbit (2,348 hunter days) and elk (2,055 hunter days), followed by wild turkey (1,019), sharp-tailed grouse (508), and sage-grouse (38). Consistent trends in hunter activity over the past decade are not discernible from the WGFD data considered in the PRB Coal Review. All of the most prominent species hunted in the study area have had high years and low years. Pronghorn hunting, for example, was greatest from 1993 to 1996, while elk hunting was at its peak in 2001 and 2002. Mule deer hunting has been the most consistent, ranging from a low of 28,311 hunter days in 1996 to a high of 37,307 hunter days in 2002.

ORV use in the Task 1 study area is available on most BLM-managed lands. Most of the public land in Johnson, Sheridan, and Campbell counties has been inventoried and designated as open, limited, or closed to ORV use. For the baseline year, approximately 20,386 acres were open to unlimited vehicle travel on and off roads. There were 4,680 acres in the area that were closed to all ORV use and approximately 867,534 acres were available for limited use. Limited use typically means ORVs are restricted to existing roads and vehicle routes.

Recreational use of public lands in the Task 1 study area has increased substantially over the past two decades, and is expected to continue to increase

by about five percent every 5 years for most recreational activities (BLM 2003). Total visitor use by residents and nonresident visitors in Campbell and Converse counties in 1980 was projected at 1,276,000 visitor days (BLM 1979). The total visitor days of 1,881,763 estimated for 1990 was approximately 47 percent higher than the 1980 visitor days (BLM 2001a). Fewer than three percent of visitor days were estimated to occur on public lands.

Few, if any, of the developed recreation sites in the PRB Coal Review Task 3 study area would be affected by development related disturbance. 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 cumulative development activities, especially the dispersed development of 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 (Shorma 2005). 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 five percent increase in use every 5 years (BLM 2001a). After coal- and oil and gas-related development activities have been completed and the disturbed areas have been reclaimed, many of the adverse effects on dispersed recreation activities would be reduced.

It is expected that the development 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 (BLM 2005d), reductions in land available for hunting also make herd management more difficult for the WGFD and reduce its hunting-derived revenues (Shorma 2005).

No direct effects on wilderness or roadless areas would be expected from the projected development activities. 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.

There would be no effects on Wild and Scenic Rivers as the only river segment identified as both “eligible” and “suitable” in the Task 1D Report of the PRB Coal Review is not in the cumulative study area.

#### 4.2.11 Cultural Resources and Native American Concerns

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to cultural resources as a result of projected development activities in the cumulative study area. The area of actual surface coal mining disturbance and reclamation for the years 2003 and 2007, and the projected

#### 4.0 Cumulative Environmental Consequences

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cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual disturbance and reclamation for all development in 2003 and 2007, and the projected cumulative total areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

Cultural sites occur throughout the cumulative study area. Surface disturbing activities can result in the loss or destruction of these sites. Table 4-29 contains an estimate of the amount of projected disturbance through 2020 for the projected lower and upper levels of coal development activity, along with the number of cultural sites estimated to be affected. The sites fall into two categories; prehistoric sites and historic sites, as described below. Also below are description of Native American traditional cultural places and a summary of the program to protect sites in any of these categories.

##### 4.2.11.1 Prehistoric Sites

All recognized prehistoric cultural periods, from Clovis through Protohistoric (about 11,500 to 200 years ago), are represented in the cumulative study area (see Section 3.12 for additional discussion about the prehistoric cultural periods.) The earliest prehistoric cultural periods, Paleoindian through Early Plains Archaic, are represented by only a small number of sites. Archaic and later prehistoric period sites (Archaic to Protohistoric) are represented in increasing numbers as a result of higher populations through time and better preservation of more recent sites. Important prehistoric site types in the region include artifact scatters, campsites, stone circles, faunal kill and processing sites, rock alignments and cairns, and stone material procurement areas.

Artifact scatters dominate prehistoric sites in the study area. When there is adequate information to evaluate these types of sites, most are not eligible to the NRHP. However, complex sites and sites with buried and dateable material can yield important information and are often field evaluated as eligible. The proportion of unevaluated sites is lower in the subwatersheds in which more studies and more follow-up studies have been conducted, such as Antelope Creek, Upper Cheyenne River, and Upper Belle Fourche River. Some portions of some of the subwatersheds which have more varied habitats or conditions more conducive to preservation are very rich in significant prehistoric sites. Within the cumulative study area, these areas include the lower Antelope Creek drainage and eastern portions of the Upper Belle Fourche River. While prehistoric sites do exist in the general Wright analysis area, it does not appear to be particularly plentiful in significant prehistoric sites. More detailed information on the known cultural sites that are present in the PRB based on the existing surveys is included in the Task 1D Report for the PRB Coal Review (BLM 2005d).

Table 4-29. Square Miles of Projected Cumulative Disturbance and Number of Potentially Affected Cultural Resource Sites in the PRB Coal Review Task 3 Study Area – Lower and Upper Coal Production Scenarios.

Sub-watershed	Average Number of Sites per Square Mile <sup>1</sup>	Lower Coal Production Scenario						Upper Coal Production Scenario					
		Year 2010		Year 2015		Year 2020		Year 2010		Year 2015		Year 2020	
		Square Miles <sup>2</sup>	Sites <sup>3</sup>	Square Miles <sup>2</sup>	Sites <sup>3</sup>	Square Miles <sup>2</sup>	Sites <sup>3</sup>	Square Miles <sup>2</sup>	Sites <sup>3</sup>	Square Miles <sup>2</sup>	Sites <sup>3</sup>	Square Miles <sup>2</sup>	Sites <sup>3</sup>
Antelope Creek	4.7	59	277	76	357	94	442	61	287	79	371	98	461
Dry Fork Cheyenne River	8.9	2.2	20	2.7	24	3.1	28	2.2	20	2.7	24	3.1	28
Little Powder River	4.6	76	350	85	391	89	409	77	354	86	396	91	419
Upper Belle Fourche River	4.3	135	580	148	636	156	671	137	589	154	662	166	714
Upper Cheyenne River	5.2	57	296	66	343	76	395	58	302	68	354	78	406
Upper Powder River	5.0	160	530	175	875	242	1,210	106	530	175	875	242	1,210
<b>Total</b>		<b>435</b>	<b>2,053</b>	<b>553</b>	<b>2,626</b>	<b>660</b>	<b>3,155</b>	<b>441</b>	<b>2,082</b>	<b>565</b>	<b>2,682</b>	<b>678</b>	<b>3,283</b>

<sup>1</sup> Average number of sites per square mile based on previous surveys in the study area.

<sup>2</sup> Calculated, based on database disturbance acreages prepared for the Task 2 Report for the PRB Coal Review, Past and Present and Reasonably Foreseeable Development Activities (Appendices A and D) (BLM 2009b).

<sup>3</sup> The number of sites was calculated by multiplying the average density of known cultural sites per square mile (based on previous surveys) by the number of square miles of projected cumulative disturbance.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

## 4.0 Cumulative Environmental Consequences

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### 4.2.11.2 Historic Sites

In the PRB region, sites are documented within the broad contexts of Rural Settlement, Urban Settlement, Mining, Transportation, Military, Exploration, and Communication. Each of these site categories and the types of sites they include are detailed in the Task 1D Report for the PRB Coal Review (BLM 2005d). Evaluation of the importance of historic sites, districts, and landscapes must consider aspects of both theme and period in assessing the historic character and contributing attributes of the resources.

### 4.2.11.3 Native American Traditional Cultural Places

General ethnographies of the tribes that may have had traditional ties to this region do not provide information on specific resources in the study area that are likely to be traditional cultural concerns because these resources are considered confidential by the tribes. Within this region, there are prominent and identifiable places such as the Medicine Wheel to the west in the Bighorn Mountains and Devils Tower to the east in the Black Hills area. These known sites offer some indication of the types of places valued by the Plains Indian horse cultures in the historic period. Any identification of sacred or traditional localities must be verified in consultation with authorized tribal representatives.

### 4.2.11.4 Site Protection

At the time an individual project is permitted, the development activities considered in this study would be subject to the following regulations relative to cultural resources. Section 106 of the National Historic Preservation Act of 1966 as amended, its implementing regulations (including but not limited to 36 CFR 800, 36 CFR 61, and Executive Order 11593), and NEPA and its implementing regulations, including 40 CFR 1500 - 1508, provide the legal environment for documentation, evaluation, and protection of historic properties (i.e., cultural resources eligible for inclusion on the National Register of Historic Places) that may be affected by development activities. In cases of split estate (where surface ownership and mineral ownership differ), surface resources, such as cultural sites, belong to the surface owner. The surface owner must be consulted about investigation, mitigation, or monitoring.

## 4.2.12 Transportation and Utilities

The PRB Coal Review Task 3D Report (BLM 2009f) discusses potential cumulative impacts to transportation and utilities systems as a result of projected development activities in the cumulative study area. The area of actual surface coal mining disturbance and reclamation for the years 2003 and 2007, and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Tables 4-2 and 4-3. The area of actual disturbance and reclamation for all development in 2003 and 2007, and the

projected cumulative total areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in Table 4-10.

Generally, transportation systems in the cumulative study area would not be directly affected by the disturbance associated with projected development. 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. In such cases, the agencies authorized to regulate such actions would have to approve any proposal to move any segments of any transportation systems and construction of alternative routing would be required prior to closing existing links so that any disruptive effects on transportation systems would be minimized.

The coal mines in the North Gillette subregion currently ship most of their coal via the east-west BNSF rail line through Gillette. That subregion produced 55 mmtpy in the baseline year (2003), which was just 22 percent of the estimated 250 mmtpy capacity of the BNSF rail line (BLM 2005a). The coal mines in the South Gillette and Wright subregions produced approximately 308 mmtpy in 2003, which was 88 percent of the estimated 350 mmtpy capacity of the joint BNSF & UP line serving those areas in the baseline year.

Potential effects of development activities on transportation and utilities may be either short- or long-term in nature, varying with the type of development. 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. The effects of coal production and the related demand for rail capacity would vary with market changes. In recent years, coal production has been increasing and the PRB Coal Review projects that the trend would continue, as shown in Tables 4-2 and 4-3. 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.

Potential direct effects of projected development on roads and highways would include increased vehicular traffic and risk of traffic accidents on existing roadways in the cumulative study area from daily travel by workers and their families. Indirect effects would include increased wear and tear on existing roads, additional air emissions from vehicles, additional 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. Indirect effects would include potential impacts of the accumulation of coal dust and fines blowing or sifting from moving, loaded rail cars. A collaborative effort between the National Coal Transportation Association, the mines, and the BNSF & UP Railroads is resulting in measures to reduce coal dust emissions from loaded, moving rail cars.

#### 4.0 Cumulative Environmental Consequences

The socioeconomic analysis conducted as a part of Task 3C of the PRB Coal Review projects a population increase of approximately 48 percent between 2003 and 2020 in Campbell County under the upper coal production scenario (BLM 2005f). Campbell County accounts for most of the population in the PRB Coal Review Task 3 study area. Based on traffic studies conducted independently of the PRB Coal Review, vehicle miles traveled tend to increase at or above the rate of population growth. Consequently, highway traffic would be expected to increase by at least 48 percent by 2020. Approximately 60 percent of the population growth would occur in or near Gillette, which would indicate that the same proportion of traffic would originate in the Gillette area. 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 Gillette area 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 Gillette would be expected to be sufficient to accommodate the growth without substantial constraints.

Existing rail lines, together with proposed upgrades on the joint BNSF & UP line, would be expected to accommodate the projected coal transportation traffic through 2015 (Table 4-30). The PRB Coal Review Task 2 Report (BLM 2009b) projects that the proposed DM&E line would be built and operational by 2015 (pending completion of additional environmental analysis), which would add 100 mmtpy in additional shipping capacity for the South Gillette and Wright subregions.

Table 4-30. PRB Rail Lines Coal Hauling Capacity and Projected Use.

Rail Line	2010 Projected			2015 Projected			2020 Projected		
	2010 Capacity	Rail Use		2015 Capacity	Rail Use		2020 Capacity	Rail Use	
	mmtpy	mmtpy	%	mmtpy	mmtpy	%	mmtpy	mmtpy	%
North BNSF	250	62-78	25-31	250	74-104	30-42	250	78-121	31-48
South BNSF & UP	450	349-398	79-88	600	381-439 <sup>2</sup>	64-73 <sup>2</sup>	600	417-455 <sup>2</sup>	70-76 <sup>2</sup>
DM&E	0	0	0	--- <sup>2</sup>	--- <sup>3</sup>	--- <sup>3</sup>	--- <sup>2</sup>	--- <sup>3</sup>	--- <sup>3</sup>

<sup>1</sup> The range of increase in use shown for each year reflects the increases that are projected for the Lower and Upper Coal Production Scenarios, respectively.

<sup>2</sup> The DM&E is assumed to be built and operational by 2015, adding 100 mmtpy of capacity for the mines served by the BNSF & UP South line.

<sup>3</sup> The BNSF & UP South line figures represent the projected combined traffic and percent capacity on the BNSF & UP South line and the projected DM&E line.

Source: PRB Coal Review Task 3D Update Report (BLM 2009f)

The Task 2 Report for the PRB Coal Review originally projected that basin-wide production of CBNG could potentially double by 2020, which would suggest that additional pipelines could be built. The recent update of the Task 2 report

(BLM 2009b) revised the projections. As noted in Section 4.1, trends in CBNG development since 2007 indicate that this estimate may be lowered as new forecasting is done. Current gas pipeline capacity out of the PRB is approximately 2.05 bcf per day; average conventional natural gas and CBNG production in 2007 was approximately 1.24 bcf per day. Based on the information in the update of the Task 2 report, potential total gas production (conventional natural gas and CBNG) has been projected at 2.06 bcf per day by 2010. This potential is pipeline capacity limited, suggesting additional pipelines could be built. There are no specific projects under way; however, two potential additional pipeline projects (Bison and Pathfinder) have been identified for potential completion in 2010 (see Section 4.1.2.3.1). These projects would increase the take-away capacity by 0.50 and 1.60 bcf, respectively, for a total of approximately 4.15 bcf per day.

By 2010, an estimated 99 megawatts (MW) of additional power would be provided by a new wind energy project. An estimated 1,380 MW of new power plant production capacity and 250 MW of new wind energy production capacity are anticipated in the cumulative study area by 2015. One new 300-MW wind energy project and potentially up to 700 MW of additional power generation provided by coal-fired power plants is projected for 2020. This level of production would require construction of additional transmission line capacity. It is assumed that new transmission lines would be constructed to connect new power plants to the grid. It is projected that these transmission lines would be constructed by 2015 to connect to outside markets. However, specific location(s), capacities, and effects on the existing system cannot be determined at this time.

#### 4.2.13 Socioeconomics

The cumulative socioeconomic impact analysis focuses on Campbell County, but also considers Converse, Crook, Johnson, Sheridan, and Weston counties as directly affected and Niobrara and Natrona counties as indirectly affected. Recent and projected socioeconomic conditions are described in more detail in the Task 1C and 3C reports for the PRB Coal Review (BLM 2005c and 2005f).

REMI Policy Insight (REMI), a professionally recognized regional economic model, was used to develop the cumulative employment and population projections presented below. The version of the REMI model for the Coal Review was comprised of two economic regions: one being Campbell County alone, the second composed of those Wyoming counties bordering Campbell County and linked to its economy by established industrial and consumer trade linkages and by work force commuting patterns. Results for the second region were analyzed to focus on the five counties, Converse, Crook, Johnson, Sheridan, and Weston, that are the most directly linked. Collectively, these five counties are referred to in the PRB Coal Review Task 3C Report (BLM 2005f) as the surrounding counties. Additional analysis was undertaken to translate the population and employment forecasts for each of the surrounding counties into housing needs and to project future school enrollment.

#### 4.0 Cumulative Environmental Consequences

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During the 1970s and early 1980s, the PRB emerged as a major coal producing region. Federal coal leasing has been a high profile activity because over 90 percent of the coal resources in the PRB are federally owned. The surface coal mines that developed during the 1970s and early 1980s are now mature operations, providing a stable economic and social foundation for the region. While energy development has produced periodic surges in population, followed occasionally by population declines in some communities, the growth in domestic energy consumption, coupled with the PRB's vast energy resource base, has resulted in a 50-year growth trend in the region without the severe economic dislocations that have characterized other western U.S. resource booms.

This period of extended energy development has been accompanied by substantial economic changes and benefits, including economic growth, employment opportunity, tax revenue growth, and infrastructure development for local governments, both locally and across Wyoming, funded by tax revenues generated by production of coal and other energy resources. At the same time, periods of rapid growth have stressed communities and their social structures, housing resources, and public infrastructure and service systems.

The emergence of the coal and other energy resource development industries in the PRB has had long-term cumulative affects on regional social and economic conditions. In general, Campbell County and the entire PRB region have developed an enhanced capacity to respond to and accommodate growth. The regional coal industry also provides a measure of insulation from dramatic economic and social dislocations. Key cumulative social and economic conditions identified in the PRB Coal Review are described below.

##### 4.2.13.1 Employment and the Economic Base

Energy resource development since 1970 has resulted in substantial economic expansion across the PRB. Total employment expanded by 163 percent as 40,674 net new jobs were added between 1970 and 2004. The most rapid expansion occurred between 1975 and 1980. After modest growth and slight decline in the 1980s and early 1990s, employment growth resumed in the late 1990s, led by increases in coal mine employment, including subcontractors, and CBNG development. Across the six-county area, total employment was 65,597 in 2004. Nearly half of the net job gain occurred in Campbell County, where total employment increased from 6,026 jobs in 1970 to 25,921 jobs in 2004. Strong gains also were posted in Sheridan County (9,821 jobs) and Converse County (4,421 jobs).

The economic stimuli associated with the gains in mining and CBNG employment and the long-term population growth triggered secondary job gains in construction, trade, services, and government. In 2004, business and consumer services accounted for 51 percent of all jobs in the region, while mining and government accounted for 14 percent and 16 percent of all jobs, respectively. Farm employment in the region, as a share of total employment,

declined from 14 percent in 1970 to 5.0 percent in 2004. However, that shift is primarily due to growth in non-farm employment rather than declines in farming, as total farm employment in the PRB recorded a net decline of only 375 jobs, from 3,571 to 3,196 (U.S. Bureau of Economic Analysis 2006).

The largest impetus to future growth over the PRB Coal Review study period (2003 to 2020) is expected to occur by 2010. Under the lower production scenario, employment in 2010 related to coal mining, oil and gas production, and oil field services is projected to increase by one-third, or more than 2,300 jobs, as compared to 2003 levels. Many of the jobs gained would be the result of increased oil and gas development. While the number of coal mining jobs would increase, the projected coal mine-related productivity gains would limit increases in the number of mine employees required for operations.

Beyond 2010, total mining industry employment would decline as major infrastructure development (e.g., additional CBNG compression capacity) is completed and the pace of conventional oil and gas drilling decreases. Increases in CBNG production and coal mining employment would occur thereafter, such that total mining employment would approach pre-2010 levels by the end of the forecast period (2020). Under the development scenarios, construction of three new power plants, having a combined capacity of 1,000 MW and a peak work force of approximately 1,550 in 2007-2008, is assumed to occur concurrently with the increases in mining employment. Under the upper production scenario, a second temporary construction work force impact would occur between 2016 and 2020 in conjunction with the construction of an additional 700-MW power plant.

The net effects of these activities, including secondary effects on suppliers, merchants, service firms, state agencies and local government in the region, would be the creation of more than 8,700 new jobs in the region between 2003 and 2010. Of those, more than 5,600 jobs (a 22 percent increase over 2003) would be based in Campbell County. The pace of economic expansion, at least in terms of jobs, would moderate after 2010. Total employment growth of 2,017 additional jobs is projected in Campbell County between 2010 and 2020, with 1,741 additional jobs projected in the surrounding counties.

However, to achieve the projected levels of energy and mineral development activity through 2010 assumes that industry has access to the necessary equipment, materials, labor, and other vital inputs. Current oil and gas exploration and development across the Rocky Mountain region has absorbed the available inventory of drilling rigs and crews. A lack of access to resources could delay or limit the job gains below the levels projected, even though prospects for such growth remain. Furthermore, competition for equipment, combined with tight labor markets, could negate the productivity gains that underlie the projections, such that the employment and associated impacts do materialize, but are associated with lower levels of activity (e.g., a lengthier construction period for a power plant or fewer new wells drilled each year).

#### 4.0 Cumulative Environmental Consequences

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Employment effects associated with the upper coal production scenario, assuming productivity gains in coal mining equivalent to those in the lower coal production scenario, would result in total employment gains of 11,563 jobs by 2010 in the six-county study area, with an additional 3,667 jobs by 2020<sup>2</sup>. As compared to the employment projections under the lower coal production scenario, those gains include 2,821 additional jobs in 2010 and 3,214 additional jobs in 2020. Most of the incremental gains would be in Campbell County, further stressing labor markets, housing, and other community resources. Such pressures could delay or affect the development plans of individual firms and operators, such that the projected employment levels would not be realized in the time frames shown. Nonetheless, substantial growth in employment is expected to occur, and even if the projected total employment levels are not realized, substantial social and economic impacts still would be anticipated.

The economic stimuli associated with the projected development also would stimulate increases in employment in other nearby counties beyond the five surrounding counties identified above. However, the potential effects in these areas are not addressed in the PRB Coal Review Task 3C Report because most of the effects would comprise indirect or induced growth that would be limited in scale relative to the size of the respective economies. Furthermore, the economic outlook for those areas is influenced by factors that are beyond the scope of this study, such as the role of the oil and gas support services industry based in Natrona County in supporting energy development in the south-central and southwestern portions of Wyoming.

##### 4.2.13.2 Labor Market Conditions

Labor market conditions in the PRB reflect a generally healthy economy, with average annual county unemployment rates between 2.1 percent (Campbell) and 3.5 percent (Weston) in 2006. Statewide and national unemployment rates for the period were 3.2 percent and 4.6 percent, respectively (U.S. Bureau of Labor Statistics 2007).

Over time, local unemployment levels and rates have reflected the influences of the large, relatively stable employment baseline associated with the region's coal mining industry and the more transitory and variable influences of natural gas development. Prior to the onset of CBNG development in 1989, unemployment in Campbell County fluctuated between 4.8 and 5.3 percent, slightly above the corresponding statewide averages. Labor demand associated with CBNG development contributed to a decline in unemployment to below 3.0 percent in the 2001. As the pace of CBNG development stabilized, labor

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<sup>2</sup> The number of jobs in the coal mining industry under the upper production scenario was estimated assuming future productivity gains comparable to those used for the lower production scenario. This approach differs from that described for the upper production scenario in the Task 2 report of the coal study, whereby a 16 percent higher production would be achieved with a 2.5 percent increase in workforce. Although that assumption reflects a continuation of historic productivity gains, it may underestimate population and employment growth and related socioeconomic effects if the production levels are achieved but productivity lags. Using the productivity gains from the lower production scenario provides a more conservative perspective on potential long-term population growth for purposes of the cumulative analysis.

demand eased and unemployment rates climbed to 3.7 percent in 2003, before again falling to current record lows.

The employment effects identified above indicate substantial pressures on local labor markets. Strong demand for labor would maintain low unemployment, creating upward pressure on wages and salaries. Those influences would stimulate substantial economic migration into Campbell County, causing impacts to population, housing demand, and other economic and social conditions. Similar influences would occur in surrounding counties, although the implications are less severe because the scale of effects would be smaller and would be distributed over multiple communities and service providers.

#### 4.2.13.3 Personal Income

A benefit associated with energy resource development, whether it is mineral mining or oil and gas development, is local wages and salaries that are among the highest in the state. Personal income registered strong gains across the region, but especially in Campbell County, during the late 1970s and early 1980s. In 1981, per capita personal income in Campbell County was \$17,520, compared to the national average of \$11,280 and the statewide average of \$12,879. Personal income growth was tempered by several years of economic stagnation during the late 1980s. Renewed economic vitality since then resulted in per capita personal income in Campbell County reaching \$33,388 in 2004. Those gains notwithstanding, per capita income among Campbell County's residents was below statewide and national norms, as well as that for Sheridan (\$35,716) County. When measured on a median household or family income basis in the 2000 census, Campbell County led statewide, national, and other counties in the PRB by considerable margins. That pattern has been maintained due to the strong economic growth in the region; in 2006 the median household income in Campbell County was \$60,800 compared to a statewide median of \$43,785 and national median of \$44,374. Median household incomes for the other five PRB counties ranged from \$40,195 to \$46,883 (U.S. Census Bureau 2006a).

In terms of total personal income, Campbell County led the six-county region with \$1.22 billion in 2004. Sheridan County residents recorded aggregate personal income of \$972 million in 2004. Total personal income in the other counties was substantially lower, ranging from \$193 million in Crook County to \$389 million in Converse County.

Personal incomes in the region would increase over the time period 2007-2020, both in aggregate and on a per capita basis, in conjunction with the economic outlooks foreshadowed by the projected development scenarios. In 2004, total personal income in the six-county area was \$3.24 billion. Under the lower production scenario, total personal income would more than double to \$7.57 billion in 2020 (in nominal dollars). The upper production scenario would generate an additional \$266 million per year in Campbell County and an additional \$35 to \$40 million per year in the surrounding counties by 2020.

#### 4.0 Cumulative Environmental Consequences

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Annual per capita incomes are projected to increase by approximately 27 percent (in real terms) across the region between 2003 and 2020. Households with one or more workers employed directly in the energy industry, associated service firms, and the construction industry likely would realize larger shares of the gains (BLM 2005f).

##### 4.2.13.4 Population and Demographics

Population change over time is perhaps the single best indicator of cumulative social and economic change in the PRB. Campbell County was not among the original 13 counties when Wyoming was admitted to statehood, but was carved from Weston and Crook counties in 1911. Campbell County's 1920 population of 5,233 ranked it seventeenth among Wyoming's counties. Forty years later and prior to the onset of coal development in the region, Campbell County ranked eighteenth among Wyoming's counties in terms of population, with a 5,861 residents. Neighboring Converse, Sheridan, and Weston counties all had larger populations.

By 1980, Campbell County's population had increased by more than 300 percent, to 24,367, seventh among Wyoming's counties. Energy development contributed to population growth in Sheridan, Converse, Johnson, and Crook counties during that period. Weston County recorded a population decline during the period; however, the combined population of the PRB climbed from 49,311 in 1960 to 82,598 in 1980.

Annual coal production in the PRB has increased by nearly 560 percent since 1980, accompanied by expanded mine service and rail transportation capacity, stimulating further growth. The impetus for growth in local employment was tempered by substantial productivity increases in the mining industry, coupled with declining production of other energy resources. Consequently, the region's population gained a relatively modest 11 percent, 9,318 residents, between 1980 and 2000, reaching 91,916. Campbell County registered a net gain of 9,331 residents during that period, raising its total population to 33,698 in 2000, fourth highest in the state. Across the PRB, the loss of about 2,000 residents in Converse County was offset by modest gains in the other four counties (U.S. Census Bureau 2001).

More recently, the PRB has seen renewed population growth, primarily linked to CBNG development. Population estimates for 2006 indicate a total regional population of 100,504, a 9.3 percent increase over the 2000 census population. Gains were reported for all six counties, ranging from 118 persons in Weston County to 5,236 persons in Campbell County (Table 4-31).

The magnitude and timing of projected employment changes from 2003-2020 under either coal production scenario would trigger corresponding effects to population across the PRB, particularly in Campbell County (Figure 4-10).

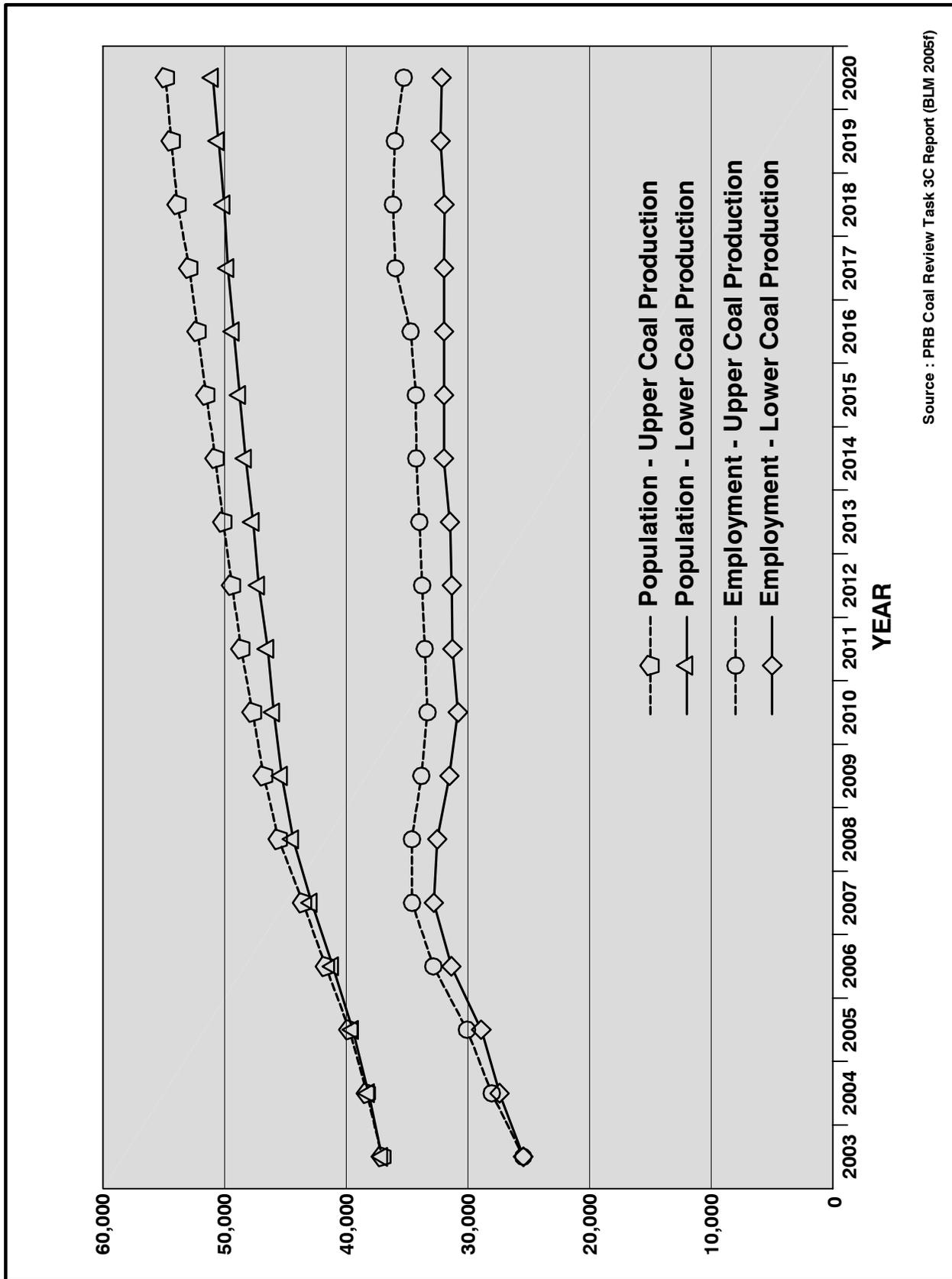
Table 4-31. Recent and Projected PRB Population.

<b>Year</b>	<b>Campbell County</b>	<b>Converse County</b>	<b>Crook County</b>	<b>Johnson County</b>	<b>Sheridan County</b>	<b>Weston County</b>	<b>Six County PRB Total</b>
<b>Census</b>							
<b>2000</b>	33,698	12,104	5,895	7,108	26,606	6,642	92,053
<b>2003</b>	36,381	12,326	5,971	7,530	27,116	6,665	95,989
<b>2006</b>	38,934	12,866	6,255	8,014	27,673	6,762	100,504
<b>Lower Coal Production Scenario</b>							
<b>2010</b>	45,925	13,103	6,542	8,389	28,459	7,108	109,526
<b>2015</b>	48,905	13,671	6,759	8,867	30,016	7,174	115,392
<b>2020</b>	50,995	14,193	6,989	9,326	31,467	7,208	120,178
<b>Upper Coal Production Scenario</b>							
<b>2010</b>	47,662	13,160	6,570	8,424	28,579	7,137	111,532
<b>2015</b>	51,558	13,763	6,802	8,924	30,214	7,219	118,480
<b>2020</b>	54,943	14,313	7,045	9,403	31,733	7,266	124,703
Source: U.S. Census Bureau (2006a) and PRB Coal Review Task 3C Report							

Under the lower coal production scenario, Campbell County's population is projected to increase by more than 14,550 residents between 2003 and 2020, nearly 9,500 of which are anticipated by 2010. Growth over the next 3 years will maintain pressures on housing and other community resources. The projected energy and mineral development in the lower coal production scenario would also result in substantial population growth elsewhere in the PRB, with Sheridan, Johnson, and Converse counties all projected to gain substantial population. Population growth, like employment growth, would moderate after 2010. Projected population growth between 2003 and 2020 ranges from 0.5 percent compounded annual growth rate (CAGR) in Weston County to 2.0 percent CAGR in Campbell County. In absolute terms, the net change ranges from 537 additional residents in Weston County to a gain of 14,557 residents in Campbell County. The total population of the six-county study area is projected to climb to 120,178 in 2020, a 1.3 percent CAGR.

As with employment, changing development conditions could result in actual population growth varying from projected growth. If project schedules or levels of development vary from the projected levels, corresponding effects on population growth could result (e.g., lower growth). Population demographics could also change due to migration and commuting, with more immigrating construction workers being single-status, rather than accompanied by families. Another possibility is that the spatial distribution of population growth could shift as a result of housing or labor constraints, such that less growth would occur in Gillette and Campbell County, and more growth would occur elsewhere.

Projected population growth through 2020 under the upper coal production scenario is approximately 19 percent higher than under the lower coal production scenario (28,625 compared to 24,100, with the six-county population reaching 124,703 by 2020). Much of the incremental population



Source : PRB Coal Review Task 3C Report (BLM 2005f)

Figure 4-10. Projected Campbell County Population and Employment to 2020.

growth would occur by 2010 in Campbell County, and in particular in and near Gillette.

Community population growth under the upper coal production scenario generally would mirror growth under the lower coal production scenario but with higher growth in Wright, Douglas, and Newcastle due to the effects of higher coal production, coal transportation, and power generation concentrated in the southern portion of Campbell County.

4.2.13.5 Housing

While the population grew by 55 percent in the 1970s, the housing stock in the study area grew by almost 78 percent. Housing growth was especially rapid during the 1970s in Campbell County, where population grew by 88 percent and the housing stock grew by 140 percent. The expansion in housing supply, combined with the slowdown in the rate of population growth, produced double-digit vacancy rates for rental housing in the late 1980s and early 1990s. After growth resumed in the mid-1990s, most county-level vacancy rates for ownership units were at or below the state levels in 2000. Vacancy rates for rental units declined even more sharply. Vacancy rates have fallen even more as a result of recent growth, with current rates below 1.5 percent in five of the six-county study area, and that in Johnson County at only 2.8 percent (Table 4-32).

Table 4-32. Rental Housing Vacancy Rates, 2004 4Q and 2006 4Q.

Year	Campbell County	Converse County	Crook County	Johnson County	Sheridan County	Weston County	Wyoming
2004 4Q	2.8%	8.3%	10.4%	2.1%	4.5%	5.0%	4.8%
2006 4Q	0.4%	1.4%	1.0%	2.8%	0.5%	0.0%	2.4%

Source: Wyoming Housing Database Partnership (2007)

In 2000, the housing inventory in the six-county study area was 41,203 units (Table 4-33). Total housing inventory had expanded to 43,363 units in 2005, a net addition of 2,160 since 2000. However, new construction hasn't kept pace with population growth, resulting in tighter market conditions in terms of availability, and higher prices.

Table 4-33. Total Housing Stock in 2000 and 2005.

Year	Campbell County	Converse County	Crook County	Johnson County	Sheridan County	Weston County	Six-county PRB Region
2000	13,288	5,669	2,935	3,503	12,577	3,231	41,203
2005	14,085	5,852	3,132	3,694	13,283	3,317	43,363
Change	797	183	197	191	706	86	2,160

Source: U.S. Census Bureau (2006b)

In 2005, the average sales price of homes in the study area varied from \$80,303 in Weston County to \$186,095 in Sheridan County. The average home price statewide in 2006 was \$178,183 (Wyoming Housing Database Partnership 2007). In addition to Sheridan County, Campbell (\$185,874) and

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Johnson (\$180,209) counties also had average home sale prices above the statewide average in 2006. The average sales price in Converse County was \$149,096, 17 percent below the statewide average.

Monthly costs for rental housing in the PRB, measured in the fourth quarter of 2006, were highest in Campbell County (Table 4-34).

Table 4-34. Monthly Housing Rents in 2006<sup>1</sup> in the PRB Study Area and Percent Change from 2004.

County	Apartments		Mobile Home Lots		Houses		Mobile Homes on a Lot	
	Rent	Change	Rent	Change	Rent	Change	Rent	Change
Campbell	\$697	25.8%	\$283	22.0%	\$975	23.0%	\$758	20.5%
Converse	\$515	31.4%	\$152	1.3%	\$545	2.8%	\$452	22.5%
Crook	\$391	17.4%	\$125	5.9%	NA	NA	NA	NA
Johnson	\$477	-5.4%	\$170	16.4%	\$700	15.3%	\$518	5.5%
Sheridan	\$571	14.0%	\$285	4.4%	\$857	27.9%	\$650	26.7%
Weston	\$459	47.1%	\$119	17.8%	\$567	36.3%	\$505	27.5%
Wyoming	\$567	14.1%	\$225	15.4%	\$782	13.0%	\$561	15.2%

<sup>1</sup> Data are for the fourth quarter of 2006. Change is the percent change since fourth quarter of 2004.

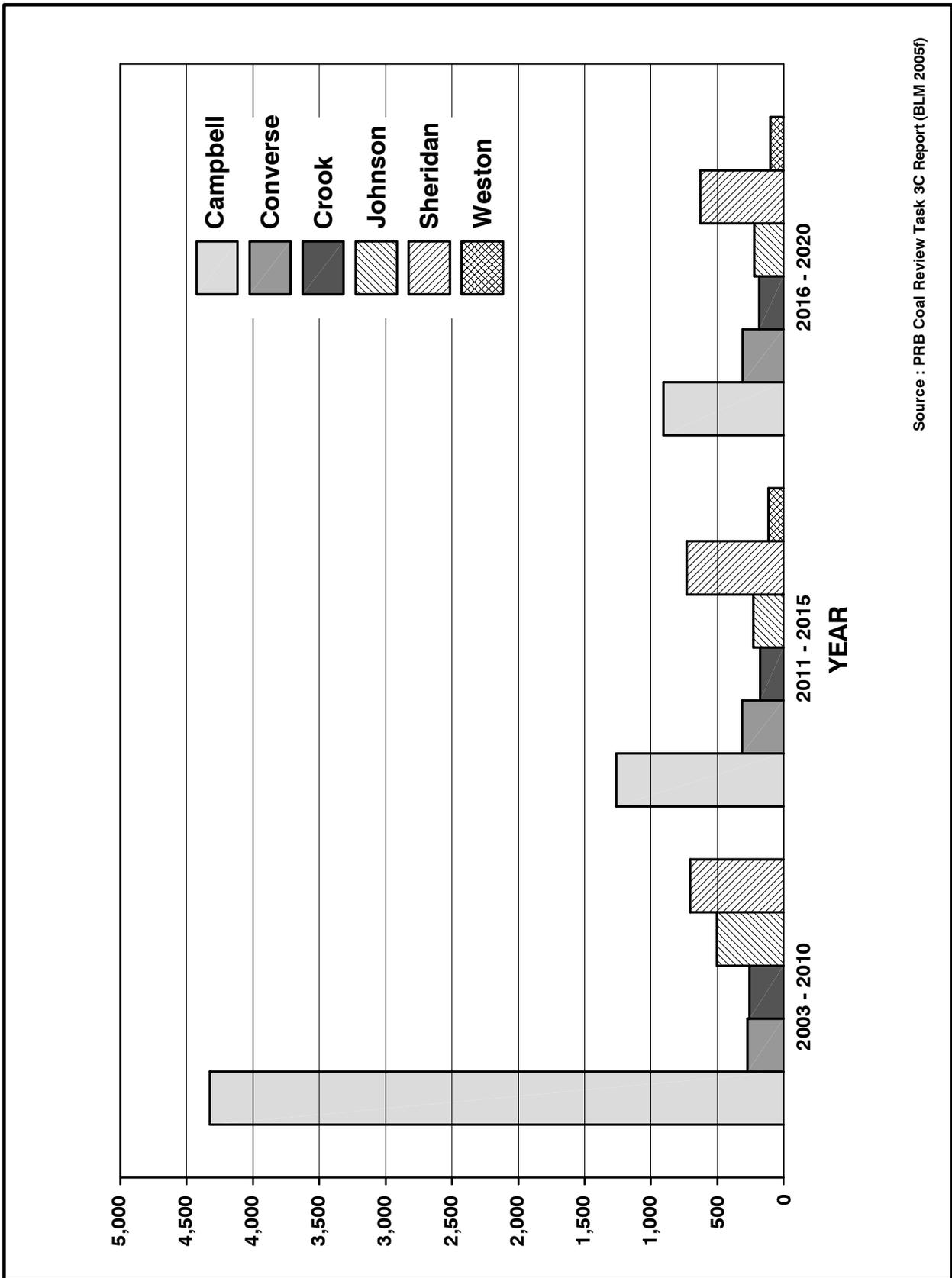
NA = information not available due to insufficient sample size.

Source: Wyoming Department of Administration and Information (2006)

Temporary housing resources are available in the PRB in the form of hotel-motel rooms, private and public campgrounds, and vacant spaces in mobile home parks. In all, there are more than 70 lodging establishments with a total of more than 2,500 rooms. These temporary housing resources, supplemented by whatever apartments, townhouses, and mobile home spaces are available in Gillette, Wright and Douglas, have accommodated temporary housing needs associated with natural resource and energy projects in the past.

Both projected coal production scenarios indicate a strong demand for housing across the six-county study area through 2020. Net housing requirements under the lower coal production scenario are for approximately 9,110 units through 2020, a 21 percent increase above the 2006 existing inventory (Figure 4-11). New housing requirements under the upper coal production scenario are estimated at 10,900 units, a 25 percent increase compared to the 2006 inventory and 1,790 units more than for the lower coal production scenario. Approximately 60 percent of the overall demand for new housing through 2010 would be in Campbell County.

A substantial portion of the near-term housing demand in Campbell County would be associated with the assumed concurrent construction of three power plants. If that occurs, one or more project sponsors may be required by the Wyoming Industrial Siting Administration to pro-actively provide housing (e.g., a construction camp for single-status workers). Such actions could temper the needs for more housing; however, the remaining needs would nonetheless be



Source : PRB Coal Review Task 3C Report (BLM 2005f)

Figure 4-11. Projected Housing Demand in the PRB Study Area Under the Lower Coal Production Scenario.

#### 4.0 Cumulative Environmental Consequences

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substantial, straining public and private sector residential development capacity.

Although smaller in scale than those in Campbell County, housing demands in the surrounding counties may also strain the capabilities of the residential construction sector to respond. Furthermore, residential contractors would be competing for available labor, contributing to the population growth and housing demand, and fueling increases in construction costs and housing prices.

The relative scale of the housing needs can be evaluated in comparison to past growth in the study area. One benchmark for comparison is the rapid growth that occurred in the PRB in the 1970s. During that decade, the number of housing units in the six-county study area rose by approximately 14,900 units, approximately 1,500 units per year on average compared to the 850 to 975 new units per year projected under the upper and lower coal production scenarios through 2010. The rapid pace of development in the 1970s coincided with a period of economic expansion and strained the region's construction trade and building supply industries. Although the underlying economies of the region are now larger, the projected needs would tax the ability of communities to respond. Signs of strain are apparent in Gillette and could surface elsewhere as greater housing needs arise in the remaining counties of the six-county study area under the low coal production scenario.

Projected housing demands under either coal production scenario, although lower than what Campbell County and the region experienced in the "boom" years of the 1970s, would exert substantial pressure on housing markets, prices, and the real estate development and construction industries, all at a time when demand for labor and other resources would be high overall.

##### 4.2.13.6 Public Education

There are 10 school districts in the six-county PRB study area, ranging in size from CCSD #1 with 7,337 students in the 2005 school year to Sheridan County School District # 3 (based in Clearmont, Wyoming) with fewer than 100 students. CCSD #1, based in Gillette, and Converse #1 in Douglas, serve the primary energy and resource development region.

Public school enrollment trends generally mirrored population trends during the period of rapid population growth. District-wide enrollment in Campbell County grew by more than 4,600 students (131 percent) between 1975 and 1985. Enrollment increased in all districts in Converse and Sheridan counties as well. Enrollment in Campbell County School District (CCSD) #1 subsequently peaked, but remained near record high levels for nearly a decade. Elsewhere in the region enrollments generally declined with a combined enrollment of 9,525 in the other study area districts in 2005, the lowest since 1975 (Wyoming Department of Education 2006). Recent natural gas and

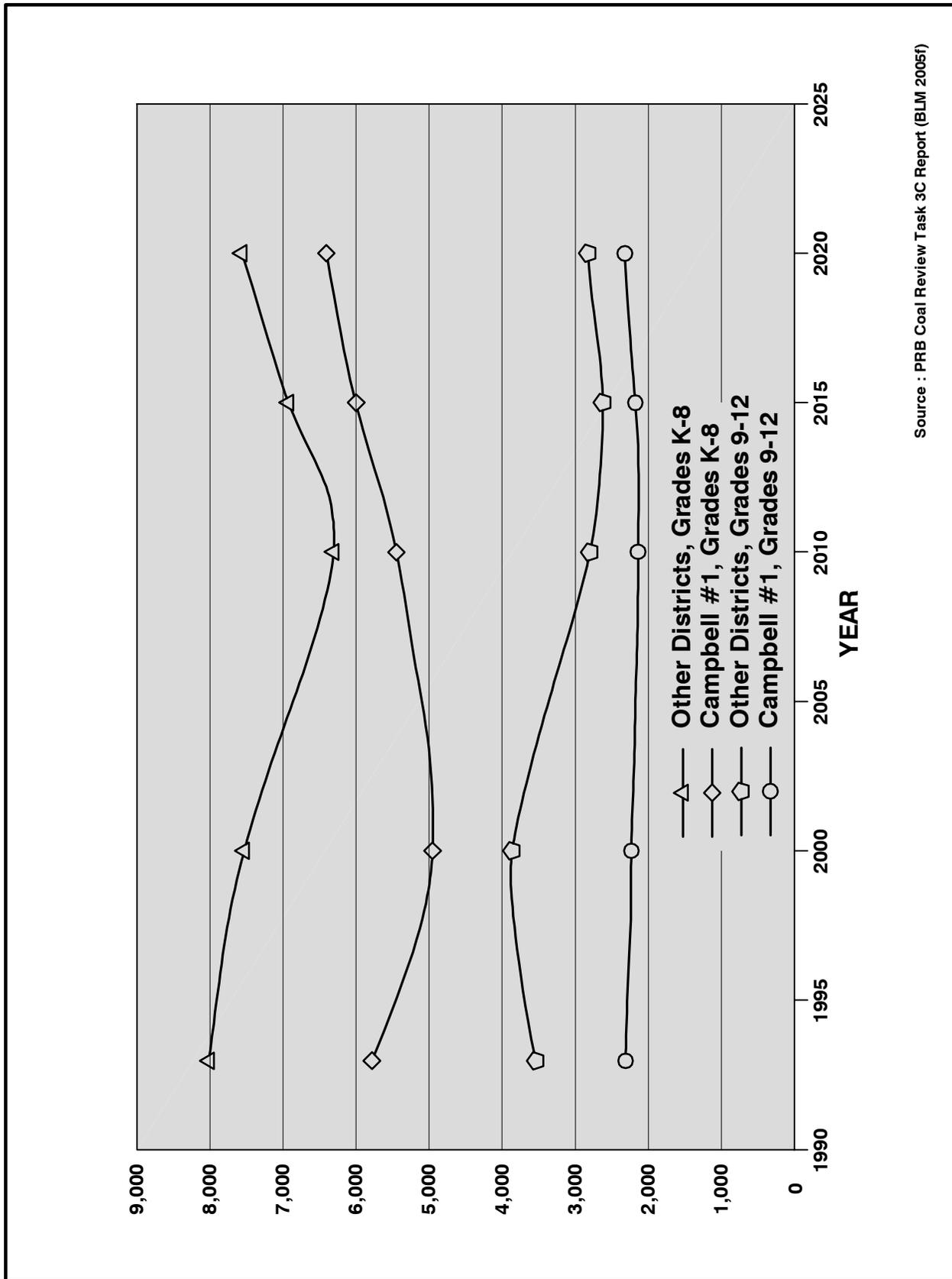
mining development has tempered, but not reversed, the trend of declining school enrollments across the region.

Communities across the PRB study area would see population growth due to economic migration from 2003 to 2020; however, the effects of such migration on public school enrollments would vary. As the demographics of the population change, school districts in the PRB would be affected by new trends. In some counties, the size of the school-age population (generally aged 5 to 17 years) may even trend in the opposite direction of total population in the short-term due to underlying demographics of the established resident population.

The demographic projections for the two coal production scenarios forecast growth in elementary school enrollments in Campbell County through 2010 and after 2010 for most PRB school districts. Projected enrollments in CCSD #1 would be approximately 10 percent higher by 2020 under the upper coal production scenario, with those in the surrounding districts about one percent higher. However, several districts still may experience enrollment levels in 2020 below current levels, as growth from 2010 to 2020 would not offset recent declines or those projected to occur before 2010.

Under the lower coal production scenario, Campbell County would experience an increase of 1,587 students, or 22 percent above recent levels, in school enrollment through 2020. However, the net impact on CCSD #1 would be composed of two trends; a substantial increase in grades K-8 but only small increases in grades 9-12 (Figure 4-12). School districts in the surrounding counties are projected to experience declining elementary and middle school enrollments through 2010 and declining high school enrollments through 2015. Thereafter, growth and the associated influences on demographics would generate renewed enrollment growth, particularly in the elementary grades in Johnson, Sheridan, and Converse counties.

Under either scenario, projected enrollments may cause short-term school capacity shortages, depending on the specific grade levels and residential locations of the additional students. Under the Wyoming School Facilities Commission planning guidelines, impacted school districts generally need to accommodate minor capacity shortages through the use of temporary facilities, such as portable classrooms. For larger and more long-term increases, the Commission's policy is to fund capital expansion where warranted by projections developed during updates of school districts' 5-year plans. The approved 5-year plan for CCSD #1 has a \$57.4 million budget covering construction of several new schools and numerous major maintenance and facility upgrade projects. The approved 5-year plans for the other school districts have combined cost of \$163 million. Capital investment in public education facilities has been a statewide priority in Wyoming for the past decade, with taxes and royalties on mineral and energy resources the primary source of program funding (Wyoming School Facilities Commission 2007, Wyoming CREG 2007).



Source : PRB Coal Review Task 3C Report (BLM 2005f)

Figure 4-12. Projected School Enrollment Trends to 2020 Under the Lower Coal Production Scenario.

#### 4.2.13.7 Facilities and Services

The types and levels of facilities and services provided by local governments reflect service demand, revenue availability, and community values regarding appropriate services and service standards. As with most socioeconomic characteristics, the level and availability of local government facilities and services varies by county and community across the PRB. There are literally several hundred separate service providers in the region. Although virtually all local government facilities and services are affected by energy development and the demand related thereto, the critical facilities and services include municipal water and sewer systems, law enforcement at the county level, and hospitals. A comprehensive assessment of facilities and services is beyond the scope of the PRB Coal Review. However, an initial screening revealed no critical needs or shortfalls and indicated that most providers are engaged in an ongoing long-term process to maintain and improve facilities and services to meet community needs and to comply with various regulations and standards.

The PRB Coal Review socioeconomic analysis focuses on water supply and wastewater systems (two essential services that are costly and have the longest lead times to develop) and law enforcement, emergency response, and road maintenance (three services that typically are most affected by energy development).

Water supply and wastewater systems in most communities have the capacity to accommodate the cumulative population growth associated with either projected coal production scenario through 2020, assuming ongoing or planned improvements are completed. In Gillette, there may be a timing issue with planned water supply system expansions, as completion of planned improvements would occur when substantial growth is anticipated under both projected coal production scenarios. Consequently, Gillette may experience water shortages in the summer months for several years, particularly if growth follows that under the upper coal production scenario. Douglas is looking to add water treatment capacity to provide additional capacity and management flexibility to address needs during times of drought.

The ability to provide desired levels of services to the projected energy-related population and development is less clear in Campbell County, Gillette, Wright, and outlying rural communities. Campbell County and its communities would experience a 25 percent increase in population between 2003 and 2010 under the lower coal production scenario and 30 percent under the upper coal production scenario.

Growth rates and the resultant facility and service demand in other counties within the study area would be substantially less during the 2003 to 2010 period under either scenario; all communities other than Johnson County and Buffalo would grow substantially less than 10 percent during the period. The populations of Johnson County and Buffalo would increase 10 percent by 2010, driven primarily by CBNG development.

#### 4.0 Cumulative Environmental Consequences

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Growth rates and resultant increases in service demands would slow substantially during both the 2011 to 2015 and 2016 to 2020 periods under either projected coal production scenario. In most communities except Sheridan County and the city of Sheridan, there would be little difference in population growth and service demand between the two scenarios.

##### 4.2.13.8 Fiscal Conditions

Federal mineral royalties and state and local taxes levied on coal and other mineral production are vitally important sources of public revenue in Wyoming. Taxes, fees, and charges levied on real estate improvements, retail trade, and other economic activity supported by energy development provide additional revenues to support public facilities and services. These revenues benefit not only those jurisdictions within which the production or activity occurs, but also the federal treasury, state coffers, school districts, and local governments across the state through revenue-sharing and intergovernmental transfer mechanisms.

Coal and other minerals produced in Wyoming, regardless of ownership, are subject to ad valorem taxation by local taxing entities and a statewide levy to support public education. Statewide ad valorem taxable valuation on coal production in 2005 was \$2,280.1 million. Of that total, 88 percent was based on production in the PRB.

The total assessed valuation of Campbell County, boosted by recent increases in CBNG production, was \$4,264 million in 2006. Valuations on aggregate mineral production accounted for 87 percent of that total. Because Campbell County has been the primary beneficiary of mineral production gains over the past three decades and the recent gains tied to CBNG, the county's assessed valuation in 2006 was nearly 38 times that of Weston County (\$112.5 million) and 31 times that of Crook County (\$137.2 million). The 2006 valuation of 2005 coal production in Campbell County was \$1,995.3 million (Wyoming Department of Revenue 2006).

Wyoming levies a severance tax on coal and many other minerals produced in the state. The severance tax rate, levied on the value of production, has varied from 1.0 percent to 10.5 percent over time. The current rate of 7.0 percent was established in 1992. Cumulative statewide severance tax proceeds on coal production since 1970 exceed \$2.8 billion. Cumulative severance tax revenues on coal produced in Campbell County total \$1.89 billion. Cumulative severance tax revenues for the corresponding period total \$96.5 million from Converse County, \$60.5 million from Sheridan County, and \$758.0 million from the remainder of the state (Wyoming CREG 2007 and Wyoming Department of Revenue 2006).

Producers pay a 12.5 percent royalty to the federal treasury on the value of all surface coal production from federal leases. Total federal mineral royalties of nearly \$3.3 billion have been paid on coal produced in Wyoming since 1970,

approximately half of which is returned to the state. Estimated 2005 mineral royalties of about \$377 million were paid on federal coal produced in the PRB (Minerals Management Service 2006).

At the foundation of the mineral development revenue projections for the period 2003 to 2020 are projected levels of future energy and mineral resource production. The projected total value of annual mineral production under the lower coal production scenario will climb by \$3.49 billion (2004 dollars) over 2003 levels, reaching \$8.54 billion by 2020, a 69 percent increase over the 2003 value. The aggregate value of energy and mineral resource production under the upper coal production scenario would increase to \$9.21 billion in 2020. The incremental difference, compared to the value under the lower coal production scenario, would be \$670 million per year, all of which represents the value of higher annual coal output.

The overwhelming majority of future mineral production value is anticipated to be in Campbell County. Over time, the future value of production in Sheridan and Johnson counties would climb. Total annual mineral production value by 2020 is projected to reach \$6.37 billion in Campbell County and \$2.17 billion in the surrounding counties. Between 2005 and 2020, total royalty and tax receipts derived from the key selected sources range between \$21.1 and \$22.6 billion for the lower and upper coal production scenarios, respectively. Receipts derived from coal production would account for the majority of the totals under either scenario, with federal mineral royalties on coal at \$4.9 to \$5.7 billion being the single largest source. Severance taxes, ranging from \$6.3 to \$6.7 billion, also would accrue to the state (Tables 4-35 and 4-36).

Table 4-35. Summary of Mineral Development Tax Revenues Associated with Energy Resource Production Under the Lower Coal Production Scenario (million \$).

<b>Industry and Taxes</b>	<b>2005-2010</b>	<b>2011-2015</b>	<b>2016-2020</b>	<b>Total</b>
Coal <sup>1</sup>	3,164.8	3,178.9	3,756.3	10,100.0
CBNG	2,915.2	3,076.4	3,288.7	9,280.3
Conventional Oil and Gas	568.5	576.4	614.0	1,759.0
<b>Totals</b>	<b>6,648.5</b>	<b>6,831.7</b>	<b>7,659.0</b>	<b>21,139.3</b>
Severance Tax	1,995.9	2,012.4	2,249.3	6,257.6
Federal Mineral Royalties	2,754.1	2,839.4	3,166.3	8,759.8
State Mineral Royalties	233.5	225.8	251.4	710.7
Ad Valorem Tax (Counties)	417.6	443.0	502.8	1,363.3
Ad Valorem Tax (Schools)	1,247.5	1,311.1	1,489.3	4,047.9
<b>Totals</b>	<b>6,648.6</b>	<b>6,831.7</b>	<b>7,659.1</b>	<b>21,139.3</b>

<sup>1</sup> Does not include coal lease bonus bids due to the uncertainty regarding timing.

Source: PRB Coal Review Task 3C Report (BLM 2005f)

The federal and state governments also benefit from coal lease bonus bids derived from future coal leasing. Bonus bids have risen over time, with successful bids for recent sales ranging from 30 cents per ton to 97 cents per ton. There is no guarantee of that trend continuing. Considerable uncertainty also exists with respect to the timing and scale of future leases, although BLM

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Table 4-36. Summary of Mineral Development Tax Revenues Associated with Energy Resource Production Under the Upper Coal Production Scenario (million \$).

<b>Industry and Taxes</b>	<b>2005-2010</b>	<b>2011-2015</b>	<b>2016-2020</b>	<b>Total<sup>1</sup></b>
Coal <sup>1</sup>	3,538.0	3,703.0	4,350.0	11,591.0
CBNG	2,915.2	3,076.4	3,288.7	9,280.3
Conventional Oil and Gas	568.5	576.4	614.0	1,759.0
<b>Totals</b>	<b>7,021.7</b>	<b>7,355.8</b>	<b>8,252.7</b>	<b>22,630.3</b>
Severance Tax	2,104.1	2,159.0	2,415.4	6,678.5
Federal Mineral Royalties	2,946.3	3,099.9	3,461.4	9,507.6
State Mineral Royalties	233.5	225.8	251.4	710.7
Ad Valorem Tax (Counties)	435.8	472.0	535.0	1,442.8
Ad Valorem Tax (Schools)	1,302.3	1,398.9	1,589.8	4,291.0
<b>Totals</b>	<b>7,022.0</b>	<b>7,355.6</b>	<b>8,253.0</b>	<b>22,630.6</b>

<sup>1</sup> Does not include coal lease bonus bids due to the uncertainty regarding timing.

Source: PRB Coal Review Task 3C Report (BLM 2005f)

currently has pending applications for more than four billion tons of federal coal, including this application. The state receives 50 percent of the bonus bid revenue.

Taxes and mineral royalties levied on energy and mineral resource production accruing to the state are disbursed to the Permanent Water Development Trust Fund, Wyoming School Foundation and Capital Facilities funds, capital construction fund for state and local government facilities, and other programs according to a legislatively-approved formula. Through these funds, the revenues derived from resource development benefit the entire state, not just agencies, businesses, and residents of the PRB.

County governments and school districts would realize benefits from future energy and mineral resource development in the form of ad valorem taxes. Such taxes, estimated on the basis of future coal, oil, and natural gas production, are estimated to range between \$5.4 billion and \$5.7 billion through 2020. Those sums do not include future property taxes levied on the new power plants, expanded rail facilities, or new residential and commercial development associated with future growth, or sales and use taxes levied on consumer and some industrial purchases. These latter revenues are not estimated in this study, but would be substantially lower than those on resource production.

Local governments would benefit from property taxes on new development, as well as from sales and use taxes on taxable sales within their boundaries. Such revenues are not estimated for this study due to the large number of jurisdictions and other analytical considerations.

#### 4.2.13.9 Social Setting

The past 30 years have seen sweeping social change in the U.S. and throughout much of the world. But in addition to the broad forces that have

driven social change in the U.S. as a whole, social conditions in some PRB communities have been substantially influenced by energy development. Factors that have affected social conditions in the PRB include industrial and natural resource development, economic and demographic change, housing and public infrastructure development, and institutional change at the local and state government levels.

One of the key drivers of social change in the PRB has been energy-related population growth. When the first oil boom occurred in the late 1950s, Campbell County was a relatively stable, sparsely-populated rural county. Like many places in Wyoming and throughout the rural west, Campbell County was a small, relatively homogeneous ranching community (ROMCOE 1982). The oil booms of the 1950s and 1960s brought an influx of new people. Development of coal mines, continued oil and gas drilling, and power plant construction precipitated another round of growth. In all, Campbell County population grew by almost 600 percent between 1950 and 2000.

On the one hand, this population growth, combined with a robust economy, generated a variety of positive social effects. Financial and technical resources poured into the community as it mobilized to accommodate the new population. Job opportunities were created in the construction industry, as the community responded to demands for housing, public facilities, and retail goods and services. The large and rapid influx of new residents, eager to take advantage of the employment opportunities, created energy, vitality, and a sense of economic optimism about the community. Where economic advancement had been limited before the boom, there was now opportunity (Gardiner 1985).

On the other hand, it is likely that many residents had mixed feelings about these changes (Heinecke 1985). New residents brought new ideas, new ways of doing things, new preferences for goods and services, and new demands for government services. Some long-time residents, particularly those who were not directly participating in the economic benefits of energy development, viewed these changes as negative.

Today, almost any organization, committee, or government body is made up of a cross-section of energy employees, ranchers, and other community members whose tenure in the community may be long or short (Bigelow 2004, Spencer 2004). Moreover, because of the turnover in the energy companies, the community has become accustomed to newcomers.

Cumulative energy development in the PRB through the year 2020 has the potential to generate both beneficial and adverse effects on community social conditions. Social effects of development activities in the PRB would vary from county to county and community to community under the coal production scenarios developed for this study, based on the existing social setting and the type of development that would occur.

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Beneficial social effects would be associated with an expanding economy and employment opportunities associated with energy development and resulting improvements in living standards for those employed in energy-related industries. Adverse social effects could occur as a result of conflicts over land use and environmental values. Negative social effects also could occur if the pace of growth exceeds the abilities of affected communities to accommodate energy-related employees and their families with housing and community services.

In the PRB, social conditions in Campbell County, the city of Gillette, and the town of Wright are most likely to be affected because the county would host much of the cumulative energy development workforce, and the county and its municipalities would receive the largest increments in population growth. Campbell County and its municipalities have a long history of energy development, and they have developed infrastructure and management systems to plan for and manage growth; consequently, major adverse social effects would not be anticipated. However, under either scenario, the county and the two municipalities may face challenges in providing adequate housing and expanding community services in anticipation of population growth through 2010, particularly if several power plant and coal mine construction projects occur simultaneously. As municipalities receive only sales and use tax revenues directly from development and purchases made within their boundaries, Gillette and Wright could face challenges in securing the necessary funding to improve municipal facilities and services. Housing shortages and limitations in public services could contribute to adverse community social effects in these communities.

Many of the people who would immigrate to Campbell County for energy-related jobs are likely to share characteristics with much of the current population; therefore, few barriers to social integration are anticipated.

Social effects on other communities in the PRB are likely to be minimal to moderate. Energy-related population growth is anticipated to be moderate in other communities. Sheridan County, also familiar with coal mining, is the only other county anticipated to host a major construction project under the development assumptions used for either projected coal production scenario. Converse, Weston, and Crook counties could experience spillover growth from projects in Campbell County.

Johnson, Sheridan, and Campbell counties could experience continued conflict over split estate and water issues associated with CBNG development, and the pace and scale of energy development across the PRB is likely to continue to generate social and political conflict over environmental issues under either coal production scenario.

4.2.14 Coal Mining and Coal-Fired Power Plant Related Emissions and By-Products

As discussed in Chapter 1, BLM does not authorize mining by issuing a lease for federal coal, but the impacts of mining the coal are considered in this EIS because it is a logical consequence of issuing a maintenance lease to an existing mine. The use of the coal after it is mined is also not determined at the time of leasing or mining, the use is determined by the purchaser and the end user. However, almost all of the coal that is currently being mined in the Wyoming PRB is being used by coal-fired power plants to generate electricity. As a result, a discussion of emissions and by-products that are generated by burning coal to produce electricity is included in this section of the EIS.

As discussed in Chapter 2, under the currently approved mining plan, which represents Alternative 1 (the No Action Alternative), from 2009 on, the Black Thunder Mine would be able to produce coal at an average production level of 135.0 mmtpy for another 9.2 years, compared with an average of 135.0 mmtpy for 11.2 years under the Proposed Action, or an average of 135.0 mmtpy for another 14.0 years under Alternative 2 for the North Hilight Field LBA Tract (Table 2-2). The Black Thunder Mine would be able to produce coal at an average production level of 135.0 mmtpy for another 10.8 years under the Proposed Action, or an average of 135.0 mmtpy for another 11.5 years under Alternative 2 for the South Hilight Field LBA Tract (Table 2-4). The Black Thunder Mine would be able to produce coal at an average production level of 135.0 mmtpy for another 12.0 years under the Proposed Action, or an average of 135.0 mmtpy for another 16.3 years under Alternative 2 for the West Hilight Field LBA Tract (Table 2-6).

As discussed in Chapter 2, from 2009 on, the Jacobs Ranch Mine would be able to produce coal at an average production level of 40.0 mmtpy for another 9.6 years under Alternative 1 (No Action Alternative), compared with an average of 40.0 mmtpy for 26.3 years under the Proposed Action, or an average of 40.0 mmtpy for another 32.4 years under Alternative 2 for the West Jacobs Ranch LBA Tract (Table 2-8).

As discussed in Chapter 2, under the currently approved mining plan, which represents Alternative 1 (No Action Alternative), from 2009 on, the North Antelope Rochelle Mine would be able to produce coal at an average production level of 95.0 mmtpy for another 9.9 years, compared with an average of 95.0 mmtpy for 16.2 years under the Proposed Action, or an average of 95.0 mmtpy for another 17.7 years under Alternative 2 for the North Porcupine LBA Tract (Table 2-10). The North Antelope Rochelle Mine would be able to produce coal at an average production level of 95.0 mmtpy for another 13.2 years under the Proposed Action, or an average of 95.0 mmtpy for another 13.5 years under Alternative 2 for the South Porcupine LBA Tract (Table 2-12).

Section 3.18.2 contains estimates of greenhouse gas emissions resulting from the specific mine operations at the three applicant mines (Black Thunder,

#### 4.0 Cumulative Environmental Consequences

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Jacobs Ranch, and North Antelope Rochelle) from projected operations under the Proposed Actions and alternatives over the life of the actions.

##### 4.2.14.1 Greenhouse Gas Emissions, Global Warming and Climate Change

Ongoing scientific research has identified the potential impacts of anthropogenic (man-made) greenhouse gas (GHG) emissions and changes in biological carbon sequestration due to land management activities on global climate. Although GHG levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused the carbon dioxide equivalent (CO<sub>2</sub>e) concentrations to increase in our lower atmosphere. As with any field of scientific study, there are uncertainties associated with the science of climate change. This does not imply that scientists do not have confidence in many aspects of climate change science. Some aspects of the science are known with virtual certainty, because they are based on well-known physical laws and documented trends (EPA 2008a). However, the science is not settled and there is strong debate among the scientific community that natural variability is the overwhelming factor influencing climate rather than the accumulation of anthropogenic GHG emissions in the atmosphere.

The National Assessment of the Potential Consequences of Climate Variability and Change, an interagency effort initiated by Congress under the Global Change Research Act of 1990, Public Law 101-606, has confirmed that climate changes, while impacts in and of themselves, can affect other aspects of the environment. The Synthesis Report, the final part of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (available online at <http://www.ipcc.ch>), was released in preliminary form on November 17, 2007. The Synthesis Report (Bernstein et al. 2007) summarizes the results of the assessment carried out by the three working groups of the IPCC. Observations and projections addressed in the report include:

- “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperature, widespread melting of snow and ice, and rising global average sea level.”
- “Observational evidence from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases.”

The term global warming is commonly used to refer to surface air temperature changes that are a response to increasing atmospheric GHG concentrations, along with other climate-influencing factors (NOAA 2007). From 1850 to present, historic trend data show an increase of 1° Centigrade (C) (1.8° Fahrenheit) in global mean temperature. However, the warming is not expected to be uniform over the globe, nor is it expected to be the same during all seasons of the year. There have been extended periods (decades) where temperature has dropped or stayed constant. This historic warming over that

same period has caused sea levels to rise by about 20 centimeters on average, and has also resulted in changes in climate patterns on land. In some areas near the equator, temperatures have cooled by about 5°C, while closer to the poles, temperatures have risen by equal amounts (Hansen and Lebedeff 1987). In northern latitudes (above 24° N), temperature increases of nearly 1.2°C (2.1° Fahrenheit) have been documented since 1900. The IPCC Fourth Assessment Report found that the “...projected warming in the 21<sup>st</sup> century shows scenario-independent geographical patterns similar to those observed over the past several decades. “Warming is expected to be greatest over land and at most high northern latitudes, and least over the Southern Ocean and parts of North Atlantic Ocean.” Observations and computer models agree that arctic surface air temperatures are warming twice as fast as the global average, which is due partly to what is called the ice-albedo feedback (albedo is a term used to describe the fraction of sunlight reflected by an object) (NOAA 2007). Because temperature is a part of climate, the phenomenon of global warming is both an element of and a driving force behind climate change.

There has been, and continues to be, considerable scientific investigation and discussion as to the causes of the recent historic rise in global mean temperatures, and whether the warming trend will continue. Several activities contribute to the phenomena of climate change, including emissions of GHGs (especially carbon dioxide and methane) from fossil fuel development, large wildfires and activities using combustion engines; changes to the natural carbon cycle; and changes to radiative forces and reflectivity (albedo). It is important to note that GHG emissions will have a sustained climatic impact over different temporal scales (EPA 2008a).

Solar variability may play a role in global climate change, though the magnitude of the influence of increased sun activity is not well understood. Physical aspects of the sun, like sunspots and solar radiation output, are known to vary over time. The intensity of energy from the sun has varied through time and has resulted in global temperature variation.

Human population doubled to two billion from the period 1780 to 1930, then doubled again by 1974. The atmospheric concentrations of GHGs have increased as human populations have increased. More land and resources were used to provide for the needs of these populations. As human activities have increased, carbon-based fuels have been used to provide for those additional energy needs. Forests and vegetation were cleared in order to provide for food production and human use.

Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), water vapor (H<sub>2</sub>O), ozone (O<sub>3</sub>), and nitrous oxide (N<sub>2</sub>O) are recognized as the major GHGs, although there are other gases that are considered GHGs. These are called “greenhouse gases” because, when released into the atmosphere, they prevent the escape of reflected solar radiation and heat from the Earth’s surface. Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks (i.e., forests) cause a net warming effect of the atmosphere,

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primarily by decreasing the amount of heat energy radiated by the earth back into space. In this way, the accumulation of GHGs in the atmosphere exerts a “greenhouse effect” on the earth’s temperature. Like glass in a greenhouse, these gases trap radiation from the sun and act as an insulator around the Earth, holding in the planet’s heat. The present CO<sub>2</sub> concentration of about 385 parts per million (ppm) is about 30 percent above its highest level over at least the last 800,000 years. U.S. average temperature has increased by about 2° Fahrenheit over the last 50 years, which is more than the global average temperature increase (U.S. Global Change Research Program 2009).

According to the IPCC’s Synthesis Report (Bernstein et al. 2007):

- “Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.”
- “Most of the observed increase in globally-averaged temperatures since the mid-20<sup>th</sup> century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. It is likely there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica).”
- “There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global greenhouse gas emission will continue to grow over the next few decades.”
- “Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21<sup>st</sup> century that would be very likely to be larger than those observed during the 20<sup>th</sup> century.”
- “There is high confidence that by mid-century, annual river runoff and water availability are projected to increase at high latitudes and in some tropical wet areas and decrease in some dry regions in the mid-latitudes and tropics. There is also high confidence that many semi-arid areas (e.g., Mediterranean Basin, western U.S., southern Africa and northeast Brazil) will suffer a decrease in water resources due to climate change.”
- “Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.”
- “Anthropogenic warming and sea level rise could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change.”

- “There is high agreement and much evidence that all stabilization levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialized in coming decades, assuming appropriate and effective incentives are in place for their development, acquisition, deployment and diffusion and addressing related barriers.”

The National Academy of Sciences has confirmed these findings, but also has indicated there are uncertainties regarding how climate change may affect different regions. Computer model predictions indicate that increases in temperature will not be equally distributed, but are likely to be accentuated at higher latitudes. Warming during the winter months is expected to be greater than during the summer, and increases in daily minimum temperatures is more likely than increases in daily maximum temperatures. Increases in temperatures would increase water vapor in the atmosphere, and reduce soil moisture, increasing generalized drought conditions, while at the same time enhancing heavy storm events. Although large-scale spatial shifts in precipitation distribution may occur, these changes are more uncertain and difficult to predict (EPA 2008a).

Relatively steep elevation gradients between valley floors and adjacent mountain ranges in the western U.S. produce considerable geographic climate variability. Warm, dry, semiarid conditions are typical on valley floors; moist and cool conditions are typical in higher parts of mountain ranges. Different plant communities occur within specific elevation zones. There also have been patterns of historic climatic variation in these areas for more than 10,000 years, during which plant communities gradually shift to higher or lower elevations depending on the direction of temperature and precipitation changes (Tausch et. al. 2004).

Temperature changes can result in shifts of weather patterns (rainfall and winds), which may then affect vegetation and habitat. If global warming trends continue into the foreseeable future, Chambers (2006) and the 2008 report by the U.S. Climate Change Science Program (U.S. Climate Change Science Program 2008a) indicate that the following changes may be expected to occur in the West:

- The amount and seasonal variability of precipitation will increase over most areas. IPCC (2001) climate model scenarios indicate that by 2100, precipitation will increase about 10 percent in summer, about 30 percent in fall, and 40 percent in winter. Less snowfall will accumulate in higher elevations, more precipitation will occur as rain, and snowmelt will occur earlier in the spring because of higher temperatures.
- Streamflow patterns will change in response to reduced snowpacks and increasing precipitation. Peak flows in spring are expected to occur earlier and be of lower magnitude because of snowpack changes. Runoff from greater amounts of winter rainfall will cause higher winter flows.

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Summer flows will be lower, but with higher variability depending on the severity of storm events.

- Some populations of native plants, invasive species, and pests will expand. Increasing amounts of atmospheric carbon dioxide and precipitation during the growing season will provide favorable growth conditions for native grasses, perennial forbs, woody species, and invasive annuals such as cheatgrass. Insect populations also will likely increase because milder winter temperatures will improve reproduction and survival rates.
- Fire frequency, severity, and extent will increase because of the increased availability of fine fuels (grasses, forbs, and invasives) and accumulation of fuels from previous growing seasons. Higher temperatures will extend the length of fire seasons. Expansion of pinyon-juniper species and increasing tree densities could increase the number of high severity crown fires. Higher rates of insect damage and disease also may increase fuel accumulations.
- Sensitive species and overall biodiversity will be reduced. High-elevation habitats will shrink in area or disappear as lower-elevation plant communities expand. It is probable that some mammalian, avian, and other species that currently inhabit these high-elevation habitats may become extinct. Higher rates of disease and insect damage also may pose threats to other sensitive plant and animal species.

Global climate models exist that project/predict future temperature changes under various scenarios. For example, atmospheric CO<sub>2</sub> concentration increasing by 1 percent per year would be an idealized scenario. The sensitivity of any climate model is generally calculated as the amount of temperature change the model produces for a doubling of atmospheric CO<sub>2</sub> concentration. Most recent models have sensitivities of more than 2°C for a doubling of CO<sub>2</sub> concentration (U.S. Climate Change Science Program 2008b). Scenarios however cannot include unknowable events such as volcanic eruptions and variations in solar activity. Perhaps the single largest uncertainty in determining the climate sensitivity to either natural or anthropogenic changes is clouds; their effects on radiation and their role in the hydrological cycle (IPCC 2007). The rate of heat uptake by the oceans is also an uncertainty when considering climate responses on time scales shorter than 100 years (U.S. Climate Change Science Program 2008b). Despite such uncertainties, models are however consistent in their prediction of climate warming under GHG increases (IPCC 2007).

Climate change models cannot be used to predict future climate changes at any particular scale less than globally. According to IPCC's Fourth Assessment Report (2007), there is considerable confidence that climate models provide credible quantitative estimates of future climate change, particularly at continental scales and above, but the changes projected by global models

decreases at smaller scales. Models are becoming more comprehensive and sophisticated in representing observed climate and past climate changes; however, models continue to have significant limitations that lead to uncertainties in magnitude and timing, as well as regional details of predicting climate change (IPCC 2007). By taking the average of all models, known as the ensemble approach, a more accurate representation of the climate emerges (U.S. Climate Change Science Program 2008b). Global climate models are at this time imperfect and due to their uncertainties should not be used as a basis for public policy.

### 4.2.14.2 Cumulative Effects of Combustion of PRB Coal by Power Plants

Historically, the coal mined in the PRB has been used as one of the sources of fuel to generate electricity in power plants located throughout the U.S. Relatively little PRB coal, about 2 percent, is burned in Wyoming. Wyoming PRB coal is shipped primarily nationwide. In 2005, Wyoming coal went to 35 states besides Wyoming, although it can also be shipped overseas. The mines in the PRB have sold, and are expected to sell coal into the open coal market. Each mine's ability to sell coal in this market will determine annual production rates at that mine. Historically, the coal buyers have been domestic electric producers, although the coal could be used in other coal applications and it has been exported.

Coal sales are made on short term contracts, generally to individual power generators, or coal is sold on a spot market. This market is very dynamic and competitive. During the coal leasing EIS process, it is uncertain and speculative to predict who might purchase future PRB coal, how it would be used, and where the coal might be transported to. In the Northern American Electric Reliability Council (NERC) power regions where PRB coal is sold, coal use ranges from 74.2 percent in the upper Midwest, to 15.6 percent in the northeast U.S. (EPA 2007e).

Coal-burning power plants currently supply about 50 percent of the electric power generated in the U.S. The demand for power is increasing in the U.S. and throughout the world. According to a recent report by NERC, peak demand for electricity in the U.S. is expected to double in the next 22 years (Associated Press 2007). Many developing countries, including China and India, are also relying heavily on coal to meet their rapidly increasing power demands as coal is more economical and more available than other sources of electrical generation.

The regulatory mechanisms proposed under the Climate Security Act of 2008, as well as the past regulation of pollutants under the CAA, are imposed at the point when coal is burned and converted to electric energy. Over 95 percent of coal produced in the PRB is sold in an open market where coal is purchased on short term contracts or spot prices based on a coal feed stock that is suitable for each buyer's power generating facility. Coal production at any one mine is not tied in any predictable way over a period of time to any one power plant.

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Power plant buyers attempt to buy coal from suppliers at the most economical prices that meet their needs. PRB coal has competed well in this market due to its low sulfur content, providing a way for electric generators to achieve acid rain reduction requirements. This makes it valuable in lowering sulfur dioxide (SO<sub>2</sub>) pollution, as well as competitive mining costs when compared to delivered costs of coal from other coal producing areas.

Wyoming coal production has increased at a more rapid rate than other domestic coal. Coal coming out of the Wyoming PRB is mined using surface mining methods which are generally safer and less labor intensive than underground mining. Rural rangelands are the areas that are mainly mined; they are reclaimed according to WDEQ/LQD's standards (see Section 3.9.4). PRB coal reserves are in thick seams, resulting in more production from areas of similar land disturbance, and lower mining and reclamation costs.

Coal-fired power plants have been identified as principal sources of anthropogenic GHG emissions. Assuming that all coal produced from all coal mines in the Wyoming PRB would be burned to generate electricity; the amount of GHG emissions that could be attributed to that coal production can be estimated. This is done by relating the portion of coal mined in the PRB to the total emission of GHG from all coal mined in the U.S. It is assumed that all PRB coal is used for coal-fired electric generation as part of the total U.S. use of coal for electric generation. This gives an upper estimate of the GHG emissions resulting from the use of the total PRB coal production to produce electricity.

U.S. coal production increased from 1,029.1 million tons in 1990, when the Powder River Federal Coal Region was decertified, to 1,161.4 million tons in 2006, an increase of 12.9 percent (USDOE 2007a). Wyoming coal production increased from 184.0 million tons in 1990 to 444.9 million tons in 2006, an increase of 242 percent (Wyoming Department of Employment 1990 and 2006). The share of electric power generated by burning coal was consistently around 50 percent during that time frame. Also, the percentage of total U.S. CO<sub>2</sub> emissions related to coal consumption was consistently around 36 percent during that same time frame. The percentage of U.S. CO<sub>2</sub> emissions related to the coal electric power sector increased from about 30 percent in 1990 to about 33 percent in 2006 (USDOE 2009c).

In 2008, the Wyoming PRB coal mines produced approximately 451.7 million tons of coal. Using factors derived from laboratory analyses, it is estimated that approximately 749.6 million metric tons (tonnes) of CO<sub>2</sub> would be generated from the combustion of all of this coal (before CO<sub>2</sub> reduction technologies are applied). This number is based on an average Btu value of 8,600 per pound of Wyoming coal and using a CO<sub>2</sub> emission factor of 212.7 pounds of CO<sub>2</sub> per million Btu (USDOE 1994). The estimated 749.6 million tonnes of CO<sub>2</sub> represents approximately 35.3 percent of the estimated 2,125.2 million tonnes of U.S. CO<sub>2</sub> emission from coal combustion in 2008 (USDOE 2009c). In 2008, Wyoming PRB mines accounted for approximately 38.5 percent of the coal produced in the U.S. (USDOE 2009a).

According to the U.S. Department of Energy (USDOE), Energy Information Administration's (EIA's) 2008 Emissions of Greenhouse Gases in the U.S. report (USDOE 2009c) and EIA's 2008 U.S. Coal Report (USDOE 2009a):

- CO<sub>2</sub> emissions represent about 83 percent of the total U.S. greenhouse gas emissions.
- Estimated CO<sub>2</sub> emissions in the U.S. totaled 5,839.3 million tonnes in 2008, which was a 1.5 percent decrease from 2006 (which was 5,928.7 million tonnes).
- Estimated CO<sub>2</sub> emissions from the electric power sector in 2008 totaled 2,359.1 million tonnes, or about 40.6 percent of total U.S. energy-related CO<sub>2</sub> emissions in 2008 (which was 5,814.4 million tonnes).
- Estimated CO<sub>2</sub> emissions from coal electric power generation in 2008 totaled 1,945.9 million tonnes or about 33.5 percent of total energy-related CO<sub>2</sub> emissions and about 82.5 percent of CO<sub>2</sub> emissions from the U.S. electric power sector in 2008.
- Coal production from the Wyoming PRB represented approximately 43.4 percent of the coal used for power generation in 2008, which means that combustion of Wyoming PRB coal to produce electric power was responsible for about 12.8 percent of the estimated U.S. CO<sub>2</sub> emissions in 2008.

As discussed earlier in this chapter, Task 2 of the PRB Coal Review projects coal development in the PRB into the future for the years 2010, 2015, and 2020. Due to the variables associated with future coal production, two projected coal production scenarios (representing an upper and a lower production level) were developed to bracket the most likely foreseeable regional coal production level. In the low scenario, the percentage of coal use for electric generation would stay about the same, assuming that all forms of electric generation would grow at a proportional rate to meet forecast electric demand. In the high scenario, percentage of coal use would also remain about the same, but with PRB coal displacing coal from other domestic coal regions. Table 4-37 shows the estimated annual CO<sub>2</sub> emissions that would be produced from the combustion of all of this coal (before CO<sub>2</sub> reduction technologies are applied).

In the following analysis, the contribution of the pending LBAs (Table 1-2) to cumulative effects on the environment by historic and projected development activity is evaluated. To do this, it is assumed that coal mining will proceed in accordance with existing permit conditions. It is further assumed that this coal will be sold to coal users in response to forecasts of demand for this coal. Historically these users have been electric utilities in the U.S., although there is potential for sales outside the U.S. This coal market is open and competitive and users can buy from the most cost effective suppliers that meet their needs.

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Table 4-37. Estimated Annual CO<sub>2</sub> Emissions from Projected PRB Coal Production Levels According to Task 2 or the PRB Coal Review<sup>1</sup>.

<b>Projected Coal Production Scenario</b>	<b>Year</b>	<b>Coal Production Rate (million tons per year)</b>	<b>CO<sub>2</sub> Emissions (million tonnes per year)</b>
Lower	2010	411	682
	2015	467	775
	2020	495	821
Upper	2010	479	795
	2015	543	901
	2020	576	956

<sup>1</sup> BLM 2005a

The BLM does not determine the destination of this coal, and the use of the coal is determined by the coal consumer. The electric utilities where this coal has historically been used are throughout the U.S., and have a variety of coal combustion technologies and emission control, but all are licensed by the appropriate regulatory authorities in their locale, and operate under necessary permit requirements, and in compliance with regulation.

Table 4-38 shows the estimated cumulative annual CO<sub>2</sub>e emissions produced by all mines in the PRB that currently have LBAs pending (listed in Table 1-2). The cumulative emissions calculated are those associated with the actual mining operations and not from the combustion of the coal produced and sold on the open coal market. The LBA tracts are addressed individually in the following EISs: the South Gillette Area Coal (SGAC) Lease Applications FEIS (BLM 2009g), the Wright Area Coal (WAC) Lease Applications EIS (this document), the West Antelope II Coal Lease Application FEIS (BLM 2008d), and the Hay Creek II Coal Lease Application DEIS (BLM 2010). Under the Proposed Actions and Alternatives 2 and 3, the three applicant mines (Black Thunder, Jacobs Ranch, and North Antelope Rochelle) anticipate producing coal included in the North Hilight Field, South Hilight Field, West Hilight Field, West Jacobs Ranch, North Porcupine, and South Porcupine LBA Tracts at or less than currently permitted levels using existing production and transportation facilities. Estimates of greenhouse gas emissions resulting from the specific mine operations at the Black Thunder, Jacobs Ranch, and North Antelope Rochelle mines from projected operations under the Proposed Actions and alternatives are also included in Section 3.18.2.

The CO<sub>2</sub> emissions related to burning coal that is produced from the three applicant mines to generate electricity would be extended as a result of leasing and mining the WAC LBA tracts. Table 4-39 shows the estimated annual coal production of each of the three applicant mines and the related annual CO<sub>2</sub> emissions that would be produced from the combustion of the coal produced from each of the six WAC LBA tracts as applied for and as reconfigured under Alternative 2 (BLM's preferred alternative), if this coal is burned to generate electric power. The total contribution of CO<sub>2</sub> emissions that would be produced

Table 4-38. Estimated Annual CO<sub>2</sub> Equivalent Emissions\* from Coal Production at PRB Mines With Pending LBAs.

<b>Source</b>	<b>2007</b>	<b>With LBA Tracts</b>
Four SGAC Mines/Four LBA Tracts	0.716	1.182
Three WAC Mines/Six LBA Tracts	1.245	2.503
Antelope Mine/West Antelope II Tract	0.225	0.348
Buckskin Mine/Hay Creek II Tract	0.197	0.197
<b>Total</b>	<b>2.535</b>	<b>4.229</b>

\* CO<sub>2</sub>e in million metric tons (tonnes)

Source: BLM 2008g, J&S 2009, WWC 2009

from the combustion of all the coal produced from each tract, if this coal is burned to generate electricity, are shown in Table 4-39. A scenario resulting in the maximum possible annual CO<sub>2</sub> emissions from burning the coal produced from the WAC LBA tracts would occur assuming all six tracts were leased under Alternative 2, and that coal removal from all six tracts were to be sequenced to maintain each of the three applicant mines at full permitted production until the new reserves were fully depleted. Under this scenario, the Black Thunder Mine would be able to extend production for 14.2 years, the North Antelope Rochelle Mine for 11.4 years, and the Jacobs Ranch Mine for 22.8 years.

It is not possible to accurately project the level of CO<sub>2</sub> emissions that burning the coal from the six WAC LBA tracts would produce due to the uncertainties about what emission limits would be in place at that time or where and how the coal in these LBA tracts would be used if they are leased and the coal is mined. Furthermore, the rate of mining and the timing of when coal removal from the tracts would actually begin are only the applicant mines' best estimate. As shown in Tables 2-2 through 2-13, under the No Action alternatives the mines are projecting that after 2008 approximately 10 to 11 years of currently permitted mine life remains. Therefore, coal removal from these six proposed maintenance lease tracts would not begin until approximately 2018 or 2019. More rapid improvements in technologies that provide for less CO<sub>2</sub> emissions, new CO<sub>2</sub> mitigation requirements, or an increased rate of voluntary CO<sub>2</sub> emissions reduction programs could result in significantly lower CO<sub>2</sub> emissions levels than are projected here.

The three WAC applicant mines produced 228.3 million tons of coal in 2008, which represents about 50.5 percent of the coal produced in the Wyoming PRB in 2008. Combustion of those 228.3 million tons of coal to produce electricity produced approximately 378.7 million tonnes of CO<sub>2</sub> emissions, or about 5.4 percent of the total estimated anthropogenic CO<sub>2</sub> emissions produced in the U.S. in 2008, which was approximately 7,052.6 million tonnes (USDOE 2009c). Under the No Action Alternative, CO<sub>2</sub> emissions attributable to burning coal produced by the Black Thunder, Jacobs Ranch, and North Antelope Rochelle mines would be extended at about this level for up to approximately 10 years

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Table 4-39. Estimated Annual CO<sub>2</sub> Emissions Produced from Combustion of Coal Produced from WAC LBA Tracts.

Applicant Mine/ LBA Tract	Anticipated Average Annual Coal Production by Applicant Mine <sup>1</sup> (mmtpy)	CO <sub>2</sub> Emissions Related to Annual Coal Production <sup>2</sup> (million tonnes)	Recoverable Coal Added Under Proposed Action <sup>1</sup> (mmt)	Mine Life Added Under Proposed Action <sup>1</sup> (years)	CO <sub>2</sub> Emissions Added by Proposed Action <sup>2</sup> (million tonnes)		Recoverable Coal Added Under Alternative 2 <sup>1</sup> (mmt)	Mine Life Added Under Alternative 2 <sup>1</sup> (years)	CO <sub>2</sub> Emissions Added by Alternative 2 <sup>2</sup> (million tonnes)	
					Total per LBA Tract	Average per Year			Total per LBA Tract	Average per Year
Black Thunder/ North Hilight Field	135	224.0	263.4	2.0	437.1	218.5	652.8	4.8	1,083.0	225.6
Black Thunder/ South Hilight Field	135	224.0	213.6	1.6	354.4	221.5	304.3	2.3	504.8	219.5
Black Thunder/ West Hilight Field	135	224.0	377.9	2.8	626.9	223.9	965.2	7.1	1,601.3	225.5
Jacobs Ranch/ West Jacobs Ranch	40	66.4	669.6	16.7	1,110.9	66.5	912.6	22.8	1,514.0	66.4
North Antelope Rochelle/ North Porcupine	95	157.6	601.2	6.3	997.4	158.3	745.4	7.8	1,236.6	158.5
North Antelope Rochelle/ South Porcupine	95	157.6	309.7	3.3	513.8	155.7	339.3	3.6	562.9	156.4

<sup>1</sup> Anticipated coal production rates at each applicant mine, coal tonnages within each LBA tract, and anticipated mine life added by each LBA tract are addressed in Chapter 2.

<sup>2</sup> Determined using emission factor of 1.659 tonnes CO<sub>2</sub>/ton of coal burned (USDOE 1994).

beyond 2008, while the mines recover their remaining estimated 2,483 million tons of currently leased coal reserves.

It is not likely that selection of the No Action alternatives would result in a decrease of U.S. CO<sub>2</sub> emissions attributable to coal mining and coal-burning power plants in the longer term, because there are multiple other sources of coal that, while not having the cost, environmental, or safety advantages, could supply the demand for coal beyond the time that the Black Thunder, Jacobs Ranch, and North Antelope Rochelle mines complete recovery of the coal in their existing leases.

In 2006, transportation sources accounted for approximately 29 percent of total U.S. GHG emissions (EPA 2008b). Transportation is the fastest growing source of U.S. GHGs, accounting for 47 percent of the net increase in total U.S. emissions since 1990. Transportation is also the largest end-use source of CO<sub>2</sub>, which is the most prevalent GHG (EPA 2008b). Transportation is also the largest end-use source of CO<sub>2</sub>, which is the most prevalent anthropogenic GHG (EPA 2008b, NOAA 2007).

Carbon dioxide is not the only GHG of concern. Another GHG, methane, in the form of coal bed natural gas (CBNG), is released into the atmosphere when coal is mined. The other major sources of U.S. methane emissions are from agriculture and waste management. According to the EIA (USDOE 2009a and 2009c):

- U.S. anthropogenic methane emissions totaled 722.7 million tonnes CO<sub>2</sub>e in 2007 and 737.4 million tonnes CO<sub>2</sub>e in 2008.
- U.S. 2008 methane emissions from coal mining were estimated at 82.0 million tonnes CO<sub>2</sub>e, which represents approximately 11.1 percent of the U.S. total anthropogenic methane emissions in 2008.
- Surface coal mining operations in the U.S. were estimated to be responsible for methane emissions of about 15.7 million tonnes of CO<sub>2</sub>e in 2008, which represents about 2.1 percent of the estimated U.S. anthropogenic methane emissions in 2008, and about 19.1 percent of the estimated methane emissions attributed to coal mining of all types.
- The Wyoming PRB produced approximately 55.5 percent of the coal mined in the U.S. in 2008 using surface mining techniques, which means that Wyoming PRB surface coal mines were responsible for approximately 1.17 percent of the estimated U.S. anthropomorphic methane emissions in 2008. The three applicant mines (Black Thunder, Jacobs Ranch, and North Antelope Rochelle) contributed about 50.5 percent of the Wyoming PRB production in 2008, which is the equivalent of about 4.4 million tonnes CO<sub>2</sub>e vented methane emissions. It should be noted that the estimated amount of annual methane emissions vented from the applicant mines based on the gas content analyses of local coal

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cores (Section 3.18.2) is more than 20 times less than this estimate that is based on EIA's 2009 report (USDOE 2009c).

Since 1990, when BLM began leasing using the lease by application (LBA) process, total U.S. anthropogenic methane emissions declined from 783.5 million tonnes CO<sub>2e</sub> to 737.4 million tonnes CO<sub>2e</sub> in 2008. Total coal mining related emissions declined from 106.4 million tonnes CO<sub>2e</sub> to 82.0 million tonnes CO<sub>2e</sub> during the same time period. The EIA attributes the overall decrease in coal mine emissions of methane since 1990 to the fact that the coal production increases during that time had been largely from surface coal mines that produce relatively little methane (USDOE 2009c).

CBNG is currently being commercially produced on a large scale by oil and gas operators from wells located within and near the WAC LBA tracts. CBNG that is not recovered prior to mining would be vented to the atmosphere during the mining process. Selection of the No Action alternatives would potentially allow more complete recovery of the CBNG from the six WAC LBA tracts in the short term (roughly 10 years), during the time that the three applicant mines' currently leased coal is being recovered. However, BLM's analysis suggests that a large portion of the CBNG resources that are currently present on the tract would be recovered prior to mining under the Proposed Action or Alternatives 2 or 3 (a complete discussion is included in Section 3.3.2.1.2.1). Selection of the No Action alternatives would not be likely to directly decrease U.S. methane emissions attributable to coal mining in the long term because there are multiple other sources of coal that could supply the coal demand beyond the time that the Black Thunder, Jacobs Ranch, and North Antelope Rochelle mines recover the coal in their existing leases.

Nitrous oxide (N<sub>2</sub>O) is the one other GHG of concern that is associated with coal mining; however, the largest source in the U.S. is agricultural (about 76 percent comes from fertilization of soils and about 24 percent from management of animal waste) (USDOE 2009c).

Specific levels of significance have not yet been established for GHG emissions, and given the current state of science, it is not yet possible to associate specific actions with the specific climate impacts. As a consequence, impact assessments of effects of specific anthropogenic activities cannot be performed. Tools necessary to quantify incremental climatic changes associated with these GHG emission estimates for the projected coal mine development activities in the PRB are presently unavailable. Technology to conduct such an analysis at this spatial and temporal scale simply does not exist; therefore, conclusions as to the magnitude or significance of the emissions on climate change cannot be reached. The impacts of climate change represent the cumulative aggregation of all worldwide GHG emissions, land use management practices, and the albedo effect. The analysis does provide a meaningful context and measure of the relative significance of coal use from the overall projected PRB coal production on total GHG emissions. Therefore, climate change analysis in this EIS is limited to accounting for and disclosing of factors that contribute to

climate change. To the extent that emission data were available or could be inferred from representative type data, potential GHG emissions that could result from development of the pending LBA tracts in the PRB (Table 1-2) have been identified, as well as emissions that would result from selection of the No Action alternatives.

Although the effects of GHG emissions and other contributions to climate change in the global aggregate are estimable, given the current state of science it is impossible to determine what effect any given amount of GHG emissions resulting from an activity might have on the phenomena of global warming, climate change, or the environmental effects stemming from it. It is therefore not currently possible to associate any particular action and its specific project-related emissions with the creation or mitigation of any specific climate-related effects at any given time or place. However, it is known that certain actions may contribute in some way to the phenomenon (and therefore the effects of) climate change, even though specific climate-related environmental effects cannot be directly attributed to them.

#### 4.2.14.3 U.S. Actions and Strategies to Address Greenhouse Gas Emissions

Potential regulatory policies to address climate change are in various stages of development at the federal, state, and regional levels (USDOE 2009b). A number of bills have been introduced in the U.S. Congress related to global climate change. At this time, there is no national policy or law in place that regulates GHG emissions.

The Lieberman-Warner Climate Security Act, which was introduced in October 2007 by Senators Joseph I. Lieberman (ID-CT) and John W. Warner (R-VA), would establish a cap-and-trade within the United States. In short, the “cap” would set a legal limit on the quantity of greenhouse gases that a region can emit each year and “trade” would allow companies to exchange the permission – or permits – to emit greenhouse gases. The cap would get tighter over time, until by 2050, emissions would be reduced by 63 percent below 2005 levels. The bill was approved by the Senate Environment and Public Works Committee in December, 2007 (<http://www.pewclimate.org>, accessed 12/21/2007). The bill was introduced in the Senate and read the first time on May 20, 2008. The Boxer-Lieberman-Warner substitute amendment to the Climate Security Act of 2008 was subsequently released by the Senate Environment and Public Works Committee on May 21, 2008. The bill was then read a second time and placed on the Senate Legislative Calendar under General Orders, Calendar No. 742. In June 2008 the U.S. Senate voted to invoke cloture on the Boxer amendment but did not pass the cap-and-trade legislation.

On June 26, 2009, the U.S. House of Representatives passed The American Clean Energy and Security Act of 2009. The legislation includes a federal GHG emissions cap-and-trade program that would take effect in 2012. The declining emissions cap requires that total GHG emissions be 17 percent below 2005 levels by 2020 and 83 percent below 2005 levels by 2050. In November 2009,

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the Senate Environment and Public Works Committee passed a GHG cap-and-trade bill that borrows much from the House American Clean Energy and Security Act and tightens the GHG emissions cap to 20 percent below 2005 levels by 2020. Several other committees are expected to weigh in before the final bill is crafted and brought before the Senate floor (USDOE 2009c).

On April 2, 2007, in *Massachusetts v. EPA*, the U.S. Supreme Court found that GHGs are air pollutants covered by the Clean Air Act (CAA). The Court held that the Administrator of the EPA must determine whether or not emissions of GHGs from new motor vehicles cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. At that time, the court directed EPA to review the latest science on climate change in order to make a determination. On April 17, 2009, the Administrator signed Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CAA. On December 7, 2009, the Administrator signed two distinct findings regarding GHGs under Section 202(a) of the CAA. The Administrator finds that the current and projected concentrations of the six key well-mixed greenhouse gases—carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>)—in the atmosphere threaten the public health and welfare of current and future generations and that the combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to climate change. The findings do not in and of themselves impose any emission reduction requirements but rather allow EPA to finalize the GHG standards proposed earlier in 2009 (EPA 2009c). The agency is now poised to regulate CO<sub>2</sub> as a pollutant, and the findings allow EPA to begin regulating GHG emissions from power plants, factories and major industrial polluters, although the precise details of that regulation have yet to be worked out. An endangerment finding under one provision of the CAA would not by itself automatically trigger regulation under the entire Act.

As a result of the Supreme Court's decision in 2007, the EPA drafted the Prevention of Significant Deterioration/Title V Greenhouse Gas Tailoring Rule. The draft rule, published in the Federal Register on October 27, 2009, limits the applicability of CO<sub>2</sub> emissions standards to new and modified sources that emit more than 25,000 tonnes CO<sub>2</sub>e annually, rather than applying the threshold of 250 tons per sources for triggering the regulation of criteria pollutants specified in Title V of the CAA. At the 25,000 tonnes CO<sub>2</sub>e annual level, the EPA expects that 14,000 large industrial sources, which are responsible for 70 percent of the U.S. GHG emissions, will be required to obtain Title V operating permits. That threshold would cover large power plants, refineries, and other large industrial operations (USDOE 2009c).

EPA has issued the Final Mandatory Reporting of Greenhouse Gases Rule (EPA 2010). The rule requires reporting of GHG emissions from large sources and suppliers in the U.S., and is intended to collect accurate and timely emissions data to inform future policy decisions. Under the rule, suppliers of fossil fuels

or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 tonnes or more per year of GHG emissions are required to submit annual reports to EPA. The gases covered by the proposed rule are carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride (NF<sub>3</sub>) and hydrofluorinated ethers (HFE). The final rule was signed by the Administrator on September 22, 2009. EPA's new reporting system will provide a better understanding of where GHGs are coming from and will guide development of the best possible policies and programs to reduce emissions. Reporters must begin to monitor their emissions on January 1, 2010 and the first annual emissions reports will be due in 2011 (EPA 2010).

The American Recovery and Reinvestment Act of 2009 ("The Stimulus Bill") was signed into law by President Obama on February 17, 2009, and under the Act, the U.S. DOE received \$36.7 billion to fund renewable energy, carbon capture and storage, energy efficiency, and smart grid projects, among others. The projects are expected to provide reductions in both energy use and GHG emissions (USDOE 2009c).

Federal, state, and local governments are also developing programs and initiatives aimed at reducing energy use and emissions. The 2002 Clear Skies and Global Climate Change Initiative is a voluntary national program to reduce greenhouse gas emissions. There are federal tax incentives for energy efficiency and conservation, and some states have renewable energy and energy efficiency policies. Regional initiatives have been started in the northeast (Northeast Regional Greenhouse Gas Initiative) as well as the Western Climate Initiative in the western states. At this time, it is not possible to predict how all of these programs would be melded into a national regulatory process if one were to be enacted.

A number of U.S. financial and corporate interests have acknowledged that enactment of federal legislation limiting the emissions of CO<sub>2</sub> and other greenhouse gases seems likely (NARUC 2007). There is uncertainty about anticipated CO<sub>2</sub> emission limits and carbon capture/sequestration regulations. This has caused some proponents to cancel or delay their proposed projects that use existing and emerging technologies to produce electricity from coal (Casper Star Tribune 2007c). Capacity planning decisions for new generating plants and investment behavior in the electric power sector are being affected by the potential impacts of policy changes that could be made to limit or reduce GHG emissions (USDOE 2009b).

#### 4.2.14.4 Current and Future Energy Sources and Emissions of Greenhouse Gases in the U.S.

The key determinant of energy consumption is population. Population influences demand for goods, services, housing, and travel. In the U.S. the population has increased by about 20 percent and energy consumption by a

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comparable 18 percent since 1990, with variations in energy use per capita depending on factors such as weather and the economy. To meet the nationwide consumer demand and requirement for energy, coal is burned in power plants to produce electricity. Coal is an important component of the U.S. energy supply partly because it is the most abundant domestically available fossil fuel (USGS 2002b). One-quarter of the world's coal reserves are found within the U.S.; the energy content of U.S. coal resources exceeds that of all the world's known recoverable oil; and coal resources supply more than half of the electricity consumed by Americans (USDOE 2008 and 2009d). Many countries are even more reliant on coal for their energy needs than is the United States. More than 70 percent of the electricity generated in China and India comes from coal (USGS 2000). The value of coal is partially offset by the environmental impacts of coal combustion (USGS 2000).

In the USDOE 2007 Annual Energy Outlook, energy-related CO<sub>2</sub> emissions were projected to grow by about 35 percent from 2006 to 2030 (USDOE 2007b). By comparison, the USDOE 2008 Annual Energy Outlook projected energy-related CO<sub>2</sub> emissions to grow by 16 percent, from 5,890 million tonnes in 2006 to 6,851 million tonnes in 2030 (USDOE 2008). However, USDOE's 2009 Annual Energy Outlook projects energy-related CO<sub>2</sub> emissions to grow by 7 percent, from 5,991 million tonnes in 2007 to 6,414 million tonnes in 2030. The mix of sources for these generation projections include coal, natural gas, nuclear, liquids (petroleum), hydro-power, and non-hydro renewables (wind, solar, etc.). The most recent, lower projected emissions growth rate is due to a slower demand growth combined with increased use of renewables and a declining share of electricity generation that comes from fossil fuels (USDOE 2009b).

Total U.S. anthropogenic GHG emissions in 2008 were 2.2 percent below the 2007 total. The decline in total emissions—from 7,209.8 million tonnes CO<sub>2</sub>e in 2007 to 7,052.6 million tonnes in 2008—was largely the result of a 177.8 million tonne CO<sub>2</sub>e drop in CO<sub>2</sub> emissions. There were small percentage increases in emissions of other GHGs, but those increases were more than offset by the drop in CO<sub>2</sub> emissions. The decrease in U.S. CO<sub>2</sub> emissions in 2008 resulted from higher energy prices, economic contraction, and lower demand for electricity (USDOE 2009c).

Energy-related CO<sub>2</sub> emissions dominate (about 81 percent in 2008) the total U.S. GHG emissions. Petroleum is the largest fossil fuel source for energy-related CO<sub>2</sub> emissions, contributing 41.9 percent of the total, whereas coal is the second-largest fossil fuel contributor, at 36.5 percent. Petroleum made up 44.6 percent of total fossil fuel energy consumption in 2008, as compared with coal's 26.8 percent. Natural gas accounted for 28.5 percent of the fossil fuel energy use in 2008, but only 21.4 percent of total energy-related CO<sub>2</sub> emissions. Energy-related CO<sub>2</sub> emissions account for 98 percent of the total U.S. CO<sub>2</sub> emissions (USDOE 2009c).

The U.S. emits about 1,900 million tonnes annually from coal-fired power plants—33 percent of total energy-related CO<sub>2</sub> emissions and 81 percent of CO<sub>2</sub> emissions from the U.S. electric power sector (USDOE 2009c). If public sentiment results in changed electric demand, or if GHG emissions are ultimately regulated, the demand forecast for coal for electric generation could change. The potential impacts of policy changes that could be made to limit or reduce GHG emissions is affecting planning decisions for new power plants, particularly with respect to new coal-fired capacity.

To assess the national electric generation portfolio and the mix of future electric generation technologies, BLM reviewed the Annual Energy Outlook 2010 Report (USDOE 2009e). An independent study representing a forecast to the year 2035, it examined the ability of the domestic electric generation industry to alter the present electric generation portfolio (mix of electric generation technologies). This report compares the 2035 projection to the electric generation mix that existed in 2008. This most recent report incorporates the 2009 downturn in electric demand, which resulted from lowered electric demand for manufacturing in the depressed domestic economy of 2009. This forecast estimated the percentage of coal-fired electric generation in the domestic electric generation portfolio at 44 percent by 2035, based on a slowing in electric demand through 2035, and a doubling, to 17 percent, of renewable electric generation in the domestic electric generation portfolio by 2035. Based on this study, even with a considerably more optimistic projection for renewable sources, coal use continues to be projected as the largest portion of the domestic electric fuel mix.

Technologies for producing cleaner, more efficient and more reliable power from coal are currently available and are being improved. These include advanced pulverized coal, circulating fluidized bed, coal gasification or Integrated Gasification Combined Cycle (IGCC), and carbon sequestration or carbon capture and storage (CCS) technologies. Systems that utilize carbon capture technologies are being developed to capture at least 90 percent of emitted CO<sub>2</sub>, which would be stored within geological formations (i.e., oil and gas reservoirs, saline formations, unmineable coal seams). These technologies are not yet commercially established due to extremely high capital costs and low system reliability, which are the biggest obstacles to integration of these technologies into the power market. However, regulatory uncertainties are affecting planning decisions, for example, unless new coal-fired power plants are equipped with CCS equipment they could incur higher costs as a result of higher expenses for siting and permitting. However, costs would not be directly affected by regulatory uncertainty for nuclear and renewable power plants because they do not emit GHGs (USDOE 2009c).

The Electric Power Research Institute (EPRI) has also attempted to identify a scenario of how the full portfolio of technologies to provide for electric energy would respond if national policy were to require that CO<sub>2</sub> emissions be reduced to 1990 levels (James 2007). EPRI updated this research in an October 2009

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report, *The Power to Reduce CO<sub>2</sub> Emissions: The Full Portfolio* (EPRI 2009), which used the EIA's Annual Energy Outlook 2009 Report for comparison.

The EPRI study predicts that national policy that forces a reduction of CO<sub>2</sub> emissions to 1990 levels would promote increased energy efficiency, and the growth of “non carbon” sources such as nuclear and renewable. Renewable sources include wind and solar, as well as emerging technologies like tidal power, river turbines and others reported in the media. Hydropower is limited because most opportunities for hydropower have been used or require large infrastructure. Use of carbon based sources such as natural gas and petroleum are less than forecasted by the USDOE EIA, while coal use remains about the same in the EPRI forecast, mostly due to forecasted improvement in GHG emission reduction in coal-fueled generation. Both EIA and EPRI forecast increases in electricity cost.

Figure 4-13 shows the current (2008) electric generation mix, compared to the 2035 EIA forecast (USDOE 2009e) as well as the older 2030 EPRI forecast (EPRI 2009). Both forecasts are consistent that the amount of electric generation fueled by coal is expected to drop from nearly fifty percent of the total presently to about 40 percent of the total in future years. Coal is forecast to remain as the major electric generation component until at least 2035. Renewable energy (other than hydroelectric) and nuclear are forecast to increase, while natural gas and other fossil fuels (i.e., oil) are forecast to remain stable or decrease to a degree.

In 2003 the USDOE initiated the FutureGen project—a commercial-scale coal-fired power plant incorporating IGCC with CCS—thus being the first facility of its kind to combine and test several cutting-edge technologies. FutureGen is a public-private partnership between the USDOE and the FutureGen Alliance, a non-profit organization that represents some of the world's largest coal producers and electric utilities, to build a first-of-its-kind coal-fired near-zero emissions power plant. The FutureGen Alliance and the USDOE reached an agreement in June 2009 to proceed with the project, which will be located at Mattoon, Illinois. The project proposes to produce electricity by turning coal into gas, remove impurities, extract CO<sub>2</sub> from the waste stream, and then sequester the CO<sub>2</sub> underground. The Alliance is responsible for design, construction, and operation of the facility, and USDOE is responsible for independent oversight and coordinating participation of international governments. USDOE's financial contribution will come from the American Recovery and Reinvestment Act. The USDOE issued a NEPA Record of Decision (ROD) on July 14, 2009 to move forward toward the first commercial scale, fully integrated, carbon capture and sequestration project in the country (USDOE 2009f). The ROD allows the Alliance to proceed with site-specific activities, and over the following 8 to 10 months the project design, costs and funding plan will be refined. The USDOE and the Alliance will then decide in early 2010 whether to continue the project through construction and operation. When fully operational the FutureGen facility will produce 275 MW

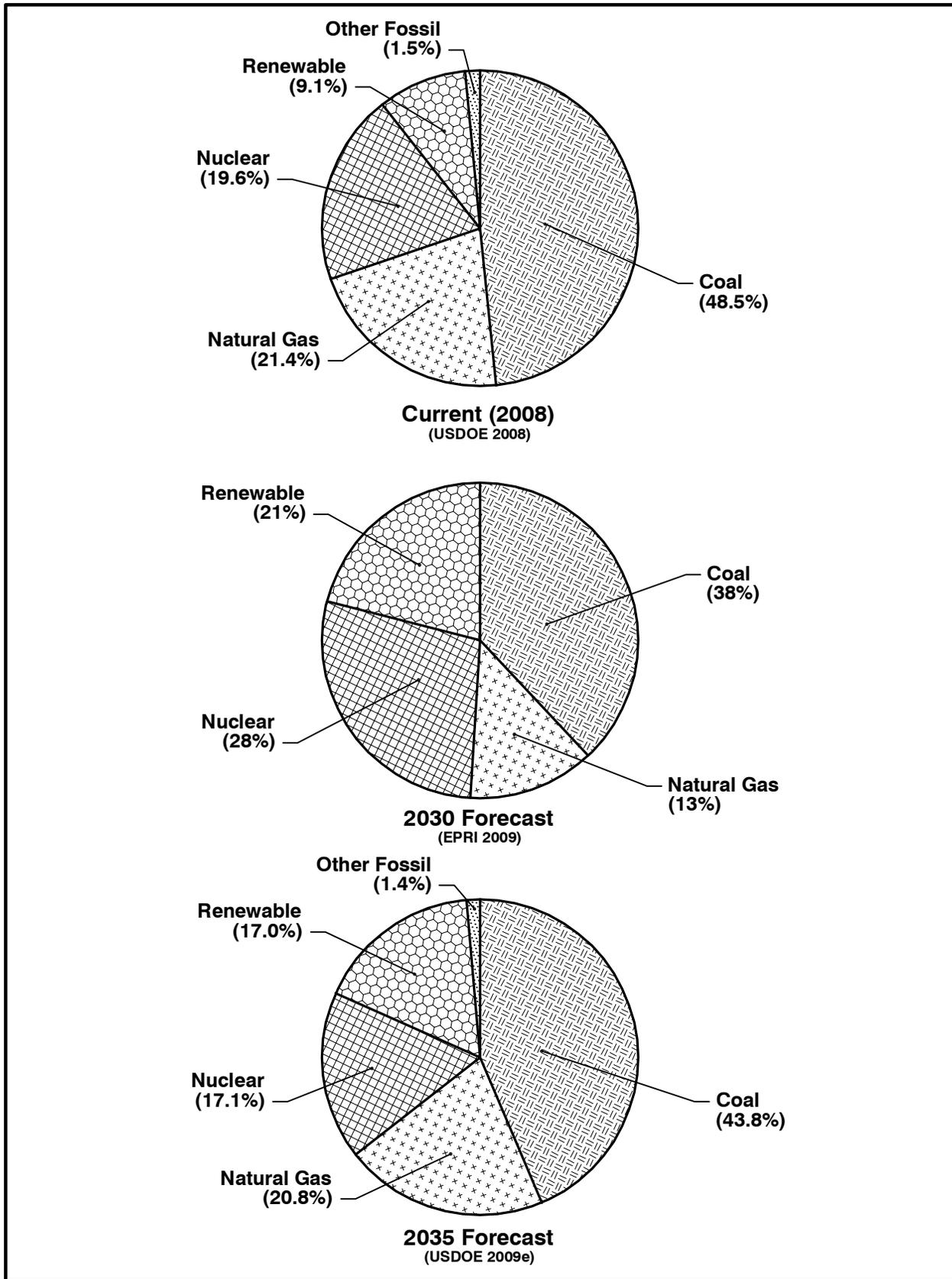


Figure 4-13. Current and Forecast Mix of Electric Generation Sources.

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of power and capture 90 percent of the carbon emissions; however, it may be operated at a 60 percent capture rate in the first 3 years to validate plant integration and sequestration capability, as well as manage the startup risks and costs. This technology should sequester a million tons of CO<sub>2</sub> annually (USDOE 2009f).

Other methods of generating electricity that result in fewer GHG emissions than burning coal include natural gas, nuclear, hydroelectric, solar, wind, and geothermal resources.

Natural gas plays a key role in meeting U.S. energy demands. Natural gas, coal and oil supply about 85 percent of the nation's energy, with natural gas currently supplying about 22 percent of the total. The percent contribution of natural gas to the U.S. energy supply is expected to remain fairly constant for the next 20 years. According to EIA's 2010 Annual Energy Outlook (USDOE 2009e), concerns about GHG emissions have little effect on construction of new capacity fueled by natural gas.

Unconventional natural gas resources are expected to play a larger role in the demand for natural gas for electricity generation (USDOE 2009b and 2009e). Natural gas production from hydrocarbon rich shale formations, known as "shale gas" is one of the most rapidly expanding trends in onshore domestic oil and gas exploration and production today. Analysts estimate that by 2011, most new natural gas reserves will come from unconventional shale gas reservoirs (NETL 2009). From 2007 to 2030, domestic production of natural gas is expected to increase by 22 percent (USDOE 2009b).

The nuclear share of power generation is projected by EPRI (2009) to increase to about 28 percent by 2030 as the addition of new power plants and upgrades at existing units increases overall capacity and generation, and the nuclear power share of total electricity generation remains somewhat constant at 17-19 percent by 2035 according to EIA (USDOE 2009e).

The share the nation's total electricity generation from renewables (i.e., biomass-based diesel, hydroelectricity, geothermal, solar, wind, ethanol), supported by federal tax incentives and state renewable programs, is expected to increase from 9 percent in 2008 to 17 percent in 2035 (USDOE 2009e). EPRI (2009) is more optimistic with renewable sources reaching 21 percent by 2030.

The estimated cumulative CO<sub>2</sub> emissions that would be produced annually from the conventional combustion of the coal produced from the six WAC LBA tracts, if they are all leased under either the Proposed Action or Alternative 2 (Section 4.2.14.2) are based on the applicant mines' projected future mining rates. Those estimates present a scenario that assumes the demand for coal in the future would not differ from current demand, technologies for producing cleaner, more efficient and more reliable power from coal (i.e., advanced pulverized coal, circulating fluidized bed, IGCC, and CCS) would not yet be

commercially established, and an explicit federal policy has not been enacted to limit or reduce U.S. GHG emissions. However, if there is a strong shift toward natural gas, nuclear, and renewable power generation, as well as fossil technologies with CCS equipment, those estimates of CO<sub>2</sub> emissions from the combustion of coal produced from the PRB would be lower than estimated in the prior discussion (Section 4.2.14.2).

#### 4.2.14.5 Mercury, Coal Combustion Residues, and Other By-Products

One of the concerns associated with burning coal for the production of electricity is the release of elements from coal to the environment (USGS 2000). When coal is burned, GHGs as well as mercury and other compounds and elements, including lead and cadmium, that may have direct or indirect effects on human health are released (EPA 2009d). The principal pollutants generated by coal combustion that can cause health problems are particulates, sulfur and nitrogen oxides, trace elements (including arsenic, fluorine, selenium, and radioactive uranium and thorium), and organic compounds generated by incomplete coal combustion (USGS 2000).

In coal combustion, concentrations of these elements and compounds vary depending on the chemistry of the coal deposits and on the type of air pollution controls in place when the coal is burned. Coal use in developing countries can potentially cause serious human health impacts (USGS 2000). Some coal mined in China is known to have caused severe health problems in several local populations because the coal was mined and burned with little regard to its chemical composition (USGS 2000). Chinese coals that contained high levels of arsenic, fluorine, selenium, and polycyclic aromatic hydrocarbons have caused severe, life-threatening health impacts to some residents that burned the coal in unvented stoves in their homes (USGS 2000).

Coal that is burned in the U.S. generally contains low to modest concentrations of potentially toxic trace elements and sulfur (USGS 2000). Specifically, PRB coal is recognized as being a clean burning coal due to its low sulfur and low ash properties. In a 2002 analysis conducted by USGS (2002b), PRB coal was found to contain, on average, approximately eight times less sulfur than coals being utilized from the Appalachian and Illinois basins to supply U.S. power plants (feed coal). PRB feed coal was also found to contain nearly half as much uranium (8.9 ppm), seven times less arsenic (17 ppm), five times less lead (19 ppm), and three times less cadmium (1.1 ppm) as compared to Appalachian and Illinois basin feed coals. When burned, PRB coal produced, on average, 38 percent less fly ash than Appalachian and Illinois basin coals (USGS 2002b). The fly ash resulting from combusted PRB coal contained approximately 39 times less mercury than fly ash that was generated from combusted Appalachian and Illinois basin coal (USGS 2002b).

Additionally, many U.S. coal burning power plants use sophisticated pollution-control systems that efficiently reduce the emission of hazardous elements (USGS 2000). The EPA conducted a detailed study of possible health impacts

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from exposure to emissions of approximately 20 potentially toxic substances from U.S. coal-burning power plants (USGS 2000). The EPA concluded that, with the exception of possibly mercury, there is no compelling evidence to indicate that emissions from U.S. coal-burning power plants cause human health problems (USGS 2000).

Mercury is a naturally occurring element and enters the environment as a result of natural sources, such as active volcanoes, and through human activities such as industrial combustion and mining (EPA 2006). Natural sources of mercury, such as volcanic eruptions and emissions from the ocean, have been estimated to contribute about 33 percent of the current worldwide mercury air emissions; anthropogenic (human-caused) mercury emissions account for the remaining 67 percent, though these estimates are highly uncertain (EPA 2009e).

When fossil fuels burn, mercury vapor can be released into the atmosphere where it may drift for a year or more, spreading with air currents over vast regions of the globe (USDOE 2006). In 1995, an estimated 5,500 tons of mercury was emitted globally from both natural and human sources, and coal-fired power plants in the U.S. contributed to less than one percent of that total (USDOE 2006).

Mercury is a global problem that knows no national or continental boundaries. It can travel thousands of miles in the atmosphere before it is eventually deposited back to the earth in rainfall or in dry gaseous forms. EPA estimates that about one-third of the U.S. anthropogenic mercury emissions are deposited within the contiguous U.S. and the remainder enters the global cycle (EPA 2009e).

Table 4-40 summarizes how the various continents contributed to the worldwide anthropogenic mercury emissions in 2004. The 2004 U.S. anthropogenic mercury emissions were estimated to account for about three percent of the global total (EPA 2009e). EPA estimates that 83 percent of the mercury deposited in the U.S. originates from international sources, with the remaining 17 percent coming from the U.S. and Canada. These figures include mercury from natural and anthropogenic sources (EPA 2006).

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Table 4-40. 2004 Percent Contribution to Worldwide Anthropogenic Mercury Emissions.

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<b>Continent</b>	<b>Percent</b>
Asia	53
Africa	18
Europe	11
North America	9
Australia	6
South America	4

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Source: EPA 2009e

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In 2006, EPA estimated that 50-70 percent of current global anthropogenic atmospheric emissions came from fuel combustion, and much of it came from China, India, and other Asian countries. Coal consumption in Asia is expected to grow significantly over the next 20 years. This international source of mercury emissions may grow substantially if left unaddressed (EPA 2006).

Over the past decade, addressing environmental and human health mercury risks has been a focus for EPA. Overall U.S. mercury air emissions have been reduced by 45 percent since 1990. EPA is most concerned with methyl mercury, a potent form of mercury and the form to which humans are primarily exposed (EPA 2006).

Atmospheric mercury can settle into water or onto land where it can be washed into the water. Certain microorganisms can transform mercury into methyl mercury, a highly toxic mercury compound that builds up in fish and shellfish when they feed. Methyl mercury is the only form of mercury that biomagnifies in the food web. Concentrations of methyl mercury in fish are generally on the order of a million times the methyl mercury concentration in the water. The primary pathway of human exposure to mercury is through eating fish containing methyl mercury (EPA 2006).

There are adverse health effects to humans and other animals that consume these fish and shellfish. Birds and mammals that eat fish may be more exposed to mercury more than other animals in water ecosystems (EPA 2008c). At high levels of exposure, methyl mercury's harmful effects may include death, reduced reproduction, slower growth and development, and abnormal behavior (EPA 2008c). Research has shown that most people's fish consumption does not cause a health concern, but high levels of methyl mercury in the bloodstream of unborn babies and young children may harm the developing nervous systems of those children (EPA 2006).

The USDOE's Office of Fossil Energy has been sponsoring studies on mercury emissions from coal-based power generators to identify effective and economical control options for the past decade. The Office of Fossil Energy manages the largest funded program in the U.S. for developing an understanding of mercury emissions and developing emission control technologies for the coal-fired electric generating industry in the U.S. (USDOE 2006). Research on advanced and improved mercury control technology is ongoing.

In the U.S., coal-burning power plants are the largest human-caused source of mercury emissions being released into the air, accounting for about 40 percent of all domestic human-caused mercury emissions (EPA 2008c). However, these emissions contribute little to the global mercury pool. EPA estimated that mercury emissions from U.S. coal-fired power plants account for about 1 percent of the global total (EPA 2009e).

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Coal production from the Wyoming PRB represented approximately 42 percent of the coal used for power generation in 2006, which would represent about 0.4 percent of the global anthropogenic mercury emissions. The three applicant mines (Black Thunder, Jacobs Ranch and North Antelope Rochelle) produced about 45.4 percent of the coal produced in the Wyoming PRB in 2006, which would represent about 0.2 percent of the global mercury emissions. Under the No Action alternatives, mercury emissions attributable to burning coal produced by the three applicant mines would be extended at about current levels of up to approximately 11 years beyond 2008, while the mines recover their remaining leased coal reserves. Under the Proposed Actions or Alternatives 2 or 3, the three applicant mines contribution to global mercury emissions would be extended from about 1.6 to 22.8 additional years, depending on the tract and alternatives selected. Uncertainties about future regulatory requirements and the use of the coal mined from the six WAC LBA tracts make it difficult to project the impacts of mercury emissions produced by burning coal produced from these tracts.

Additionally, burning coal in electric utility boilers generates residual materials which are referred to as coal combustion residues. These residues include non-combustible materials left in the furnaces and ash that is carried up the smokestacks and collected by air pollution control technologies. As previously referenced, coal and coal combustion residues can contain a variety of compounds, metals, and other elements depending on the coal deposit and upon the site-specific characteristics of where the coal originated from. Coal-fired boilers are required to have control devices to reduce the amount of emissions that are released into the atmosphere (EPA 2007f). The use of air pollution control equipment at power plants has resulted in fewer emissions but has also increased the amount of solid residues.

In the past, coal combustion residues have generally been recycled or disposed of in landfills or surface impoundments. More recently, these residues have been disposed of in mines as part of the reclamation process. There can potentially be risks of contamination of drinking water supplies and surface water bodies by coal combustion residues, particularly when they are disposed of in mines (National Academy of Science 2006, EPA 2002). The EPA is evaluating management options for solid wastes from coal combustion, including whether current management practices pose risks to human health or ecological receptors. A draft report, dated August 6, 2007, prepared for the EPA Office of Solid Waste, and entitled "Human and Ecological Risk Assessment of Coal Combustion Wastes," is available at <http://www.earthjustice.org/library>; however, the report is labeled as a draft document that is not to be cited or quoted.

As discussed above, the WAC applicant mines produced about 45.4 percent of the coal produced in the Wyoming PRB in 2006. Under the No Action alternatives, production of coal combustion residue attributable to burning coal produced from the coal mines would be extended at about current levels for up to approximately 11 years beyond 2008, while the mines recover their

remaining leased coal reserves. Under the Proposed Action or Alternatives 2 or 3, coal combustion residue related to burning coal mined at the applicant mines would be extended from 1.6 to 22.8 additional years, depending on the tract and alternatives selected. Uncertainties about future regulatory requirements and the use of the coal mined from the six WAC LBA tracts make it difficult to project the impacts of disposing coal combustion residues produced by burning coal produced from these tracts.

Depending on the size, shape, and chemical composition, some coal combustion residues can be recycled and beneficially reused as components of building materials or as replacement to raw materials that would ordinarily need to be mined such as sand, gravel, or gypsum (EPA 2007f). Coal combustion products (CCPs) are the materials produced primarily from the combustion of coal in coal-fired power plants and can include the following materials: fly ash, bottom ash, boiler slag, and flue gas desulfurization material (EPA 2007f). Studies and research conducted or supported by the EPA, Electric Power and Research Institute (EPRI), other government agencies, and universities have indicated that the beneficial uses of coal combustion products have not been shown to present significant risks to human health or the environment (EPA 2008d).

Fly ash is a byproduct of burning finely ground coal in a boiler to produce electricity. Physically, fly ash is a fine, powdery material composed mostly of silica and nearly all particles are spherical in shape. Fly ash is a pozzolan—a siliceous material which, in the presence of water, will react with calcium hydroxide at ordinary temperatures to produce cementitious compounds. Because of its spherical shape and pozzolanic properties, fly ash can be useful in cement and concrete applications (EPA 2007g).

Bottom Ash is agglomerated ash particles, formed in pulverized coal furnaces that are too large to be carried in the flue gases. Bottom ash is coarse with grain sizes spanning from fine sand to fine gravel. It can be used as a replacement for aggregate and is usually sufficiently well-graded in size to avoid the need for blending with other fine aggregates to meet gradation requirements (EPA 2007h).

Boiler slag is the molten bottom ash collected at the base of slag tap and cyclone type furnaces. Boiler slag particles are uniform in size, hard, and durable with a resistance to surface wear. The permanent black color of this material is desirable for asphalt applications and aids in the melting of snow (EPA 2007i).

Flue Gas Desulfurization (FGD) material is a product of a process typically used for reducing SO<sub>2</sub> emissions from the exhaust gas system of a coal-fired boiler (EPA 2007j). These materials can be used as embankment and road base material, wallboard manufacturing, and in place of gypsum for the production of cement. Currently, the largest single market for FGD material is in wallboard manufacturing (EPA 2007j).

#### *4.0 Cumulative Environmental Consequences*

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Utilizing CCPs can generate significant environmental and economic benefits (EPA 2009f). CCPs can be used for raw feed for cement, concrete, grout, flowable fill, structural fill, road base/sub-base, soil modification, mineral filler, snow and ice traction control, blasting grit and abrasives, roofing granules, mining applications, wallboard, waste stabilization/solidification, and soil amendment. Using CCPs can reduce energy consumption and GHG emissions and can help reduce the need for landfill space. Economic benefits include reduced costs associated with managing coal ash and slag disposal, potential revenue from the sale of CCPs, and savings from using CCPs in place of other more costly raw materials (EPA 2009f).

CCPs offer product-performance benefits as well. Boiler slag is a sought-after replacement for sand in blasting grit because it is free of silica and eliminates the potential health risk of silicosis (EPA 2007i). High coal ash-content concrete is used for building long-lived pavements designed to last 50 years—twice the lifetime of conventional pavements. Coal fly ash can create superior products because of its self-cementing properties. Using coal fly ash in concrete can also produce stronger and longer-lasting buildings (EPA 2007g). This not only reduces the costs of maintaining buildings, but provides the additional environmental benefit of reducing the need for new concrete to repair or replace aging buildings. This translates to a significant reduction in future energy consumption and GHG emissions (EPA 2007g).

In 2005, demand had become so strong for coal ash that some power plants were selling all the ash they produced (EPA 2005b). EPA estimated that through the utilization of 15 million tons of coal fly ash, the U.S. reduced its GHG emissions equivalent to the annual emissions of nearly 2.5 million passenger vehicles (EPA 2008e).

Because of the many potential uses of CCPs, EPA has sponsored the Coal Combustion Products Partnership (C<sup>2</sup>P<sup>2</sup>) Program to further the beneficial use of these coal combustion by-products (EPA 2003b). With more than 170 private and public partners (EPA 2009g), the C<sup>2</sup>P<sup>2</sup> Program is a cooperative effort between EPA and various organizations to help promote the beneficial use of CCPs and the environmental benefits that can result from the proper use of these potentially recyclable materials (EPA 2003b). The C<sup>2</sup>P<sup>2</sup> Program will help meet the national waste reduction goals of the Resource Conservation Challenge—an EPA effort to find flexible yet more protective ways to conserve valuable natural resources through waste reduction, energy recovery, and recycling (EPA 2009g).

In 2007, the U.S. used approximately 43 percent of its coal combustion products (EPA 2009f). The C<sup>2</sup>P<sup>2</sup> Program aims to reduce adverse effects on air and land by increasing the use of coal combustion products to 50 percent in 2011 from 32 percent in 2001 (EPA 2009g). The program also plans to increase the use of CCPs as a supplementary cementitious material in concrete by 50 percent, from 12.4 million tons in 2001 to 18.6 million tons in 2011; this

would decrease GHG emissions from avoided cement manufacturing by approximately 5 million tons (EPA 2009g).