4.0 CUMULATIVE ANALYSES

Chapter 4 summarizes existing conditions and cumulative impacts in the PRB[1], as well as projected changes to those cumulative impacts that could result from adding future developments in the area. 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.

The table (table 4-41) presented at the end of this chapter provides a summary of the magnitude and duration of cumulative impacts in the PRB based on upper and lower estimates for future coal production in the region, as described in the following discussion. The Proposed Action and alternatives for the Hay Creek II EIS fall within those projections.

The BLM completed three regional 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 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.

The BLM is currently completing the final phases of 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, CBNG, 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 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 Proposed Action, are approved. The contents and completion dates of the various task reports include:

- Task 1A Report (BLM 2005a): existing air quality conditions;

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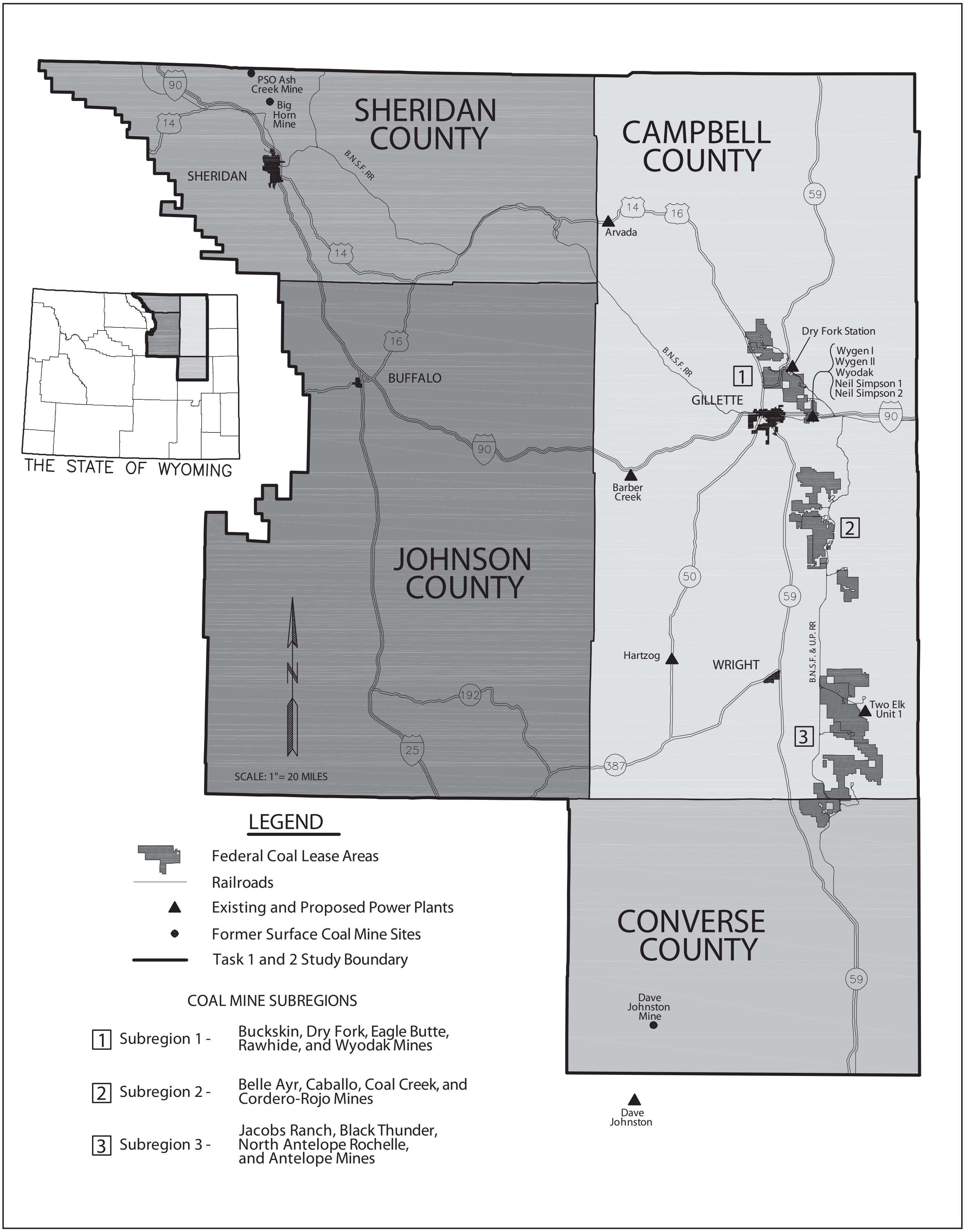
[1] Refer to page xx for a list of abbreviations and acronyms used in this document.

- Task 1B Report (BLM 2006c) and update to the Task 1B Report (BLM 2009e): existing water resources conditions;
- Task 1C Report (BLM 2005b): existing social/economic conditions;
- Task 1D Report (BLM 2005c): existing other environmental resource conditions;
- Task 2 Report (BLM 2005d) and update to the Task 2 Report (BLM 2009c): past and present coal, oil and gas, and other development;
- Task 3A Report (BLM 2006d) and updates to the Task 3A Report (BLM 2008a, BLM 2009d): predicted air quality conditions;
- Task 3B Report (BLM 2006e) and update to the Task 3B Report (BLM 2009f): predicted water resources conditions;
- Task 3B Phase 2 evaluation (BLM, in progress): predicted water resource conditions;
- Task 3C Report (BLM 2005e): predicted social/economic conditions; and
- Task 3D Report (BLM 2005f) and update to the Task 3D Report (BLM 2009g): predicted other resource conditions.

The Task 1 and Task 2 reports have been completed. The update to the Task 2 Report (BLM 2009c) is reflected in this document. The Task 3 reports for air quality conditions, water resources conditions, social/economic conditions, and other resource conditions have also been completed. Information from the 2008 update to the Task 3A Report (BLM 2008a) was included in the Hay Creek II LBA draft EIS to project air quality effects for 2015. After the draft EIS was issued, modeling of cumulative air quality effects for 2020 was completed (BLM 2009c); data and analyses for both model years are reflected in this final EIS. The groundwater impacts modeling portion of the Cumulative Water Resources Effects (BLM 2009e) was recently completed and is also reflected in this document, along with the cumulative surface water effects. The Task 3B Phase 2 evaluation of water resource conditions is in progress. 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 at: 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 (map 4-1).



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

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 within the PRB, because that is the area where surface coal mining operations and CBNG production operations would affect 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 analyses of past, present, and future levels of development presented in the Task 1 and Task 2 reports. Section 4.2 summarizes the predicted cumulative impacts on air, water, socioeconomic, and other resources presented in the Task 3 reports.

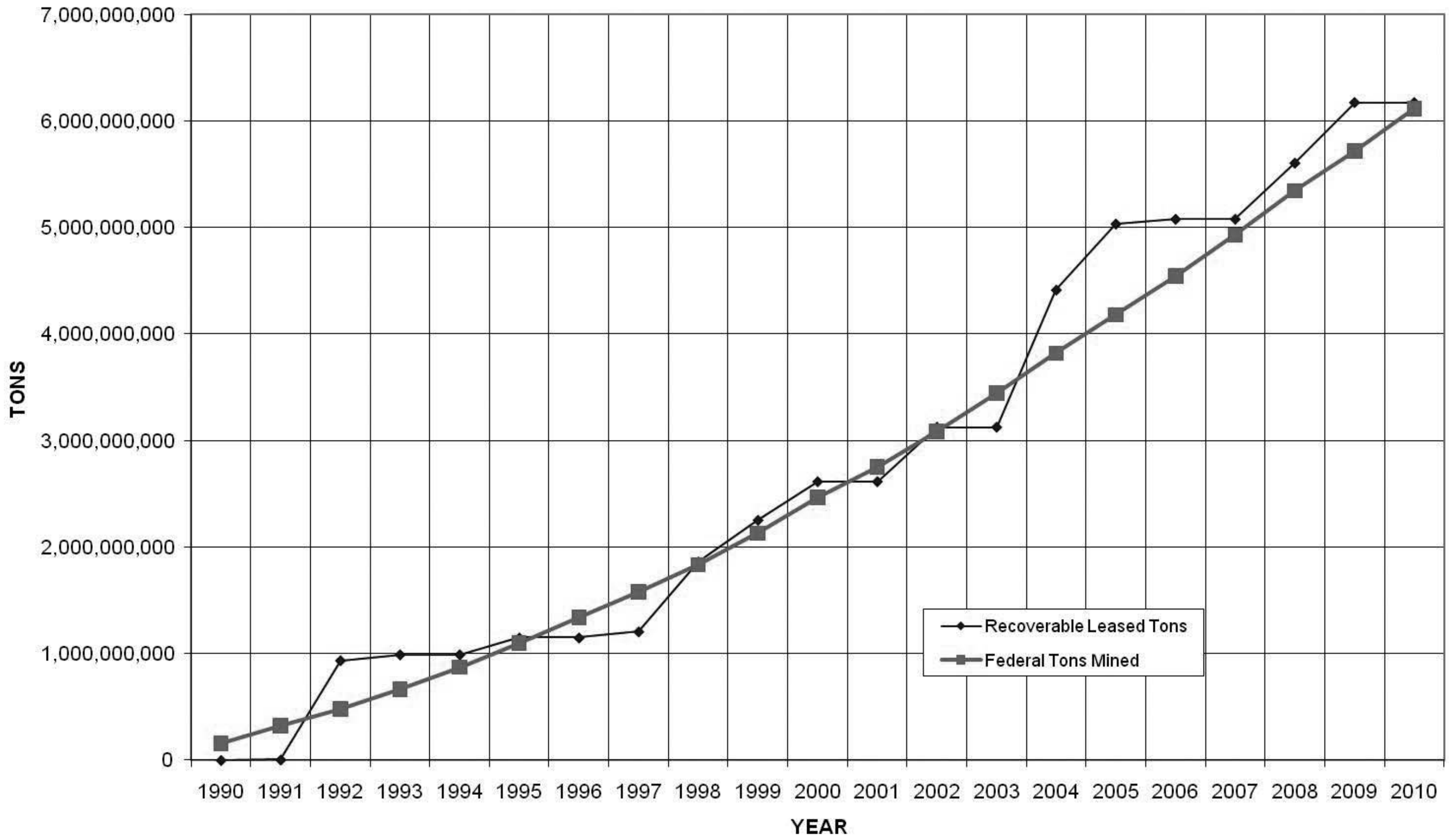
4.1 Past, Present, and Reasonably Foreseeable Development

Past, present, and reasonably foreseeable development in the Wyoming PRB are considered in the Task 1 and Task 2 reports. 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 2009 (BLM 2009c).

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 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 July 2010, the BLM's Wyoming State Office held 28 competitive coal lease sales and issued 20 new federal coal leases containing almost 5.7 billion tons of coal using the LBA process. The lease sales are listed in chapter 1, table 1-1, and the leased tracts are shown on map 1-1. This leasing process has undergone the scrutiny of two appeals to the Interior Board of Land Appeals and one audit by the General Accounting Office. As can be seen on figure 4-1, 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 listed in table 1-2.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Figure 4-1

Recoverable Tons of Federal Coal Leased Versus Tons of Federal Coal Mined Since 1990 in Campbell and Converse Counties, Wyoming

The 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 (I-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.
- Powder River Coal Company Alluvial Valley Floor 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, the baseline year for the 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 mines 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 Mine, 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 (map 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 postmining 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. The WDEQ approved this change of land use in three stages between September 2007 and May 2008. The Glenrock Wind Energy Project is sited at the reclaimed surface coal mine and; it began operations in late 2008 and early 2009.

Other operations related to surface coal mining have existing permits 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. Nevertheless, the WDEQ continues to monitor all three mines with field inspections; groundwater monitoring is also conducted at the Ash Creek Mine. 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 later in this chapter.

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 (million tons)[a]	Permitted Production Level (million tons)[b]	Status and Additional Comments
Subregion 1 (North Gillette)					
Buckskin	SMC (Zeigler)	Kiewit Mining Properties, Inc.	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, Inc.[c]	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)
Total			77.7	128.0	
Subregion 2 (South Gillette)					
Belle Ayr	Cyprus-Amax	Foundation Coal West, Inc.	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[d]	40.5	65.0	Active (consolidation of former Cordero and Caballo Rojo Mines)
Coal Creek	ARCO	Arch Coal Inc.	10.2	25.0	Inactive 2000, operations resumed in May 2006
Total			108.5	185.0	
Subregion 3 (Wright)					
Antelope	Kennecott	Rio Tinto Energy America[d]	34.5	36.0	Active
Black Thunder	ARCO	Arch Coal Inc.	65.3	100.0	Active
Jacobs Ranch	Kerr-McGee	Rio Tinto Energy America[d]	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
Total			250.3	325.0	
Total for 3 Subregions			436.5	638.0	

[a] Wyoming State Inspector of Mines (2007) and Shamley pers. comm.
[b] WDEQ 2007 permitting levels (Shamley pers. comm.)
[c] Ownership of the Eagle Butte Mine and Belle Ayr Mine changed from Foundation Coal West, Inc., to Alpha Coal West, Inc. as of July 31, 2009. Notification of new ownership was submitted to the BLM in August 2009.
[d] Kennecott Energy Company changed its name to Rio Tinto Energy America in 2006 and to Cloud Peak Energy Resources LLC in 2009.

In March 2008, the Fort Union plant was idled down. In August 2010, Evergreen Energy Inc. agreed to sell the Fort Union site to Synthetic Fuels LLC of Colorado, which has plans to develop a coal-to-liquids facility on the site (MarketWatch, Inc. 2010).

The active mines in the Wyoming PRB are geographically grouped into three subregions (map 4-1) for purposes of this cumulative impact discussion: 1) North Gillette; 2) South Gillette; and 3) Wright. 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 2005 Task 2 Report (BLM 2005b) projected that a new mine would be developed near Sheridan by 2010. In April 2007, P&M and CONSOL Energy Inc. announced that they had 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 (Shewski 2007).

The surface coal mines listed in table 4-1 currently produce over 96% of the coal produced in Wyoming each year. Since 1989, coal production in the PRB has increased by an average of 6% per year. The increasing production is primarily because of 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 CAA Amendments. Electric utilities account for 97% of Wyoming's coal sales. In 2009, production from the Wyoming PRB coal mines dropped by about 7% from the 2008 levels, the first drop since the early 1900s. This drop coincided with a national coal production decline resulting from reduced industrial electric demand in 2009.

In 2003, the baseline year for the PRB Coal Review, more than 35% of the coal mined in the United States came from the Wyoming PRB. According to the DOE, that amount had increased to about 38% by 2007 and to over 38% by 2009 (U.S. Energy Information Administration 2009a and 2009b).

The 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% of Campbell County, where the majority of the leases are located.

Both the 2005 and updated 2009 Task 2 reports 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:

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

- availability, projected production cost, and quality of future mine-specific coal reserves within the PRB region; and
- 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 in figure 4-2 and tables 4-2 and 4-3. The actual 2007 and 2008 production levels are also shown on figure 4-2 for 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 that are or that are projected to be permanently reclaimed;
- areas that are or that are projected to be undergoing active mining or that have been mined but are not yet reclaimed; and
- areas that are or that are projected to be occupied by mine facilities, haul roads, stockpiles, and other long-term structures, and that 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 Hay Creek II LBA is associated with the Buckskin Mine in the North Gillette subregion of mines. The analysis assumes that if the proposed tract or an alternative tract configuration is offered and if the applicant becomes the lessee, the mine will increase current production to a level where the five mines collectively will produce at an aggregate production level midway between the low and high projected coal production scenarios for 2015 and 2020 shown in figure 4-2 and tables 4-2 and 4-3; Kiewit does not anticipate an actual increase in average annual production as a result of acquiring a new maintenance tract. The existing and projected coal development levels and associated disturbance shown in tables 4-2 and 4-3 include production at the five North Gillette 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 proposed tract or alternative tract configuration. If the Proposed Action or Alternative 2 is implemented, mining of the federal coal reserves would extend the current Buckskin Mine life-of-mine estimate by two years or up to six years, respectively.

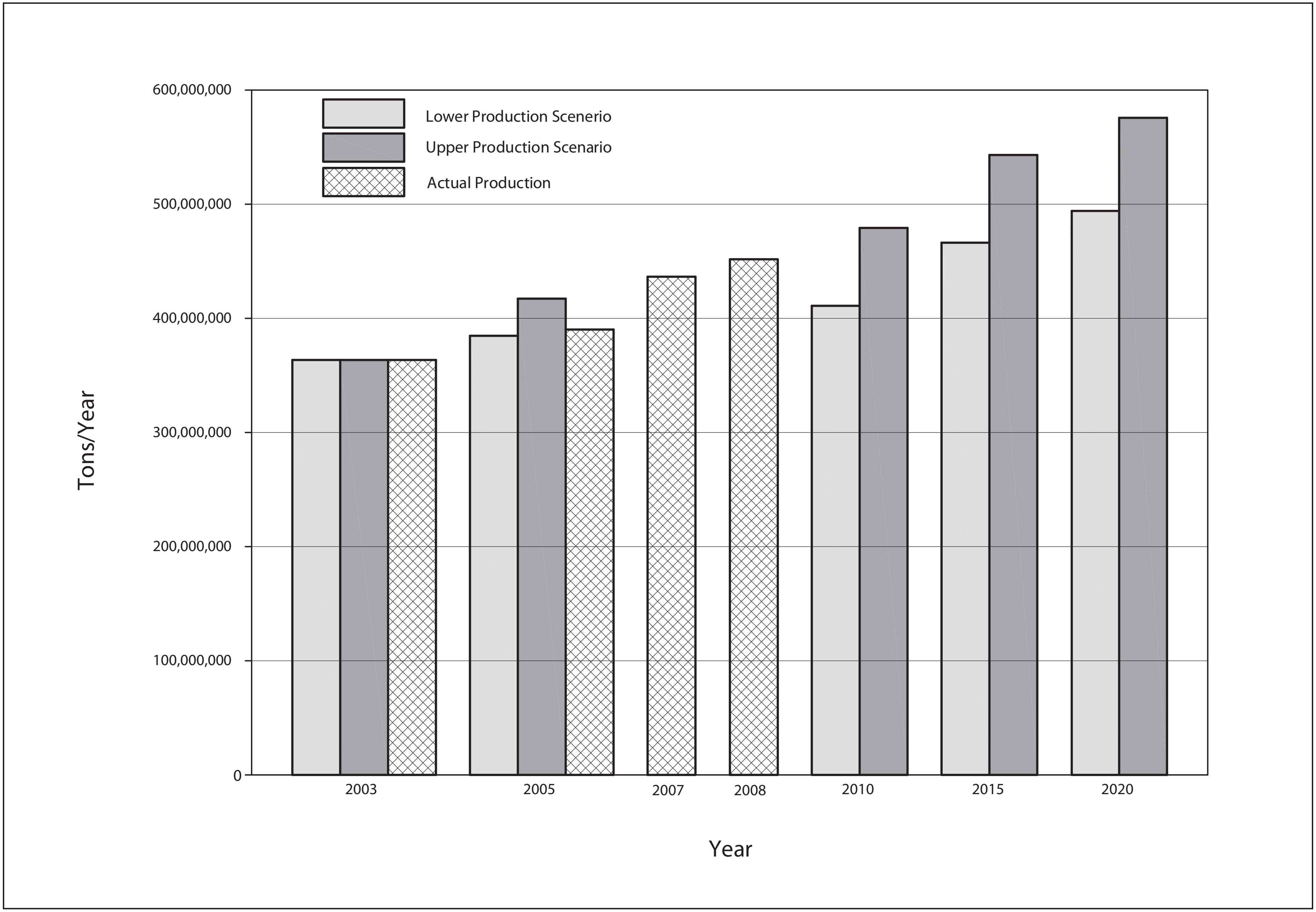


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Figure 4-2

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

Subregion	Annual Production (million tons)	Cumulative Disturbed Area (acres)	Cumulative Permanently Reclaimed Area (acres)	Cumulative Active Mining Area and Unreclaimed Mined Area (acres)	Cumulative Area Disturbed and Unavailable for Reclamation[a] (acres)	Total Mine Employment	Annual Water Consumption (mmgpy)	Annual Water Production (acre-feet)
Original Baseline Year (2003)								
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
Total for 2003	364	68,794	21,238	23,459	24,097	4,697	2,640	1,386
Actual 2007								
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
Total for 2007	428	83,593	25,884	52,272	24,338	5,533	2,604	1,386
Reasonably Foreseeable Development for 2010								
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
Total for 2010	411	98,662	44,938	27,386	26,338	5,263	1,793	2,258
Reasonably Foreseeable Development for 2015								
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
Total for 2015	467	117,236	61,188	28,499	27,549	5,405	2,059	2,258
Reasonably Foreseeable Development for 2020								
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
Total for 2020	495	137,443	79,463	29,182	28,797	5,531	2,162	2,258

[a] Area unavailable for reclamation includes disturbed areas occupied by permanent or long-term facilities such as buildings, roads, and topsoil stockpiles.

Source: Updated Task 2 Report (BLM 2009c).

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

Subregion	Annual Production (million tons)	Cumulative Disturbed Area (acres)	Cumulative Permanently Reclaimed Area (acres)	Cumulative Active Mining Area and Unreclaimed Mined Area (acres)	Cumulative Area Disturbed and Unavailable for Reclamation[a] (acres)	Total Mine Employment	Annual Water Consumption (mmgpy)	Annual Water Production (acre-feet)
Original Baseline Year (2003)								
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
Total for 2003	364	68,794	21,238	23,459	24,097	4,697	2,640	1,386
Actual 2007								
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
Total for 2007	428	83,593	25,884	52,272	24,338	5,533	2,604	1,386
Reasonably Foreseeable Development for 2010								
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
Total for 2010	479	102,448	46,771	29,989	25,688	5,339	2,030	2,258
Reasonably Foreseeable Development for 2015								
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
Total for 2015	543	124,545	65,396	32,139	27,009	5,522	1,897	2,258
Reasonably Foreseeable Development for 2020								
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
Total for 2020	576	149,089	86,196	34,545	28,345	5,678	2,403	2,258

[a] Area unavailable for reclamation includes disturbed areas occupied by permanent or long-term facilities such as buildings, roads, and topsoil stockpiles.
Source: Updated Task 2 Report (BLM 2009c).

As discussed in sections 1.1.3.1, Kiewit estimates that the existing Buckskin Mine had approximately 344.3 million tons of recoverable coal reserves at the end of 2008. Overall, the mine had produced a total of 339.8 million tons of coal as of December 2008, with annual production averaging 20.6 million tons over the previous six years. The mine's current air quality permit as approved by the WDEQ allows mining of up to 42 million tons of coal per year. If the mine produces coal at the projected average annual estimate of 25 million tons, the remaining recoverable reserves would be depleted in less than 14 years (2022). If the mine increases production to the permitted level, the remaining recoverable reserves at the Buckskin Mine would be depleted in about 8.8 years (2016). Kiewit estimates that the proposed tract includes approximately 54.1 million tons of recoverable coal. Based on that estimate, acquisition of the proposed tract would increase the recoverable reserves at the Buckskin Mine by almost 14.6%. At the estimated future average annual production level (25 million tons), mine life would be extended by over two years. However, if production levels increase to the currently permitted level (42 million tons per year) or if the WDEQ 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-kilovolt [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 (acres)

Actual			Projected	
2003	2007	2010	2015	2020
4,892	5,802	5,963	6,915	6,914

Source: Updated Task 2 Report (BLM 2009c).

Coal Transportation

As discussed above, electric utilities account for about 97% 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% in 2007, of national coal production is exported abroad, but data are not published as to where this export coal is produced. A joint BNSF and UP rail line serves the coal mines in the Wright and South Gillette subregions. For the baseline year of 2003, the existing capacity of the line was estimated at approximately 350 million tons per year. For that same year, the existing capacity of the BNSF line, which services the North Gillette subregion, was estimated at 250 million tons per year.

The PRB Coal Review projected that two coal transportation projects would be developed prior to 2020 in Wyoming: expansion of the BNSF and UP rail facilities south of Gillette and the construction of the Dakota, Minnesota and 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 and UP completed work to improve sections of the existing joint rail line and had increased capacity from 350 million tons per year to 450 million tons per year by 2008 with plans to improve additional sections of the existing joint rail line and to further increase capacity to 500 million tons per year by 2012. 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 million tons per year and 455 million tons per year 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 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 U.S. Court of Appeals for the Eighth Circuit upheld the appeal of the supplemental EIS in December 2006. In 2007, Canadian Pacific Railway Ltd. (CP) acquired DM&E and the Surface Transportation Board 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 (Dakota, Minnesota & Eastern Railroad 2009).

The Surface Transportation Board 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 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 (Brown 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 million tons per year 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 (Brown 2009) and the Montana Land Board voted to lease the 572 million tons of state-owned coal in December 2009 (Dennison 2009). The Montana Board of Land Commissioners voted to approve the lease of the Otter Creek tracts to Ark Land Company on March 18, 2010 (Montana Department of Natural Resources and Conservation 2010).

Electric Power Generation

Five coal-fired power plants are in the Wyoming PRB study area analyzed in Tasks 1 and 2 (map 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 5 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.

Three separate interconnected gas-fired power plants (Hartzog, Arvada, and Barber Creek) are also located near Gillette, Wyoming (map 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 quality 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 development by 2015.

- 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 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) 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 was considered moderately likely in 2015. Currently, the Wyoming Power Company (a subsidiary of NAPG) has a proposal for Two Elk Unit #2. Some paperwork for this project was filed with WDEQ. The paperwork was returned in March 2010.

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

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 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. Information is insufficient 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 to move power from Wyoming to growing load demands in Idaho, Nevada, and other areas in the western United States (Hodges 2007). 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.

An estimated 1,380 MW of new power plant production capacity and 250 MW of new wind energy production capacity are anticipated in the Task 2 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.

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 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 reopening 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. Although the plant would be located on surface owned by the Buckskin Mine, and would purchase coal from the mine, it would be permitted and operated independently from the mine by White Energy Company and NRG Energy.
- *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 (Wyoming Infrastructure Authority 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 (Wyoming Infrastructure Authority 2008a), including the PRB.

- Additionally, there 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 is currently being developed by the Department of the Interior.

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 CO_2 (a GHG). Direct options for carbon sequestration would involve means to capture CO_2 at the source (e.g., power plant) before it enters the atmosphere coupled with "value-added" sequestration (e.g., use of captured CO_2 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, CO_2 is being injected underground for the purpose of EOR near that study area in the Salt Creek area.

The 59th 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 on other fluid resources, and identify a program for detecting migration or excursion of the CO_2. 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_2 through an approved EOR project and establish, verify, register, and sell emissions reduction credits.

Based on the coal-related 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.

Table 4-5 is 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.

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

Year	Coal Production (million tons per year)	Number of Active Coal Mines[a]	Number of Active Power Plants	Number of Active Coal Conversion Facilities[b]	Direct Coal Mine Employment	Total Coal Disturbance (acres)[c]
Past and Present						
1990	163	18	3	1	2,862	N/A
1995	247	19	4	1	3,177	N/A
2000	323	12	4	2	3,335	N/A
2003	364	12	4	0	4,697	68,794
2007	428	13	5	0	5,533	83,593
Projected Development—Lower Coal Production Scenario						
2010	411	131	7	12	5,433	98,662
2015	467	131	7	12	5,705	117,236
2020	495	131	7	12	5,731	137,443
Projected Development—Upper Coal Production Scenario						
2010	479	131	7	12	5,509	102,448
2015	543	131	7	12	5,722	124,545
2020	576	131	8	12	5,998	149,089

N/A = Not Available

[a] 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.

[b] Several coal conversion facilities currently are being evaluated; however, there is only one for which the likelihood of future development currently can be assessed.

[c] 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 Updated Task 2 Report (BLM 2009c).

4.1.2 Oil and Gas Development

The following information on existing conventional and CBNG development is summarized from the updated Task 2 Report (BLM 2009c). 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 Energy Services 2004) in the Task 2 study area. Of those, 60% were development wells drilled in established producing areas. The remaining 40% 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% 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 of non-CBNG (Wyoming Oil and Gas Conservation Commission 2004).

As of the end of 2003, approximately 3,500 producing conventional oil and gas wells were in the Wyoming PRB study area plus 1,386 seasonally active wells (IHS Energy Services 2004). The WOGCC reported that these wells produced approximately 13 million barrels of oil and 41 billion cubic feet of conventional gas in 2003 (Wyoming Oil and Gas Conservation Commission 2004). The USGS (2002a) estimated that the mean undiscovered noncoal bed hydrocarbon resource in the PRB (including Montana) is 1.8 billion barrels of oil equivalent.

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 Energy Services 2008). WOGCC reported that these wells produced approximately 11.4 million barrels of oil and 22 billion cubic feet of conventional gas in 2007 (Wyoming Oil and Gas Conservation Commission 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 (Wyoming State Geological Survey 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% (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. Thus, 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_2 flood projects in the PRB (Wyoming State Geological Survey 2003). This projected temporary upward trend in conventional oil and gas development is reflected in the PRB Coal Review projections (table 4-6).

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

Production and Wells	Actual 2003	Actual 2007
Annual Gas Production (billion cubic feet)	39.9	22.0
Annual Oil Production (million barrels)	12.9	11.4
Active Wells	5,067[a]	3,857[b]
Inactive Wells	1,994	0[c]

[a] Total includes approximately 1,500 seasonally active wells.
[b] Total includes approximately 1,500 seasonally active wells and an unknown number of inactive wells.
[c] Unknown.
Source: Updated Task 2 Report (BLM 2009c).

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 Coal Review study area (Wyoming Oil and Gas Conservation Commission 2008). However, the number of idle wells would gradually be reduced in the future through plugging programs, and the idle well locations (once the wells are abandoned) would be reclaimed, and would no longer represent a disturbance.

4.1.2.2 CBNG Development

Natural gas production has been increasing in Wyoming. In the PRB, this is because of 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 Task 1 and Task 2 study areas.

On private and state oil and gas leases, the WOGCC and the Wyoming State Engineer's Office (SEO) authorize CBNG drilling. On federal oil and gas leases, the 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. The 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, 14,758 producing CBNG wells were in the study area (IHS Energy Services 2004), and total production for 2003 was 346 billion cubic feet, or 88% of the total gas production from the PRB (Wyoming Oil and Gas Conservation Commission 2004). Total CBNG production in the PRB was 377 billion cubic feet for 2006, 432 billion cubic feet for 2007, and 536 billion cubic feet for 2008 (Wyoming Oil and Gas Conservation Commission 2009). Average daily CBNG production was about 947 million cubic feet per day in 2003 (Holcomb 2003), 1,033 in 2006, 1,177 in 2007, and 1,469 in 2008 (Wyoming Oil and Gas Conservation Commission 2009). From 1987 to 2003, the total cumulative gas production from PRB coals was over 1.2 trillion cubic feet. The total water production for the same period was approximately 2.3 billion barrels (96,600 million gallons). According to the WOGCC website, water production in the PRB associated with CBNG production has ranged between just over 567 million barrels (23,814 million gallons), or about 1.6 million barrels per day, in 2003, and 679 million barrels, about 1.9 million barrels per day, since December 2003.

Since the early 1990s, the Wyoming BLM has completed numerous environmental assessments 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, 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 updated Task 2 Report (BLM 2009c) 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 baseline 2003, actual 2007, and projected 2010, 2015, and 2020 levels of CBNG development used to evaluate projected cumulative environmental impacts in the PRB Coal Review.

Table 4-7. Actual Wyoming PRB CBNG Development Scenario

Production and Wells	2003	2007
Annual Production (billion cubic feet)	338	432
Active Wells	14,758	20,408

Source: Updated Task 2 Report (BLM 2009c).

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 Task 2 Report (BLM 2005b). 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, basinwide, would range from 2,892 to 3,943. As shown in table 4-7, there would be 31,943 CBNG wells basinwide 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 billion cubic feet per year observed in 2007 to approximately 1,026 billion cubic feet per year in 2020. These estimates are relatively aggressive related to actual activity from 2003 to 2007 (BLM 2009c), 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 2003	Actual 2007	Projected 2010	Projected 2015	Projected 2020
Cumulative Disturbed Area (acres)[a]	177,140	178,023	248,086	344,713	427,557
Cumulative Permanently Reclaimed Area (acres)	114,777	111,926	157,803	226,775	310,959
Cumulative Unreclaimed Area (acres)	62,363	66,097	90,283	117,959	116,598
Annual Water Production (million gallons per year)	26,405	31,738	50,865	71,166	72,047

[a] 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: Updated Task 2 Report (BLM 2009c).

Pipelines

Major transportation pipelines for the transport of oil and gas to outside markets are a key factor in the development of CBNG and conventional oil and gas resources in the Task 2 study area for the Wyoming portion of the PRB. Major transportation pipelines also provide for transport of CO_2 to crude oil well fields, which depend somewhat on the availability of CO_2 for EOR. Currently, there are more than 13 major transportation pipeline systems in the PRB that transport gas resources to markets outside of the PRB (Flores et al. 2001; Wyoming Pipeline Authority 2008). The current capacity of these pipeline systems is approximately 2.1 billion cubic feet per day. Currently, the combined natural gas production (CBNG and conventional gas) in the Wyoming PRB study area is approximately 1.22 billion cubic feet 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.

Currently, there are two proposed natural gas transportation pipeline projects and one proposed EOR pipeline 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 capacity of 470 million cubic feet per day with potential to expand to approximately 1,000 million cubic feet per day. 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 was a 42-inch-diameter, 500-mile-long natural gas pipeline that 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 had a 1.2 to 2.0 billion cubic feet per day capacity. TransCanada received a notice of pre-filing on the Pathfinder Project from FERC on June 4, 2008. TransCanada sent a letter to FERC asking that pre-filing activities be suspended on March 23, 2009. TransCanada has no record to indicate termination the Pathfinder docket (Dodson pers. comm.).

- Encore's proposed 231 mile CO_2 pipeline would extend from near Lysite, Wyoming, to the Belle Creek oil production field in Powder River County near Ridge, Montana. The Greencore pipeline would go through the PRB and transport CO_2 used for EOR and carbon sequestration. The pipeline construction is planned to start in the summer of 2011pending issuance of a federal right of way and surface owner consents. This project is considered to have a high likelihood of completion. Information on this project can be found by contacting the Wyoming Enhanced Oil Recovery Institute.

Beyond the Task 2 study area for the Wyoming PRB, the oil and gas pipeline projects essentially would parallel one another to 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" (Federal Energy Regulatory Commission 2008), no formal applications have been filed with the regulatory agencies (Federal Energy Regulatory Commission 2008; WDEQ 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 2009c).

Currently proposed and construction-in-progress natural gas transportation pipeline projects 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 2005 Task 2 Report (BLM 2005b), it was estimated that growth of Wyoming PRB CBNG production could rise from the 2003 level of 947 million cubic feet per day up to 3 to 4 billion cubic feet per day around 2007 and remain at or above those levels until 2015 (Holcomb 2003). However, production rates of 3 to 4 billion cubic feet per day were not realized by 2007, and the average daily production for all gas (conventional and CBNG) was approximately 1.22 billion cubic feet per day (Wyoming Oil and Gas Conservation Commission 2008). Average CBNG production in 2007 was approximately 1.24 billion cubic feet per day. The addition of the Bison Pipeline Project would increase the take-away capacity of the PRB by approximately 0.5 billion cubic feet per day, resulting in total take-away capacity for the PRB of approximately 2.55 billion cubic feet per day. The addition of the Pathfinder Pipeline Project would increase the take-away capacity by approximately an additional 1.6 billion cubic feet per day, for a total of approximately 4.15 billion cubic feet per day. Based on the assumptions in the updated Task 2 Report (BLM 2009c), the projected total gas production (conventional and CBNG) would increase to 2.06 billion cubic feet per day in 2010, 2.86 billion cubic feet per day in 2015, and 2.91 billion cubic feet per day in 2020. Therefore, likelihood for additional new pipeline construction for 2010 is low, with a higher likelihood in subsequent years (BLM 2009c).

In the 2005 Task 2 Report (BLM 2005b), it was indicated that Anadarko Petroleum Corporation was planning to extend its CO_2 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_2 include Hartzog Draw, Hilight, and House Creek (Boyles and vant Veld 2006). Laterals from the Greencore Pipeline could be constructed in the future to carry CO_2 to potential oil recovery projects in the Wyoming portion of the PRB; however, no projects are currently planned. The 2005 Task 2 Report (BLM 2005b) projected that basinwide production of CBNG could double by 2020, which would suggest that additional pipelines could be built. The recent update of the that report (BLM 2009c) 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 billion cubic feet per day; average conventional natural gas and CBNG production in 2007 was approximately 1.24 billion cubic feet per day. Based on the information in the updated Task 2 Report (BLM 2009c), potential total gas production (conventional natural gas and CBNG) has been projected at 2.06 billion cubic feet per day by 2010. This potential is pipeline capacity limited, suggesting additional pipelines could be built.

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, Wyoming. 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 from the refinery will include naptha, 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 Wyoming 59, with the joint BNSF and 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 pers. comm.). Currently, no specific plans for expansion 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 (Wyoming State Geological Survey 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 mines are the Smith Ranch-Highland operation and the Christensen Ranch operation. The Smith Ranch-Highland operation is located in Converse County in the Southern Powder River District, and the Christensen Ranch operation is located in Johnson and Campbell counties in the Pumpkin Buttes area. 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 (NRC) is the Christensen Ranch/Irigaray operation (owned by COGEMA Mining, Inc.) located in Johnson and Campbell counties (U.S. Nuclear Regulatory Commission 2009).

In the 2005 Task 2 Report (BLM 2005b), 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. Because of 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 to $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 (Wyoming State Geological Survey 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 NRC is currently reviewing applications for two new uranium recover facilities in the PRB: the Moore Ranch and the Nichols Ranch-Hank Unit (U.S. Nuclear Regulatory Commission 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 NRC 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.

Table 4-9. In-Situ Recovery Uranium Projects Currently Proposed in the Task 2 Study Area for the Wyoming portion of the PRB

Project/Company	County	Application Type	Watershed/Mining District	Likelihood/Rationale
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 NRC 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 NRC 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 NRC 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 NRC 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 NRC 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 NRC March 2008, application expected 2009.

NRC = U.S. Nuclear Regulatory Commission

Sources: U.S. Nuclear Regulatory Commission (2009), World Information Service on Energy (2009).

Bentonite is weathered volcanic ash that is used in a variety of products, including drilling mud and cat 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 (Wyoming Mining Association 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.

Aggregate (i.e., sand, gravel, and stone) is used for construction purposes. In the PRB, the more important aggregate mining localities are in Johnson and Sheridan counties (Wyoming State Geological Survey 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 (known locally as scoria or red dog), 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 Converse and Campbell counties in 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

A number of existing industrial manufacturing establishments are 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 Campbell County Economic Development Corporation and Converse Area New Development Organization, are continually engaged in efforts to recruit or assist new business formation in the PRB study area. For example, the latter 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

Because of 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 because of 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. 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. Among the lower 48 states, Wyoming currently ranks in eleventh place in terms of existing wind power capacity with 986 MW currently in operation 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 (American Wind Energy Association 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 was 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. Construction was expected to begin in mid-2010, with an online date anticipated for the end of 2010 (Rogers 2008). This project is considered moderately likely to occur (BLM 2009c).

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 5,000 to 5,500 watt hours per square meter per day solar resource for flat plate collectors, currently, no utility-scale solar power collection facilities are located on federal, state, or private lands in Wyoming. Furthermore, no applications for the development of utility-scale solar energy projects had been filed as of June1, 2011.

The BLM, the Office of Energy Efficiency and Renewable Energy, and the DOE are jointly preparing a solar energy programmatic EIS which could facilitate future solar energy development application processes. Wyoming is not covered in the programmatic EIS but still may be affected by it. Information on the programmatic EIS can be found at: http://solareis.anl.gov. The BLM currently evaluates solar energy project proposals on a case-by-case basis.

Solar energy use 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.

4.1.3.5 Reservoirs

Currently, five key water storage reservoirs are present 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 surface disturbance associated with these 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 2009c).

Local economic development organizations, including Campbell County Economic Development Corporation and Converse Area New Development Organization are continually engaged in efforts to recruit or assist new business formation in the PRB study area. For example, the Converse Area New Development Organization 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 2009c).

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 in the City of Gillette and Campbell County, are included in the current City of Gillette development summary (City of Gillette 2009) and are 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 annual. 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 competed 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.
- The new $55 million Campbell County Recreation Center was completed and opened in April 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. The 100-bed Gillette College Student Housing project was completed and opened for use in September 2009. The $55 million, 97,700-square foot Technical Education Center opened in January 2010.
- Campbell County Memorial Hospital is undergoing a major expansion and renovation project that began in 2009 and is expected to be completed in 2011.
- The new Hillcrest Elementary School in Gillette has been completed and opened in September 2009.
- The Burma Road extension is under construction. It will provide a north-south route across I-90 connecting the hospital area with Lakeway Road. This will improve traffic flow, and

open up more land for future development. The section across I-90 opened in August 2010 with full completion of the project projected for spring 2011.

- 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 oversees all aspects of construction and maintenance of school facilities and physical plant. School districts submit five-year plans for facilities spending, which are subject to approval and funding by the commission. 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; 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 (Wyoming School Facilities Commission 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 (Campbell County Economic Development Corporation 2008; City of Gillette 2008a).

- The 2010 Wyoming Department of Transportation State Transportation Improvement Program 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 six 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.
- In addition to highway projects included in Wyoming Department of Transportation'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 West 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 the department. Construction of the new highway segment is anticipated in 2011/2012 (Wyoming Department of Transportation 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 because of proximity or coincidental project schedules and timetables (BLM 2009c).

4.2 Affected Environment and Cumulative Environmental Consequences

This section summarizes the existing conditions based on the results of the Task 1 Report and the cumulative environmental consequences of projected development for 2010, 2015, and 2020, based on the Task 3 report.

As discussed in section 4.0, 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 (map 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 River, Antelope Creek, and Dry Fork Cheyenne River subwatersheds that lie within Sheridan, Johnson, Campbell and northern Converse counties (map 4-2). This analysis region includes over 4 million acres and is referred to below as the Task 3 study area. Table 4-10 summarizes the total disturbance and reclamation acreages for the 2003 baseline, 2007 actual, and the total projected disturbance and reclamation acreages for 2010, 2015, and 2020 in the Task 3 study area.

A total of approximately 210,096 acres (5%) within the Task 3 study area had been disturbed by cumulative development activities as of 2003. Based on the information presented in Appendices A and D of the updated Task 2 Report (BLM 2009c), approximately 222,568 acres (5%) had been disturbed by development activities by the end of 2007. Of those 222,568 acres of cumulative disturbance, approximately 83,593 acres (38%) were associated with coal mine development.

Of the 222,568 total acres of actual cumulative disturbance documented through 2007, approximately 113,382 acres (51%) have been reclaimed. The remaining 109,186 acres of disturbance would be reclaimed incrementally or following a project's completion, depending on the type of development activity and permit requirements.

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

Year	Total Acres Disturbed	Total Acres Reclaimed	Acres Unreclaimed	Acres Unavailable for Reclamation[a]	Acres Affected by Coal Development[a]
Actual					
2003	210,096	111,879	98,217	24,097	68,794
2007	222,568	113,382	109,186	24,338	83,593
Projected Development—Lower Coal Production Scenario					
2010	278,209	159,291	118,918	26,338	98,662
2015	354,148	219,816	134,332	27,549	117,236
2020	422,727	289,937	132,790	28,797	137,443
Projected Development—Upper Coal Production Scenario					
2010	281,996	161,124	120,872	25,688	102,448
2015	361,456	224,024	137,432	27,099	124,545
2020	576,646	397,155	179,491	28,345	149,089

[a] Includes coal mine and coal-related disturbance; those acres will be reclaimed when mine operations end.

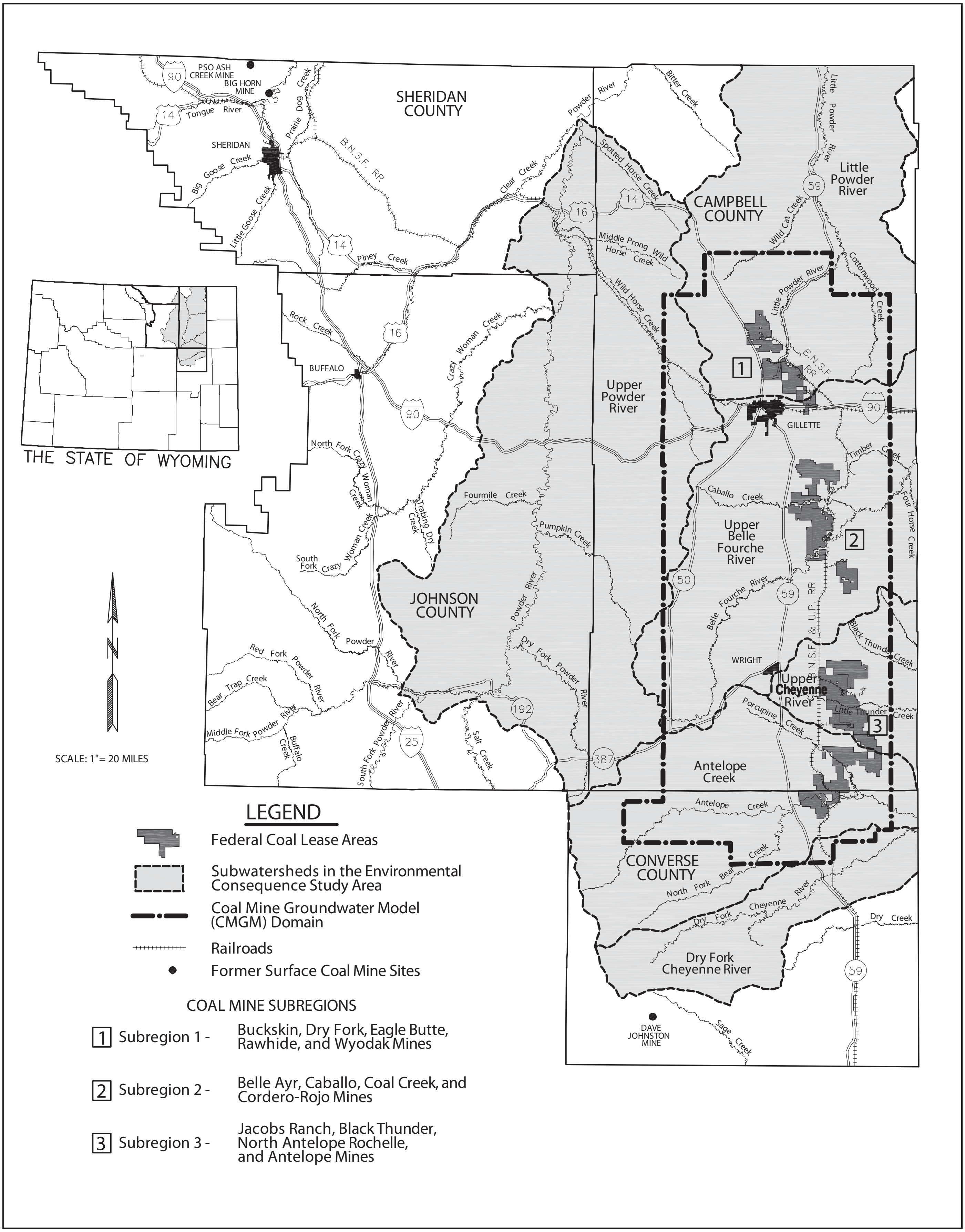
Source: Updated Task 2 Report (BLM 2009c).

Of the 83,593 total cumulative acres of disturbance directly associated with coal mine development through 2007, approximately 25,884 acres (31%) have been reclaimed. Of the remaining 57,709 acres of coal-related disturbance, approximately 24,338 acres (42%) currently are not available for reclamation, as they are occupied by long-term facilities necessary to conduct mining operations. These areas would be reclaimed near the end of each mine's life. Reclamation of the remaining 33,371 acres (58%), 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 576,646[2] acres in 2020 under the upper coal production scenario (table 4-10), which would represent approximately 12.9% of the study area. This projected disturbance includes coal mining, coal-related development, and oil and gas and related development disturbance in the study area. Of those 576,646 acres, it is projected that 149,089[3] acres (26%) would be associated with coal mining activities. Oil and gas related disturbance represents over 70% of the remaining cumulative disturbance.

[2] Data for 2020 total cumulative disturbance and reclamation projections obtained from Appendix C, Table C-3 in the updated Task 2 Report (BLM 2009c).

[3] Data for 2020 cumulative coal-related disturbance and reclamation projections obtained from Appendix A, Table A-2 in the updated Task 2 Report (BLM 2009c). Math errors in that update have been corrected in table 4-10 and the above text for the Hay Creek II final EIS.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Map 4-2

Wyoming Task 3 Study Area for PRB Coal Review Studies Evaluating Projected Environmental Consequences

Areas reclaimed during each future time period shown in table 4-10 reflect the amount of disturbed acreage projected to be permanently reclaimed by that respective point in time. For example, under the upper coal production scenario for 2020, of the 576,646 acres of total cumulative disturbance, approximately 397,155 (69%) would be reclaimed by 2020. The remaining 179,491 acres (31%) 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 cumulative disturbance projected to be associated with coal mining through 2020, approximately 86,196 (58%) would be reclaimed by 2020. Of the remaining 62,893 acres of coal mining-related disturbance, it is estimated that approximately 28,345 acres (45%) 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 (55%) of projected disturbance through 2020 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.

The PRB Coal review study areas are defined by discipline for projected environmental consequences, with some changes to the watershed map (map 4-2) as defined 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 air quality 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 on map 4-2 (groundwater study area), 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 PRB to less than 4,000 feet above sea level on the north and northeast along the Montana state line. The major drainages in the PRB 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 on map 4-2, 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 on 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) 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 study area for geology, mineral resources, and paleontology is the Task 3 study area (map 4-2).

4.2.2.1 Geology

The PRB is one of a number of structural basins in Wyoming and the Rocky Mountain area that were formed during the Laramide Orogeny events. The basin is asymmetric with a structural axis that generally trends northwest to southeast along the western side of the basin (Flores et al. 1999). Natural earthquakes, landsides, and subsidence do not present a hazard in the PRB based on the lack of active faults in the study area (U.S. Geological Survey 2004); the low risk of ground shaking in the PRB 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 (U.S. Geological Survey 2008). Seismic activity induced by coal mine blasting operations occurs throughout the PRB and has reached a USGS local magnitude rating of 3.6 in some instances (U.S. Geological Survey 2004).

4.2.2.2 Mineral Resources

Coal

Most of the coal resources in the PRB are found in the Fort Union and Wasatch formations; however, coal layers in the Wasatch formation are thinner and less continuous than those in the Fort Union formation. Therefore, Wasatch coal is not as economically important as Fort Union coal for either coal mining or CBNG development. Projected levels of coal production and disturbance under the lower and upper coal production scenarios are listed 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.

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 in table 4-10.

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.

4.2.2.3 Paleontology

Paleontological Resources are any fossilized remains, traces, or imprints of organisms, preserved in or on the earth’s crust, that are of paleontological interest and that provide information about the history of life on earth. 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 paleontological resources are documented in the scientific literature, in museum records, and are known by paleontologists and land managers familiar with the area. It has been determined that paleontological resources on federal land shall be managed and protected using scientific principles and expertise. Appropriate plans for the inventory, monitoring, and the scientific and educational use of these resources shall be developed, in accordance with applicable agency laws, regulations, and policies, These plans shall emphasize interagency coordination and collaborative efforts where possible with non-federal partners, the scientific community, and the general public.

Significant paleontological localities have been recorded on federal lands in some areas of the PRB. However, the absence of localities in the PRB does not always 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 Task 3 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 paleontological resources are predicted to be greatest in areas where PFYC Class 4 or 5 (High or Very High) formations are present (see section 3.3.3.1). In addition, in most cases those rock units with a PFYC of 3 (Moderate or Unknown) will require some management decision and action. Class 3 formations are fossiliferous units where fossil content varies in significance, abundance, and predictable occurrence; or of unknown fossil potential. Surface-disturbing activities will require sufficient assessment to determine whether significant paleontological resources occur in the area of a proposed action, and whether that action could affect the paleontological resources.

The Wasatch Formation is the most geographically widespread unit exposed on the surface over most of the Task 3 study area. It is underlain by the Fort Union Formation. The fossiliferous (PFYC 5) Sundance, Morrison, Cloverly, and Lance formations crop out along the margins of the basin and occur at depth in the vicinity of the coal mines and CBNG activity in the eastern portion of the basin. Within the Task 3 study area, the highly fossiliferous (PFYC 5) White River Formation occurs only on Pumpkin Buttes in southwestern Campbell County.

In recent years, the Wasatch Formation has been downgraded to a Class 3a formation (geologic units with widely scattered scientifically significant fossils) in the PRB, but remains a Class 5 formation (highest rating) statewide. The Fort Union Formation is under consideration to be upgraded from a Class 3 (geologic units where fossil content varies in significance, abundance, and predictable occurrence; or of unknown fossil potential) to a Class 4 formation (geologic units containing a high occurrence of scientifically significant fossils) statewide. The Potential Fossil Yield Classifications of these rocks units, as well as many others in Wyoming, are currently under revision and may change in the near future.

The greatest potential impact on surface and subsurface paleontological resources 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. However, as only portions of the Task 3 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. 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 on paleontological resources as a result of these activities.

4.2.3 Air Quality

There is substantial scientific evidence that increased atmospheric concentrations of GHG and land use changes are contributing to an increase in average global temperature. As of January 1, 2011, GHG are regulated pollutants. A discussion of this subject has been included in section 4.2.14.

The 2005 Task 1A Report (BLM 2005a) 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, because actual emissions data was unavailable. 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 2005 Task 2 Report (BLM 2005b) identifies reasonably foreseeable development activities for the years 2010, 2015, and 2020.

The 2006 Task 3A Report (BLM 2006d) evaluates the impacts on air quality and air quality-related values for the year 2010 using the development levels projected for 2010—the same model and meteorological data that were used for the baseline year study in the Task 1A Report (BLM 2005a). The BLM updated the model and conducted an impact analysis for the year 2015. This updated model is reflected in the 2008 update to the Task 3A Report (BLM 2008a), which uses a revised baseline year of 2004 and revised projected scenarios for the year 2015. The BLM updated the model again in 2009 and conducted an impact analysis for the year 2020. The most recent update to the Task 3A Report for 2020 (BLM 2009d) uses the same baseline year of 2004 with revised projected scenarios for the year 2020. A 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 revised 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 west of the PRB, and the northern portion of Converse County, Wyoming; and
- 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 Task 1A and 3A study areas in each state (overall, the near-field receptor grid points were spaced at 1-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. 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 (BLM 2009d). Year 2004 emission inventory data were previously developed for the Montana Statewide Oil and Gas Supplemental EIS. 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 and the Montana Department of Environmental Quality. 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 estimated construction-related fugitive dust emissions, were computed based on EPA emission factors and on input data from the WDEQ.

The PRB Coal Review generally considers existing regional air quality conditions in the Task 1A and Task 3A study areas to be very good. 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 complies with the ambient air quality standards for NO_2 and SO_2. There have been no monitored exceedances of the annual PM_{10} standard in the Wyoming PRB.

Air quality modeling indicates the projected mine activities at the Buckskin Mine will comply with the PM_{10} and $PM_{2.5}$ near-field and short-term NO_2 air standards for the 2015 and 2020 modeled air quality impacts at the currently permitted mining rate. The applicant has indicated that they propose to mine either action alternative at a rate (average of 25 million tons per year) well below its currently permitted level (42 million tons per year). 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 National Park and Jim Bridger Wilderness Area from 1989 to 2005 (figure 3.4-2).

Predicted impacts from baseline year (2004) and projected 2015 and 2020 emissions were modeled for four air quality criteria pollutants (NO_2, SO_2, $PM_{2.5}$, and PM_{10}), along with changes in air quality-related values at Class I and identified sensitive areas. For regulatory purposes, the Class I PSD 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 shown represent the maximum impact at any point in each receptor group; 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 the lower and upper development scenarios (table 4-11). For the Wyoming near-field receptors, the predicted impact of the 24-hour PM_{10} and $PM_{2.5}$ concentrations show localized exceedances in the region of the NAAQS for the baseline year (2004), as well as for both development scenarios for 2015 and 2020. Both 2020 development scenarios show the concentration increases by a factor of 2.5 relative to the base year for these two parameters. Additionally, while down about 10% from 2015, the 2020 development shows a 20% increase of annual PM_{10} and $PM_{2.5}$ concentrations at peak Wyoming near-field receptors relative to the base year. This level of increase for 2020 predicted modeled exceedances of annual standards for $PM_{2.5}$ that year. Impacts of NO_2 and SO_2 emissions are predicted to be below the NAAQS and WAAQS at the Wyoming near-field receptors.

Based on the modeling results, impacts at Montana near-field receptors would be in compliance with the NAAQS and the Montana Ambient Air Quality Standard (MAAQS) for all pollutants and averaging periods, with one exception (table 4-11). Importantly, the 1-hour NO_2 concentrations at Montana near-field receptors for all years and development scenarios were predicted to exceed the NAAQS. Those concentrations were also predicted to exceed the MAAQS in 2015 at isolated locations because of CBNG development in Wyoming; however, with the anticipated southward progression of the CBNG wells, the 1-hour NO_2 concentrations in 2020 are predicted to remain below the MAAQS. The southward progression of the CBNG wells also contributes to a predicted slight decrease in 2020 of impacts for annual NO_2, PM_{10} and $PM_{2.5}$ relative to the baseline year. Although large percentage increases were predicted in SO_2 impacts by 2020, especially for 1- and 3-hour monitoring, those levels would remain below the national and state ambient standards for all pollutants in the Montana near-field.

As discussed in section 3.4.2.2, modeling tends to over-predict the 24-hour impacts of surface coal mining and, as a result, the WDEQ does not consider short-term PM_{10} modeling to be an accurate representation of short-term impacts. In view of this, a memorandum of agreement between the WDEQ and EPA Region VIII, dated January 24, 1994, allows the WDEQ 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 mining permits (WDEQ and EPA 1994). The monitored exceedances at surface coal mines in the Wyoming PRB and the measures that the WDEQ has implemented or is proposing to implement to prevent future exceedances of the PM_{10} NAAQS are discussed in chapter 3, sections 3.4.2.1 and 3.4.2.3.

Table 4-11. Projected Maximum Potential Near-Field Impacts (µg/m³)

Pollutant	Averaging Time	Base Year (2004) Impacts	2015 Lower Coal Development Scenario Impacts	2015 Upper Coal Development Scenario Impacts	2020 Lower Coal Development Scenario Impacts	2020 Upper Coal Development Scenario Impacts	National AAQS	Wyoming AAQS	Montana AAQS	PSD Class II Increments
Wyoming Near-Field										
NO_2	Annual	31.3	46.7	47.4	30.5	30.6	100	100	—[a]	25
SO_2	Annual	15.3	16.2	16.2	16.4	16.5	80	60	—	20
	24-hour	112.3	119.6	119.6	143.3	143.3	365	260	—	91
	3-hour	462.0	814.1	814.1	936.7	936.7	1,300	1,300	—	512
$PM_{2.5}$	Annual	13.4	**18.7**	**21.4**	**16.3**	**16.3**	15	15	—	—
	24-hour	**87.6**	**179.5**	**179.5**	**218.4**	**218.4**	35	35	—	—
PM_{10}	Annual	38.4	**53.5**	**61.0**	46.6	46.6	—	50[b]	—	17
	24-hour	**250.4**	**512.8**	**512.9**	**624.1**	**624.3**	150	150	—	30
Montana Near-Field										
NO_2	Annual	3.3	6.5	6.5	2.5	2.6	100	—	100	25
	1-hour	**409.0**	**826.3**	**826.4**	**440.1**	**442.7**	188.1	—	564	—
SO_2	Annual	1.6	1.7	1.7	3.0	3.1	80	—	80	20
	24-hour	16.1	16.5	16.6	24.7	27.1	365	—	365	91
	3-hour	65.0	66.5	66.5	138.9	138.9	1,300	—	1,300	512
	1-hour	162.9	166.6	166.6	237.0	259.1	—	—	1,300	—
$PM_{2.5}$	Annual	1.0	1.8	1.9	0.9	0.9	15	—	15	—
	24-hour	10.2	15.4	20.6	10.2	10.2	35	—	35	—
PM_{10}	Annual	2.8	5.2	5.3	2.5	2.6	—	—	50	17
	24-hour	29.1	44.0	58.5	29.3	29.3	150	—	150	30

µg/m³ = microgram per cubic meter; AAQS = Ambient Air Quality Standards; PSD = prevention of significant deterioration; NO = nitrogen oxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter measuring 10 microns or less in diameter; $PM_{2.5}$ = particulate matter measuring 2.5 microns or less in diameter

[a] No standard or increment.

[b] The EPA has revoked the NAAQS annual PM_{10} standard of 50 µg/m³, but that standard is still effective for Wyoming until it enters into rulemaking to revise the state AAQS.

Bold values indicate projected exceedance of national and/or state ambient air quality standards.

Source: 2009 update to the Task 3A Report (BLM 2009d).

The maximum modeled impact on the annual $PM_{2.5}$ level is projected to be above the standard (15 μg/m^3) at near-field receptors in Wyoming for the lower and upper coal production scenarios for both 2015 and 2020. Annual PM_{10} levels are projected to be above the standard (50 μg/m^3) 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. The EPA has revoked the NAAQS annual PM_{10} standard of 50 μg/m^3, but until Wyoming enters into rulemaking to revise the WAAQS, that standard is still effective. The WDEQ issues air quality permits for coal mining. That agency cannot issue any permit that violates ambient air quality standards. As noted, impacts of NO_2 and SO_2 emissions are predicted to be below the NAAQS and WAAQS at all Wyoming near-field receptors for all years. 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. The table compares the modeled impacts to the PSD Class I and sensitive Class II increment levels. 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.

Most modeled impacts for the four pollutants (NO_2, SO_2, $PM_{2.5}$, and PM_{10}) analyzed are below the Class I increment levels in all coal development scenarios (base year, lower and upper 2015 and 2020). At the Northern Cheyenne Indian Reservation and Wind Cave National Park, impacts are slightly above the Class I comparative increment levels for 24-hour PM_{10} in all years (baseline, 2015, 2020) and development scenarios (table 4-12). Those impacts are also above the Class I increments at the Badlands National Park for both scenarios in 2020. Additionally, the SO_2 impacts at the Northern Cheyenne Indian Reservation for the 3-hour and 24-hour averaging period exceed the Class I PSD increment levels for one or both development scenarios in 2020. In the other Class I areas, only the modeled 24-hour SO_2 impacts at Theodore Roosevelt National Park and Fort Peck Indian Reservation, and 3-hour SO_2 impacts at Theodore Roosevelt National Park are above the PSD increment levels for the 2020 development scenarios. However, the predicted exceedances for these areas are related to sources outside the PRB study area, consequently, neither area is included in table 4-12.

In the sensitive Class II areas, the only modeled exceedances of the Class II PSD increments relate to the 24-hour PM_{10} levels at the upper 2015 development scenario in the Cloud Peak Wilderness Area and Crow Indian Reservation. The modeled annual NO_2 impacts at those two areas are projected to increase by a factor of 2 to 4, respectively, in 2020 as a result of projected CBNG and coal hauling activities. However, modeling results for all sensitive Class II areas are far below PSD increment levels for all pollutants for both 2020 development scenarios.

Table 4-12. Maximum Predicted PSD Class I and Sensitive Class II Area Impacts (µg/m³)

Location	Pollutant	Averaging Period	Base Year (2004) Impacts	2015 Lower Coal Development Scenario	2015 Upper Coal Development Scenario	2020 Lower Coal Development Scenario	2020 Upper Coal Development Scenario	PSD Class I/II Increments
Class I Areas[a]								
Northern Cheyenne Indian Reservation	NO_2	Annual	0.4	0.6	0.9	0.8	1.1	2.5
	SO_2	Annual	0.5	0.6	0.7	1.1	1.3	2
		24-hour	3.1	3.4	3.4	7.1	12.8	5
		3-hour	9.4	9.6	9.6	23.6	39.7	25
	$PM_{2.5}$	Annual	0.3	0.5	0.5	0.4	0.5	—[b]
		24-hour	3.4	5.1	5.1	4.5	4.6	—
	PM_{10}	Annual	0.9	1.5	1.5	1.2	1.5	4
		24-hour	9.6	14.4	14.6	12.9	13.2	8
Badlands National Park	NO_2	Annual	0.1	0.0	0.0	0.2	0.2	2.5
	SO_2	Annual	0.5	0.2	0.2	0.6	0.2	2
		24-hour	3.6	3.1	3.1	4.0	4.0	5
		3-hour	8.1	6.3	6.3	8.2	8.2	25
	$PM_{2.5}$	Annual	0.2	0.1	0.1	0.3	0.3	—
		24-hour	2.1	1.6	1.6	3.0	3.1	—
	PM_{10}	Annual	0.7	0.2	0.2	0.9	1.0	4
		24-hour	5.9	4.6	4.7	8.5	8.8	8
Wind Cave National Park	NO_2	Annual	0.2	0.3	0.3	0.3	0.3	2.5
	SO_2	Annual	0.7	0.8	0.8	0.8	0.8	2
		24-hour	3.7	4.1	4.1	4.6	4.7	5
		3-hour	7.0	7.4	7.4	7.5	7.7	25
	$PM_{2.5}$	Annual	0.4	0.5	0.5	0.5	0.5	—
		24-hour	3.8	4.6	4.7	4.6	4.7	—
	PM_{10}	Annual	1.0	1.3	1.4	1.4	1.4	4
		24-hour	10.9	13.3	13.6	13.0	13.3	8

Table 4-12. Continued

Location	Pollutant	Averaging Period	Base Year (2004) Impacts	2015 Lower Coal Development Scenario	2015 Upper Coal Development Scenario	2020 Lower Coal Development Scenario	2020 Upper Coal Development Scenario	PSD Class I/II Increments
Sensitive Class II Areas[c]								
Cloud Peak Wilderness Area	NO_2	Annual	0.06	0.6	0.7	0.12	0.12	25
	SO_2	Annual	0.2	0.6	0.6	0.3	0.3	20
		24-hour	2.0	3.7	4.0	2.5	2.5	91
		3-hour	8.0	14.3	14.3	8.9	9.0	512
	$PM_{2.5}$	Annual	0.2	0.5	0.7	0.2	0.2	—
		24-hour	2.6	7.8	11.9	3.2	3.39	—
	PM_{10}	Annual	0.5	1.6	2.1	0.7	0.7	17
		24-hour	7.4	22.3	34.1	9.1	9.3	30
Crow Indian Reservation	NO_2	Annual	0.9	1.4	1.7	3.6	4.2	25
	SO_2	Annual	2.3	2.3	2.3	2.4	2.7	20
		24-hour	14.4	14.6	14.6	14.8	14.8	91
		3-hour	76.8	77.0	77.0	77.0	77.0	512
	$PM_{2.5}$	Annual	0.8	1.0	1.4	0.8	0.8	—
		24-hour	7.2	9.4	14.3	7.2	7.2	—
	PM_{10}	Annual	2.2	2.9	4.1	2.3	2.4	17
		24-hour	20.5	26.9	40.7	20.6	20.6	30

PSD = prevention of significant deterioration; µg/m^3 = microgram per cubic meter; NO_2 = nitrogen dioxide; SO_2 = sulfur dioxide; PM_{10} = particulate matter measuring 10 microns or less in diameter; $PM_{2.5}$ = particulate matter measuring 2.5 microns or less in diameter

[a] Pristine attainment area.

[b] No standard or increment.

[c] Certain federal assets with Class II status for which air quality and/or visibility are valued resources.

Bold values indicate exceedance of PSD class I or II increment.

Source: 2009 update to the Task 3A Report (BLM 2009d).

Table 4-13 provides a detailed listing of visibility impacts for all analyzed Class I and sensitive Class II areas. 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 Park in South Dakota. For these locations, the base year showed more than 200 days of impacts with more than 10% light extinction (i.e., reduction in visibility). A 10% change in light extinction corresponds to 1.0 dv, which is an expression of visibility impairment. A change in visibility of 1.0 dv represents a “just noticeable change” by an average person under most circumstances. Increasing dv values represent proportionately larger perceived visibility impairment.

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 2015 and 2020, the visibility impacts for the base year of 2004 were subtracted from the modeled results for those two years. Table 4-13 shows the number of additional days that the projected impacts were greater than 1.0 dv (10% change in light extinction) for each site under the upper and lower coal production scenarios for each modeled year. Using Badlands National Park as an example, the analysis showed 218 days with impacts greater than 1.0 dv in 2004. Under the 2015 and 2020 coal production scenarios, the modeling analysis projects an additional 26 and 44 days, respectively, with impacts greater than 1.0 dv under both the lower and upper development scenarios. That equates to a total of 244 to 262 days with impacts greater than 1.0 dv, respectively.

Both the 2015 and 2020 modeled visibility impacts at the identified Class I areas (table 4-13) continue to show a similar pattern as exhibited for the baseline year (2004), with the highest number of days with a greater than 10% change in visibility predicted at the three most affected Class I areas. All but four of the sensitive Class II areas had more than 100 days with greater than a 10% change during the base year. The most significant visibility changes to sensitive Class II areas in both 2015 and 2020 are predicted for Mount Rushmore National Monument, followed by Black Elk Wilderness Area (table 4-13). Class II areas do not have any visibility protection under federal or state law.

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 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 both 2015 and 2020 show an increased impact at Florence Lake, leading to an impact above the 10% change in acid-neutralizing capacity. Impacts also are predicted to be above 1 microequivalent per liter for Upper Frozen Lake.

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

		Coal Development Scenario			
	Base Year (2004)	2015 Lower	2015 Upper	2020 Lower	2020 Upper
Location	No. of Days >10% Change in Visibility	Change in No. of Days >10% in visibility			
Class I Areas[a]					
Badlands National Park	218	26	26	44	44
Bob Marshall Wilderness Area	8	0	0	0	0
Bridger Wilderness Area	144	2	2	5	5
Fitzpatrick Wilderness Area	91	2	2	6	6
Fort Peck Indian Reservation	105	10	10	20	21
Gates of the Mountain Wilderness Area	55	0	0	4	4
Grand Teton National Park	70	2	2	6	6
North Absaroka Wilderness Area	61	3	3	8	8
North Cheyenne Indian Reservation	243	32	47	59	60
Red Rock Lakes	42	2	2	3	3
Scapegoat Wilderness Area	27	1	1	2	2
Teton Wilderness Area	57	4	4	8	8
Theodore Roosevelt National Park	178	5	9	24	24
UL Bend Wilderness Area	77	8	10	18	18
Washakie Wilderness Area	83	5	5	8	8
Wind Cave National Park	262	18	19	28	31
Yellowstone National Park	84	2	2	5	5

Table 4-13. Continued

Location	Base Year (2004) No. of Days >10% Change in Visibility	Coal Development Scenario: 2015 Lower	2015 Upper	2020 Lower	2020 Upper
		Change in No. of Days >10% in visibility			
Sensitive Class II Areas[b]					
Absaroka Beartooth Wilderness Area	101	2	3	10	10
Agate Fossil Beds National Monument	251	20	20	26	26
Big Horn Canyon National Rec. Area	331	1	3	1	1
Black Elk Wilderness Area	236	34	36	47	47
Cloud Peak Wilderness Area	126	18	18	29	30
Crow Indian Reservation	360	4	4	3	3
Devils Tower National Monument	274	25	25	31	32
Fort Belknap Indian Reservation	66	6	7	14	15
Fort Laramie National Historic Site	260	10	10	15	16
Jedediah Smith Wilderness Area	79	1	1	3	5
Jewel Cave National Monument	261	19	21	36	37
Lee Metcalf Wilderness Area	97	2	2	2	2
Mount Naomi Wilderness Area	51	1	1	1	1
Mount Rushmore National Monument	222	36	36	49	52
Popo Agie Wilderness Area	139	4	4	6	6
Soldier Creek Wilderness Area	268	18	18	19	19
Wellsville Mountain Wilderness Area	130	10	10	17	17
Wind River Indian Reservation	217	2	5	9	10

[a] Pristine attainment area.
[b] Certain federal assets with Class II status for which air quality and/or visibility are valued resources.
Source: 2009 update to the Task 3A Report (BLM 2009d).

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)	2015 Lower Coal Development Scenario Change (percent)	2015 Upper Coal Development Scenario Change (percent)	2020 Lower Coal Development Scenario Change (percent)	2020 Upper Coal Development Scenario Change (percent)	Thresholds (percent)
Bridger Wilderness Area	Black Joe	67.0	890	4.00	4.11	4.11	4.26	4.27	10
	Deep	60.0	205	4.70	4.82	4.82	4.98	4.99	10
	Hobbs		293	3.95	4.03	4.03	4.14	4.15	10
	Upper Frozen	5.0	64.8	2.42	2.47	2.48	2.55	2.56	1[a]
Cloud Peak Wilderness Area	Emerald	55.3	293	5.24	5.97	6.02	6.69	6.30	10
	Florence 70.0		417	9.09	**10.41**	**10.48**	**11.79**	**11.99**	10
Fitzpatrick Wilderness Area	Ross 32.7	53.5	4,455	2.72	2.79	2.79	2.89	2.90	10
Popo Agie Wilderness Area	Lower Saddlebag	55.5	155	6.28	6.42	6.43	6.65	6.67	10

μeq/L = microequivalents per liter

[a] Data for Upper Frozen Lake presented in changes in μeq/L rather than percent change (for lakes with less than 25 μeq/L background acid-neutralizing capacity).

Bold values indicate exceedance of threshold percent.

Source: 2009 update to the Task 3A Report (BLM 2009d).

The study also modeled impacts of selected hazardous air pollutant emissions (benzene, ethyl benzene, formaldehyde, n-hexane, toluene, and xylene) on 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 baseline year (2004) and the 2015 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 because of benzene exposure is predicted to increase 50% as a result of projected development in the PRB; however, even with this substantial increase, the predicted risk is well below EPA carcinogenic risk thresholds.

Comparing the updated Task 3A Report for 2020 (BLM 2009d) to the earlier update for 2015 (BLM 2008d) shows a similar general increase in air quality effects over time compared to the base year. The production from conventional oil and gas and CBNG 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_{10} and $PM_{2.5}$ impacts in the near-field between 2015 and 2020, and these impacts would result from the proximity of the receptors to both the operations. As noted above, the general south and westward trend of CBNG activity has lowered NO_2 and particulate air quality effects projected in Montana by 2020.

Power plants currently are the major contributors to all SO_2 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_2 concentrations are the result of emissions from all the source groups. No one source group dominates the NO_2 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 coal mine operations and CBNG operations would continue to dominate the PM_{10} and $PM_{2.5}$ impacts, the power plants would continue to dominate the SO_2 impacts (although they would continue to be below the standards), and the overall source groups would continue to contribute to NO_2 impacts. Impacts should remain below the annual NO_2 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_2 emissions from power plants, exceeded the thresholds of significance for the acid-neutralizing capacity at sensitive (high alpine) lakes. The results indicate that with increased growth in power plant operations, the reduced acid-neutralizing capacity of the sensitive lakes would need to be addressed carefully for each proposed major development project.

The WDEQ 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 on 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 updated Task 1B Report (BLM 2009e) describes the baseline year (2002) water resource conditions in that study area, which comprises all of Campbell County, all of Sheridan and Johnson counties less the Big Horn National Forest lands to the west of the PRB, and the northern portion of Converse County (map 4-1). The updated Task 3B Report (BLM 2009f) presents potential future cumulative groundwater impacts in the area of CBNG development and coal mine expansion in the eastern PRB (map 4-2), 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

Five main aquifers are present in the PRB Coal Review ground water study area (map 4-1) 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% 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% specific yield value for coal.

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

Hydrogeologic Unit	Surface Area (acres)	Average Formation Thickness (feet)	Percentage of Sand/Coal	Average Sand/Coal Thickness (feet)	Specific Yield (percent)	Recoverable Groundwater (acre-feet)[a]
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
Tullock Aquifer Sandstones	7,999,682	1,110	52.0	430	13.0	447,246,784

[a] 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.

In response to 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 USGS, in cooperation with the WDEQ and 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, *Cumulative Potential Hydrologic Impacts of Surface Coal Mining in the Eastern Powder River Structural Basin, Northeastern Wyoming*, referred to herein 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 16 current mines and 6 proposed mines in the PRB as of 1987. It did not 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 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. In response to 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 proposed tract or an alternative tract configuration is leased to the respective applicant, the existing mining and reclamation permit for the mine must be revised and approved to include the new lease before it can be mined.

The PRB Oil and Gas Project Final EIS (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 Task 1 and Task 2 study areas (map 4-1).

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 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, 2001a, and 2007).

Another source of data on the impacts of surface coal mining on groundwater is the monitoring that is required by the WDEQ and administered by the mining operators. Each mine is required to monitor groundwater levels and water 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 annually.

The cumulative impacts on 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. 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 on wells outside the immediate mine area.

Wells in the Wasatch Formation were predicted to be affected 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.

If the proposed tract or alternative tract configuration is 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. The WDEQ 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 updated Task 2 Report (BLM 2009c) 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 (map 4-2). The Task 2 Report also defines the projected reasonably foreseeable development 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 updated Task 3B Report (BLM 2009f) 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 study area for water resources encompasses the groundwater model domain (map 4-2), with emphasis placed on the overlap in the groundwater drawdown areas related to coal mining and CBNG. Projected groundwater level changes primarily are because of 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 2009f).

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 study area for water resources comprises the Coal Mine Groundwater Model (CMGM) domain as shown in map 4-2 (BLM 2009f). 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 on water resources in the eastern PRB of Wyoming because of 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 2009f).

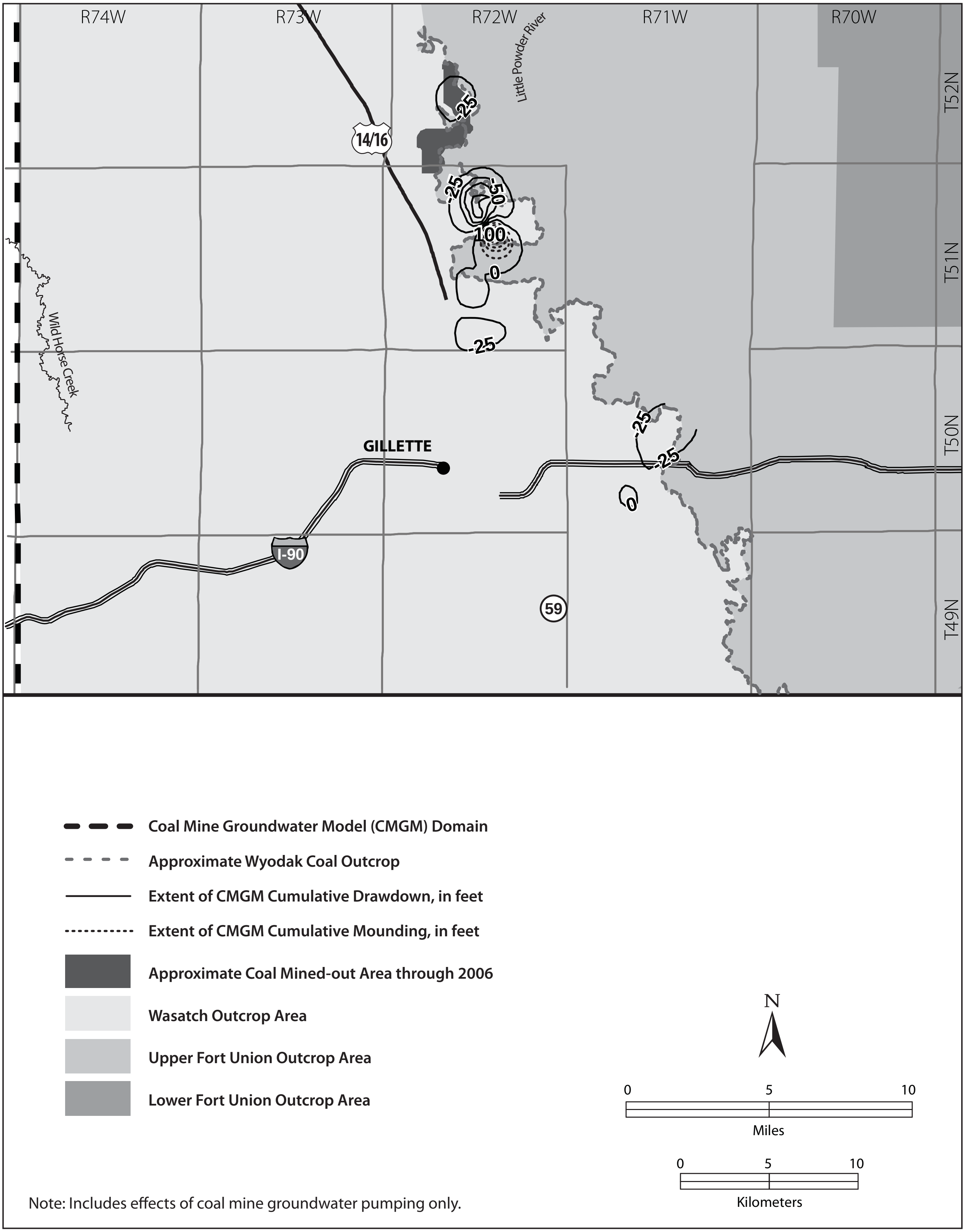
Projected groundwater level changes in the Wasatch generally are due to coal mine dewatering and CBNG pumping and discharge, which generally result in local mounding of groundwater in the Wasatch near CBNG fields and drawdown near the coal mines (BLM 2009e). The Wasatch Formation is not a true aquifer in that it has only discontinuous water-bearing sand units not consistent and uniform groundwater level over the eastern PRB; therefore, groundwater level drawdowns because of 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 Subregion1 in the area of the Buckskin Mine is a cumulative drawdown ranging from approximately 0 to 25 feet (map 4-3). Using the 2002 baseline data update, it shows a recovery of between 0 and 25 feet to the 1990 level in the 12 years between 1990 and 2002. The 2002 baseline modeling also shows an additional rise in the water level of between 0 and 25 feet from the 2010 level by the year 2015, with no change between 2015 and 2020 of the Upper Fort Union water levels in the area of the Buckskin Mine (map 4-4) (BLM 2009e).

The second issue of concern is the potential for cumulative impacts on groundwater resources because of 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 because of coal mining development alone, and this would be expected to continue.

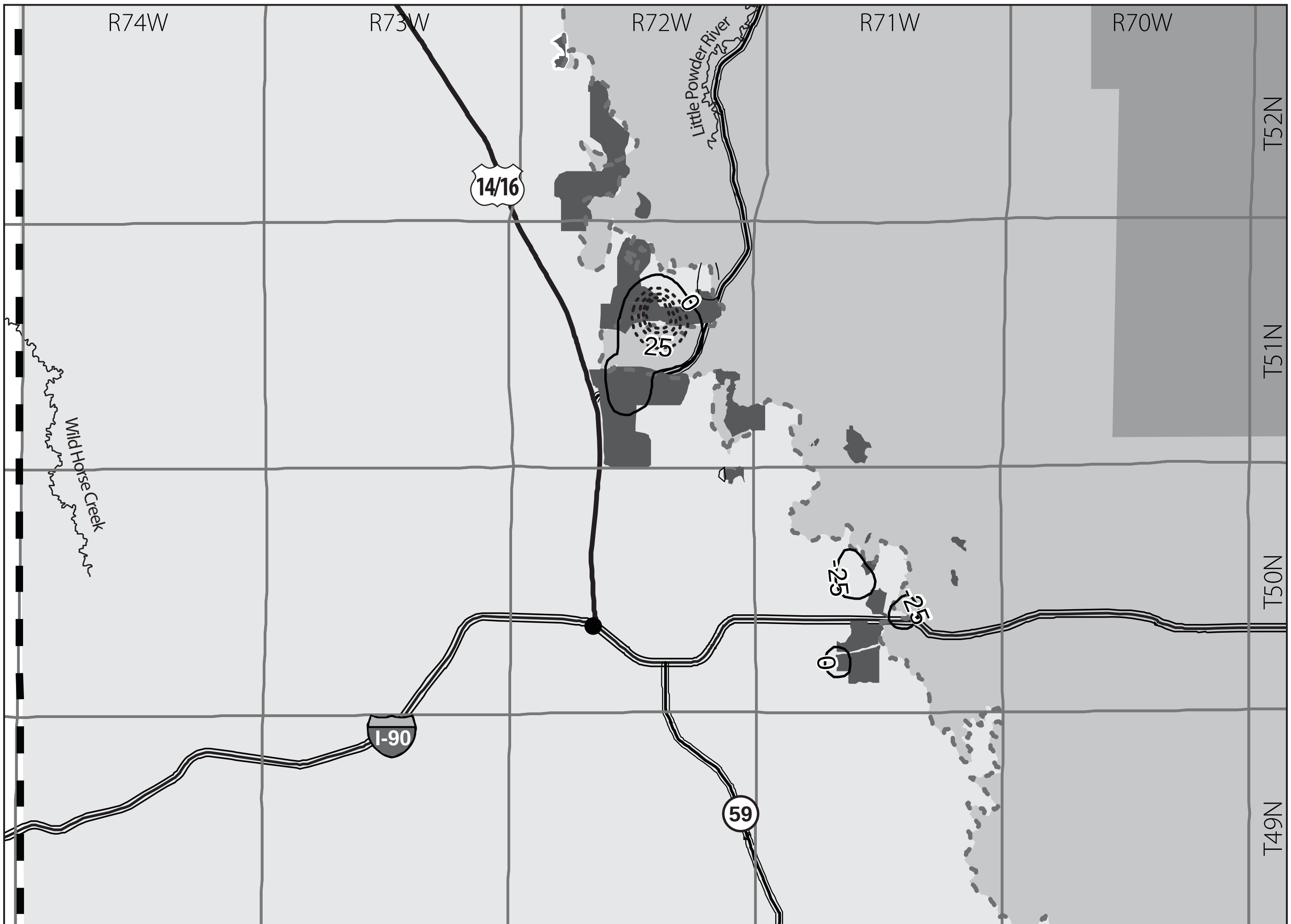
Numerical groundwater flow modeling was used to predict the impacts of the cumulative stresses imposed by mining and CBNG development on the Upper Fort Union Formation coal aquifer in the PRB Oil and Gas Project EIS (BLM 2003). Modeling was necessary because of the large areal extent, variability, and 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 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 because of the water production from the Wyodak coal aquifer by CBNG producers (Hydro-Engineering 2007).

As previously stated, the updated Task 2 Report (BLM 2009c) defines the projected reasonably foreseeable development 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 updated Task 3B Report (BLM 2009f) 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 that 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 2009f).



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Map 4-3
Coal Mine Groundwater Model, Upper Fort Union Formation, Subregion 1—North Gillette
1990–2010 Coal-Mine-Related Groundwater Level Drawdown



Coal Mine Groundwater Model (CMGM) Domain

Approximate Wyodak Coal Outcrop

Extent of CMGM Cumulative Drawdown, in feet

Extent of CMGM Cumulative Mounding, in feet

Approximate Coal Mined-out Area through 2006

Wasatch Outcrop Area

Upper Fort Union Outcrop Area

Lower Fort Union Outcrop Area

N

0 5 10

Miles

0 5 10

Kilometers

Note: Includes effects of coal mine groundwater pumping only.

Map 4-4

Coal Mine Groundwater Model, Upper Fort Union Formation, Subregion 1—North Gillette

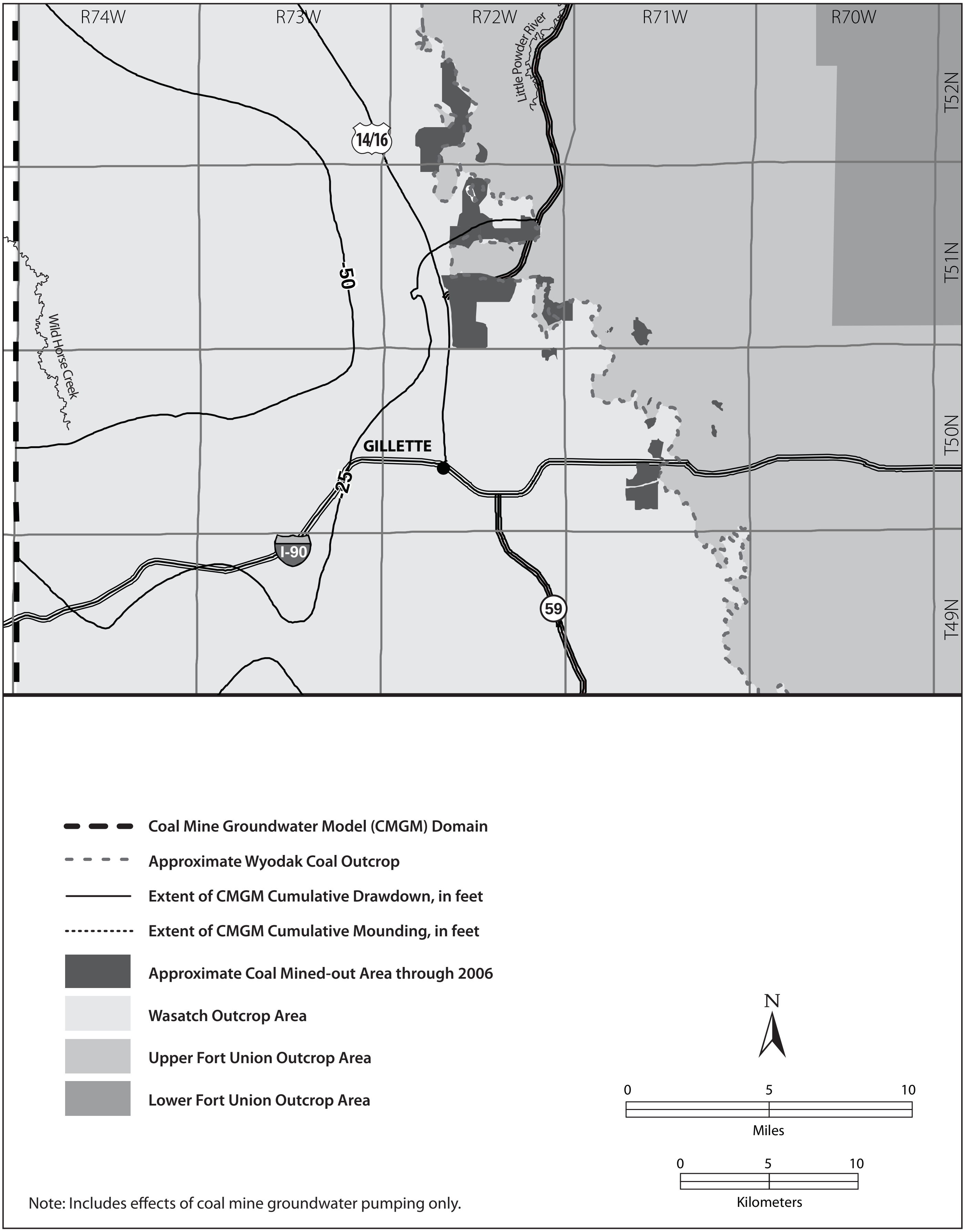
1990–2020 Coal-Mine-Related Groundwater Level Drawdown

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 on water resources in the eastern PRB of Wyoming because of 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 2009f).

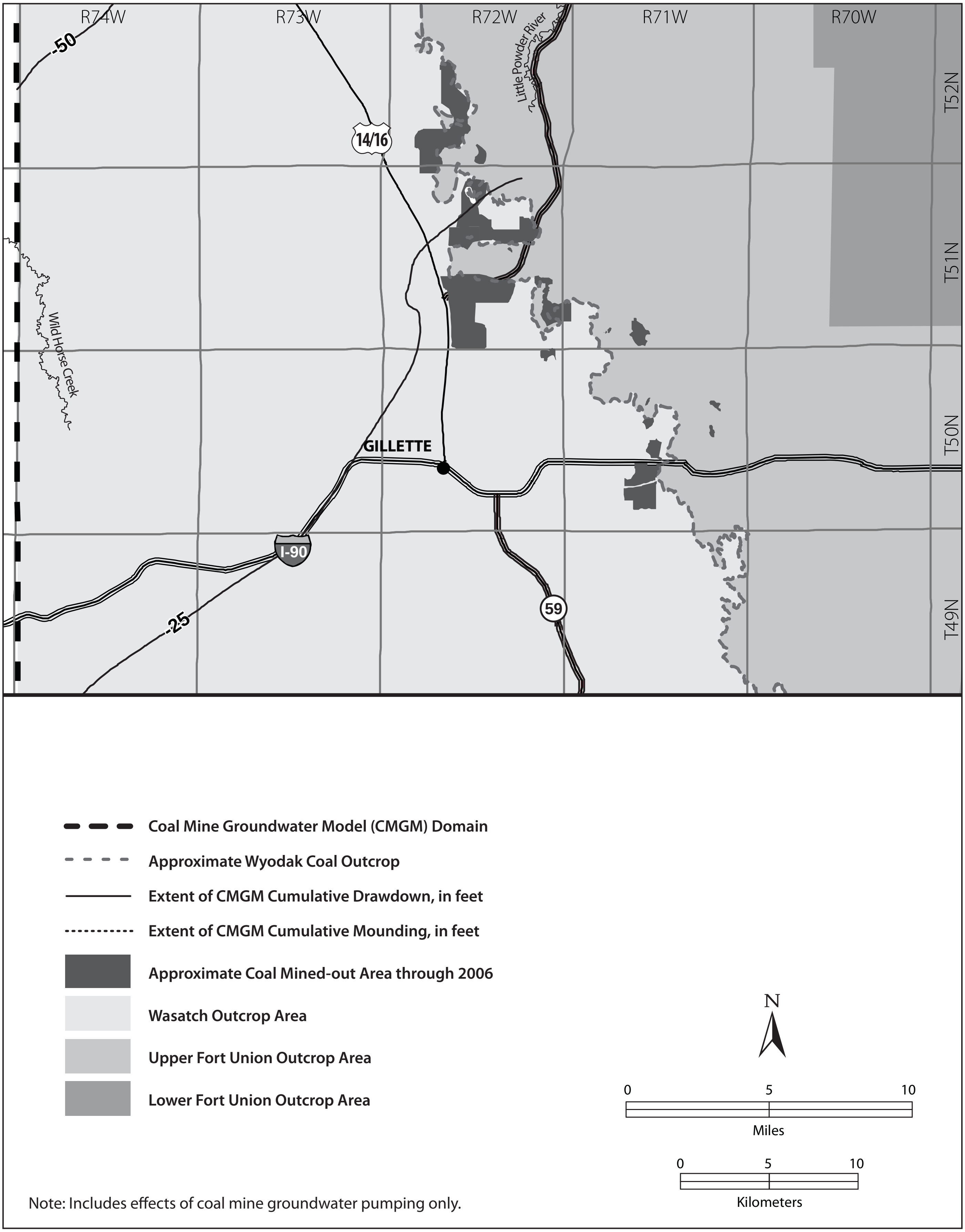
Projected groundwater level changes in the Wasatch generally are because of coal mine dewatering and CBNG pumping and discharge, which generally result in local mounding of groundwater in the Wasatch near CBNG fields and drawdown near the coal mines (BLM 2009e). For the Upper Fort Union, groundwater 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 mine boundaries and especially within the basin west of the coal mines (BLM 2009e).

Based on the results of the CMGM, CBNG pumpage on the Upper Fort Union from 1990 to 2010 in Subregions 1 and 3 results in two areas of drawdown. One extensive area is in Subregion3, centered just southwest of Wright, and covers nearly 15 townships. Drawdowns in that area range from 25 feet on the southern margin to 575 feet in the center of the depression. The second drawdown area is much smaller and is located in Subregion 1, approximately 10 miles west of Buckskin Mine the mines in this subregion (map 4-5). Drawdowns in this area range from 25 feet on the eastern margin to 50 feet at the Task 3 study area boundary for the water model. The modeled drawdown in the Upper Fort Union because of CBNG pumpage from 1990 to 2015 in Subregion 1 is projected to decrease to between 0 feet and 20 feet, with the center located northwest of the Buckskin Mine and other mines in this subregion by approximately 7 miles. The modeled drawdown in the Upper Fort Union because of CBNG pumpage for the 1990 data set for 2020 in Subregion 1 (map 4-6) is projected to be similar to the 2015 projection. Using the updated 2002 data, Subregion 1 for 2015 the projection is for a rebound of between 0 and 25 feet centered just north of Gillette, Wyoming. For the 2002–2020 projection the model predicts a 0 to 10 foot drawdown in the area north of Gillette, Wyoming, and a rebound of 0 to 10 feet west of Gillette, Wyoming (BLM 2009e).



Map 4-5

Coal Mine Groundwater Model, Upper Fort Union Formation, Subregion 1—North Gillette
1990–2010 CBNG-Related Groundwater Level Drawdown



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Map 4-6
Coal Mine Groundwater Model, Upper Fort Union Formation, Subregion 1—North Gillette
1990–2020 CBNG-Related Groundwater Level Drawdown

There is a potential for conflicts to occur over who (coal mine 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 an excerpt 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, 2001a, 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% of the 51 backfill wells reported at that time (Hydro-Engineering 1991). In the GAGMO 20-year report, 79% of the 82 backfill wells measured contained water (Hydro-Engineering 2001a). In the GAGMO 25-year report, 86% 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 Wyodak-Anderson coal outcrop on the eastern side of the PRB (Ellis et al. 1999), 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 along the eastern edge of the Buckskin Mine, and along the northeastern edge of the Hay Creek II general analysis area.

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 proposed tract or alternative tract configuration. 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 updated Task 3B Report (BLM 2009f) 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% 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 mining has on the water quality in the surrounding area and the potential water quality problems in the backfill aquifer following mining.

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 mg/L for TDS when recharge occurs (Martin et al. 1988).

Water quality samples from coal mine backfill monitor wells 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 2001a). The 2000 Annual GAGMO report (Hydro-Engineering 2001b) evaluated samples from 48 backfill wells in 1999 and found that the TDS in 75% were less than 5,000 mg/L, TDS in 23% 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% of the wells were within the acceptable range for the Wyoming livestock standard, with 25% exceeding that standard (Ogle 2004).

The WDEQ 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. The WDEQ 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 because of leasing and mining the proposed tract or alternative tract configuration would be to increase the total volume of backfill and, thus, the time for equilibrium to reestablish.

The updated Task 3B Report (BLM 2009f) 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 on 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 third 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 1 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 1 mile or more, so little interference between mine supply wells would be expected (see 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 may be similar and are summarized as follows.

- 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 used 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. Two industrial water supply wells within Buckskin Mine’s existing permit area are completed in the Fort Union Formation. Extending the life of the Buckskin Mine by issuing a new lease would result in additional water being withdrawn from the subcoal Fort Union Formation, 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 because of the discontinuous nature of the sands in the Tullock Member and the fact that drawdown and yield reach equilibrium in a well because of recharge effects. Because of the distances separating subcoal Fort Union Formation 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 Buckskin Mine. 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 the PRB Coal Review for the

Wyoming PRB 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 basin receives substantial surface water runoff from the Big Horn Mountains, leading to major agricultural development along drainages in the Powder/Tongue River Basin. 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 Basin (acre-feet per year)

Water Use Categories	Dry Year		Normal Year		Wet Year	
	Surface	Ground	Surface	Ground	Surface	Ground
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[a]	—	68,000	—	68,000	—	68,000
Recreation	Non-consumptive					
Environmental	Non-consumptive					
Evaporation	11,300	—	11,300	—	11,300	—
Total	192,000	73,100	198,000	73,100	208,000	73,200

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

Table 4-17. Surface Water Availability in the Powder/Tongue River Basin (acre-feet per year)

	Surface Water Availability		
Subbasin	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
Total	1,502,000	931,000	414,000

Source: HKM Engineering et al. 2002a.

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

	Dry Year		Normal Year		Wet Year	
	(acre-feet per year)					
Water Use Categories	Surface	Ground	Surface	Ground	Surface	Ground
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[a]	—	46,000	—	46,000	—	46,000
Industrial (Other)[b]	—	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	—
Total	85,300	74,400	89,300	80,400	91,300	80,400

[a] Includes conventional oil and gas production water and CBNG production water.

[b] 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 subbasins of the northeast Wyoming river basin is summarized in table 4-19.

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

	Surface Water Availability (acre-feet per year)		
Subbasin	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
Total	318,000	148,000	49,000

Source: HKM Engineering et al. 2002b.

The updated Task 3B Report (BLM 2009f) 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 because of projected CBNG production water discharge. The surface water resources in the Task 3 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 Anderson Consulting Engineers (2009) and the projected water discharge volumes presented in the updated Task 2 Report (BLM 2009c). 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 on 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 that 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 permits, thereby minimizing the potential for degradation of water quality and impacts on channel stability.

Table 4-10 summarizes the cumulative baseline (2003), actual (2007), and projected (in 2010, 2015, and 2020) acres of surface disturbance and reclamation. The projected activities would result in surface disturbance in each of the six subwatersheds in the study area (map 4-2). 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 local water bodies. This affects the 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% (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 implementing appropriate erosion control measures, as would be determined during future permitting.

Future coal mining could remove intermittent or ephemeral streams and stockponds in the Little Powder River, Upper Belle Fourche River, Upper Cheyenne River, and Antelope Creek subwatersheds. As discussed in section 3.5.2, the Buckskin Mine is in the Little Powder 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 updated Task 1B and Task 2 reports (BLM 2009e 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 study area (Antelope Creek, Dry Fork Cheyenne River, Upper Cheyenne River, Upper Belle Fourche River, Upper Powder River, and Little Powder River) (map 4-2).

The Task 3B Report (BLM 2009f) uses 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 on surface water quality from surface discharge of CBNG development. The linear model used by Anderson Consulting Engineers (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 CBNG discharge water (70–90%) either infiltrates or evaporates within a few miles of the discharge points and generally is not recorded at USGS stream gauge stations. Impacts on surface water flow and quality are, therefore, generally limited to within a few miles of the discharge point. In view of this, the updated Task 3B water quality impact analysis assumes a conveyance loss of 70% 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 SAR, and salinity, measured by electrical conductivity (EC), were used for this 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 on 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 projections for 2010, 2015, and 2020.

Table 4-20. Summary of Proposed Limits for Sodium Absorption Ratios and Electrical Conductivity

	Most Restrictive Proposed Limit (MRPL)		Least Restrictive Proposed Limit (LRPL)	
Subwatershed	SAR	EC (µS/cm)	SAR	EC (µS/cm)
Little Powder	5.00	2,000	9.75	2,500
Upper Powder	2.00	2,000	9.75	2,500
Belle Fourche	6.00	2,000	10.00	2,500
Cheyenne River & Antelope Creek	10.00	2,000	10.00	2,500

SAR = sodium absorption ratio; EC= electrical conductivity; µS/cm = microsiemens per centimeter

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

The cumulative impacts on surface water quality focused on reasonably foreseeable development 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 reasonably foreseeable development scenarios. The impact analysis, conducted using monthly flows, comparatively evaluated the water quality parameters (SAR and 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 on water quality are likely to be maximized during the low flow months; consequently, the comparative evaluation of water quality also 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 PRB Coal Review 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 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 2015.

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 because of mixing with CBNG waters and SAR values would increase. The data indicate that the MRPL and LRPL would not be exceeded for either EC or SAR 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 vales 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 because of 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 on 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, Anderson Consulting Engineers (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 hydrologic study area (see fig 4-2) through 2020.

To the extent possible, the impact on 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 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%. For the Belle Fourche River, it was calculated to be less than 0.2% (table 4-21) (Anderson Consulting Engineers 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. Impact of CBNG Production Water on Perennial Streams

	Channel Forming Discharge[a]	CBNG Discharge		Estimated Width (feet)		Potential Impact (Increased Channel Width)	
Location	(cfs)	(cfs)	(%)	Existing Conditions	Combined Discharge	(feet)	(%)
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

cfs = cubic feet per second

[a] 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.

In the updated Task 3B Report (BLM 2009f), there is a discussion of a special study that was done of the Caballo Creek drainage in the Belle Ayr Mine permit area, to see how reclaimed drainages were affected by increased CBNG discharges. It was determined that CBNG discharge represented less than 1% of the two-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 because of relatively larger flow increases from 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 2005 Task 1D Report (BLM 2005e), and are 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 administers the AVF regulations for coal mining activities in Wyoming. Coal-mine-related impacts on 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 PRB Coal Review 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. No AVFs are present in the Hay Creek II general analysis area.

4.2.7 Soils

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on soils from projected development activities in the study area for that report. The area of actual surface coal mining disturbance and reclamation for 2003 and 2007 and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in table 4-2 and table 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, rights-of-way, well pads, industrial sites, and associated ancillary facilities) would result in cumulative impacts on soils in the study area. In general, soil disturbance and handling from these activities would generate both long-term and short-term impacts on soil resources through accelerated wind or water 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 on 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 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 on 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 updated Task 2 Report (BLM 2009c), a variety of CBNG water disposal methods may be employed in the Task 3 study area. The potential impacts on soils would depend on the water treatment method, if any, and the nature of the disposal method. As discussed in the 2005 Task 3D Report (BLM 2005f), because of 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 Little Powder River 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 on soils.

4.2.8 Vegetation, Wetlands, and Riparian Areas

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on vegetation, wetlands, and riparian areas from projected development activities in the Task 3 study area. The area of actual surface coal mining disturbance and reclamation for 2003 and 2007 and the projected cumulative areas of disturbance and reclamation for 2010, 2015, and 2020 are shown in table 4-2 and table 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, including 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 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 2005 Task 1D Report (BLM 2005e).

Impacts on vegetation can be classified as short-term and long-term. Potential short-term impacts arise from removing and disturbing herbaceous species during a project's development and operation (e.g., coal mining, CBNG drilling and production), which would cease upon project completion and successful reclamation in a given area. Reclaimed mine land is defined by the WDEQ as affected land that has been backfilled, graded, topsoiled, and permanently seeded in accordance with the approved practices specified in the reclamation plan (Christensen pers. comm.). 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).

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, USDA Forest Service sensitive species, and WGFD species of special concern in Wyoming. No lands administered by the USDA Forest Service are located in the Hay Creek II general analysis area. Species protected under the ESA, as well as BLM sensitive species, are discussed further in appendices J and K of this EIS. Two federally listed plant species (Ute ladies'-tresses orchid and blowout penstemon) and three USDA Forest Service sensitive species (Barr's milkvetch, rosy palafox, and lemonscent) are known to occur or may have potentially suitable habitat in the updated Task 3 study area. Three BLM sensitive species may occur in the Task 3 study area: Nelson's milkvetch, Laramie columbine (Casper Field Office), and William's wafer-parsnip (Buffalo Field Office).

Potential direct impacts on 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 Task 3 study area, depending on their location in relation to development activities. Indirect impacts could occur because of 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 nonnative 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 following 25 plant species are currently designated as noxious weeds by the State of Wyoming:

- 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 tinctori*a),
- 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*), and
- Russian olive (*Elaeagnus angustifolia L.*).

The following three plant species are currently designated as noxious weeds by Campbell County in addition to those listed above.

- buffalobur (*Solanum rostratum Dun.*),
- common cocklebur (*Iva xanthifolia Nutt.*), and
- black henbane (*Hyoscyamus niger L.*).

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, resulting in 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 rights-of-way, oil- and gas-related road systems) than for site facilities (e.g., mines and power plants) due to the potential for dispersal of noxious weeds over a larger area.

Chapter 4, section 2(d)(xiv) of the WDEQ 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 section 3.9.4, the Buckskin Mine works with the Campbell County Weed and Pest Department and conducts 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 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 or plans of development (BLM 2003). BLM also participates in a collaborative effort with the South Goshen Cooperative Extension Conservation District, the Natural Resources Conservation Service, private surface owners, WGFD, and the Campbell County 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 through 2020, between 30,000 and 42,000 million gallons per year 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 the long term. Alternately, the discharge of abnormally high flows or water with SAR values of 13 or more could impact existing vegetation as discussed in the 2005 Task 1D Report (BLM 2005e). For agricultural uses, the current Wyoming water quality standard for SAR is 8 (WDEQ 2009). SAR values 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 area.

4.2.9 Wildlife and Fisheries

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on wildlife from projected development activities in that study area. The area of habitat disturbance and reclamation for 2003 and 2007and 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 on 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) 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). Direct impacts on wildlife populations from 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 Task 3 study area include pronghorn, white-tailed deer, mule deer, and elk. Potential direct impacts on 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 Task 3D Report concluded that displacement of big game as a result of development activities would create some unquantifiable reduction in wildlife populations (BLM 2009g).

A number of big game habitat ranges have been defined within the Task 3 study area. In Wyoming, the WGFD 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 updated Task 2 Report (BLM 2009c), 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 (BLM 2009g) to provide some level of quantification of potential future impacts on big game ranges.

Tables 4-22 through 4-25 summarize the effects on pronghorn, deer, and elk game ranges from 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

	Pronghorn Ranges[a] (acres/percent affected)			
Time Period/Scenario	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%

N/A = Not Applicable

[a] 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 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: Updated Task 3D Report (BLM 2009g).

Table 4-23. Potential Cumulative Disturbance to White-tailed Deer Ranges from Development Activities—Lower and Upper Coal Production Scenarios

	White-Tailed Deer Ranges[a] (acres/percent affected)			
Time Period/Scenario	Crucial Winter	Severe Winter	Winter Yearlong	Yearlong
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%

N/A = Not Applicable

[a] 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 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: Updated Task 3D Report (BLM 2009g).

Table 4-24. Potential Cumulative Disturbance to Mule Deer Ranges from Development Activities—Lower and Upper Coal Production Scenarios

	Mule Deer Ranges[a] (acres/percent affected)			
Time Period/Scenario	Crucial Winter	Severe Winter	Winter Yearlong	Yearlong
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%

N/A = Not Applicable

[a] 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 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: Updated Task 3D Report (BLM 2009g).

Table 4-25. Potential Cumulative Disturbance to Elk Ranges from Development Activities—Lower and Upper Coal Production Scenarios

	Elk Ranges[a] (acres/percent affected)			
Time Period/Scenario	Crucial Winter	Severe Winter	Winter Yearlong	Yearlong
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%

N/A = Not Applicable

[a] 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 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: Updated Task 3D Report (BLM 2009g).

Direct and indirect effects to small game species (i.e., upland game birds, waterfowl, small game mammals) within the Task 3 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 Task 3 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 million gallons per year of water would be produced in association with oil and gas production in 2010, increasing to about 42,000 million gallons per year 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, stockponds, 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 on 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 Task 3 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 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 in the PRB Coal Review 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, long-eared owl (*Asio otus*). Bald eagles and long-eared owls (*Asio otus*) are rare nesters in the area.

One potential direct impact on raptors is habitat (nesting and foraging) loss because of additional surface disturbance in the Task 3 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. Efforts to minimize impacts on nesting raptors are addressed in each mine's USFWS-approved avian monitoring and mitigation plan.

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) (Avian Power Line Interaction Committee 2006). 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 lines to flight patterns and movement corridors, species composition, line visibility, and structure design. Few collisions have been reported in the Task 3 study area because of the limited presence of perennial water bodies and other features that would attract large numbers of migrating waterfowl or other vulnerable species.

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 (Avian Power Line Interaction Committee 2006). It is assumed that future permitting for power lines would require the use of appropriate raptor-deterring designs, thereby minimizing potential impacts. For example, SMCRA requires that surface coal mine operators use the best technology available to ensure that electric power lines are designed and constructed to minimize electrocution hazards to raptors. Power line impacts on 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 from of development activities in the Task 3 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 Task 3 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 stockponds would eliminate habitat for invertebrates and possibly fish species. This loss would be temporary if the stockponds 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 actual cumulative acres of surface disturbance and reclamation as of 2003 and 2007 and the projected cumulative acres of surface disturbance and reclamation for 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 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 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 study area subwatersheds. 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 were projected to be completed by mid-December 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 right-of-way; however, site-specific stream crossing methods and reclamation would be determined at the time of project permitting.

Future coal mining also could remove intermittent or ephemeral streams and stockponds in the Antelope Creek, Upper Cheyenne River, Upper Belle Fourche River, and Little Powder River subwatersheds. 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 Little Powder River and its tributaries drain the existing Buckskin Mine permit area and the Hay Creek II general analysis area. All streams in and adjacent to the general analysis area are typical for the region, in that flow events are ephemeral. Under natural conditions, aquatic habitat is limited by that ephemeral nature and seasonal occurrence of surface waters in the general analysis area. No uncommon fish species have been documented in baseline aquatics monitoring conducted for Buckskin and other mines in the PRB since the mid-1970s. Given the limited nature and extent of drainages and water bodies, none would be expected to occur in the Hay Creek II general analysis area or at other mines in the north group. Surveys for fish species of concern will be conducted as needed in appropriate habitat prior to disturbance.

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 affected 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 1% to 7% (Martin et al. 1988). Typically, sedimentation effects are short-term 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 subwatershed.

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 rights-of-way, 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 energy development activities in the PRB 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 from 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 subwatersheds (Antelope Creek, Upper Cheyenne River, Upper 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. The review anticipates that approximately 31,000 million gallons per year of water would be produced in association with oil and gas production in 2010, increasing to approximately 42,000 million gallons per year in 2020; it also 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 Hay Creek II general analysis area, much as is currently allowed in the six subwatersheds in the study area. Based on past monitoring in receiving streams, no change in surface flows would be expected beyond approximately 2 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, USDA Forest Service sensitive species, and WGFD species of special concern in Wyoming. No USDA Forest Service administered lands are present in the Hay Creek II general analysis area. Species that are protected under the ESA, as well as BLM sensitive species, are further discussed in appendices J and K. The USFWS also has a list of migratory bird species of management concern for surface coal mines in Wyoming, which is discussed in section 3.10. Special-status species potentially occurring in the 2005 Task 1 study area are identified in section 2.4.3.5 of that Task 1D Report (BLM 2005e). Additional information about the occurrence of these species in the general analysis area is contained in the annual wildlife reports for the Buckskin Mine, on file with the Sheridan, Wyoming office of the WDEQ.

Potential impacts on 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 on special-status species would result in a reduction in habitat suitability and overall carrying capacity for species currently inhabiting the Task 3 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 because of 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 the common loon (*Gavia immer*), American bittern (*Botaurus lentiginosus*), white faced ibis (*Plegadis chihi*), trumpeter swan (*Cygnus buccinator*), greater sandhill crane (*Grus canadensis*), mountain plover, upland sandpiper, long-billed curlew, black tern (*Chlidonias niger*), yellow-billed cuckoo (*Coccyzus americanus*), Lewis' woodpecker (*Melanerpes lewis*), pygmy nuthatch (*Sitta pygmaea*), sage thrasher (*Oreoscoptes montanus*), loggerhead shrike, Baird's sparrow (*Ammodramus bairdii*), sage sparrow (*Amphispiza belli*), Brewer's sparrow, and greater sage-grouse. Only the Brewer's sparrow, sage-grouse, upland sandpiper, long-billed curlew, loggerhead shrike, and sage thrasher (one sighting) have been documented at the Buckskin Mine during 25 years of annual monitoring. Only the Brewer's sparrow is seen with any regularity, and those observations typically occur in a sagebrush stand approximately 1.5 miles south of the Hay Creek II general analysis area. 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 from 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 the bald eagle, ferruginous hawk, northern goshawk, merlin, peregrine falcon, western burrowing owl, and short-eared owl. Species that have been documented in the general analysis area are discussed at length in section 3.10.5, with additional information in appendix K. Potential direct impacts on raptors would result from the surface disturbance of nesting and foraging habitat, as well as injury or mortalities because of collisions with vehicles and equipment. Nesting 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 multiple laws, including the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The implementation of USFWS-approved avian monitoring and mitigation measures at surface coal mines in the Task 3 study area has minimized impacts on nesting raptors over the last 30 years. Any impacts that could occur would likely be limited to individual pairs and, thus, are not likely to affect populations of raptors or other migratory bird species that are known to or can occur in 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 Avian Power Line Interaction Committee guidelines for new construction designs and retrofitting measures for new and existing utility structures would help mitigate these impacts.

At least 477 greater sage-grouse strutting grounds (leks) were identified in the six subwatersheds in the PRB Coal Review study area through 2008, though not all leks are counted every year (WGFD 2008b). As discussed in section 3.10 and in the Task 1D Report (BLM 2005e), 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; WGFD 2008b). Direct and indirect impacts on sage-grouse from 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 from this disease has been much higher in northeast Wyoming than the rest of the state in the past, though fewer cases have been reported in recent years.

Based on results from annual counts and lek searches conducted for the Buckskin Mine since 1984, sage-grouse occur but are not abundant in the general analysis area (section 3.10.6). Three sage-grouse leks have been identified in the general analysis area. One of those three sites is classified by the WGFD as unoccupied (historical/abandoned) due to its consistent lack of use over the last 16 consecutive years. The remaining two leks have also been inactive in recent years, but are still classified as occupied by the WGFD. The Hay Creek sage-grouse lek is within the existing Buckskin Mine permit area, approximately 0.5 mile southeast of the general analysis area. This site has been or will be affected by previously permitted disturbance in the permit area. The McGee sage-grouse lek is approximately 1.25 miles north of the general analysis area, on the far side of multiple ridgelines. Two displaying males and three hens were seen at the Hay Creek lek on one morning in 2001, but no grouse were present during subsequent checks that year, or in any year since then. The McGee sage-grouse lek is located beyond the required annual monitoring area for the Buckskin Mine and, therefore, is not included in that monitoring program. A WGFD biologist first recorded the lek in 2001. Three displaying males were observed at the McGee sage-grouse lek in 2004. No grouse have been recorded at that lek since then, but it was not monitored every year.

If the proposed tract or an alternative tract configuration is leased and mined, potential nesting habitat for grouse that were bred at those leks would be affected by mining activity in those areas. However, as discussed in section 3.10.6.1, no sage-grouse nests or broods have been encountered in the general analysis area during specific surveys or incidental to other wildlife surveys conducted there annually since at least 1984. The noise associated with mining operations may also disrupt sage-grouse breeding and nesting activities that might occur in the area. Direct and indirect effects on greater sage-grouse within the general analysis area from development activities are outlined in section 3.10.6.2.

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 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 on 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 because of slight variations in the projected disturbance areas. An unquantifiable number of lek sites initially could be affected by CBNG activity, which would occur in advance of coal mine development. Potential direct impacts on 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 on Greater Sage-grouse Leks from Coal Mine Development—Upper and Lower Coal Production Scenarios

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

Source: Updated Task 3D Report (BLM 2009g).

Seven special-status fish species potentially occur in the Task 3 study area subwatersheds: the flathead chub (*Platygobio gracilis*) (Antelope Creek, Upper Cheyenne River, and Little Powder River subwatersheds), 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 on special-status fish species from development activities would be similar to effects discussed above for fisheries. Surface disturbance in three subwatersheds (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 and future permits, and 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 on special-status fish species would be low.

4.2.10 Land Use and Recreation

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on land use and recreation as a result of projected development activities in that study area (map 4-2). The area of actual surface coal mining disturbance and reclamation for 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. Table 4-10 shows 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.

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, and barren land. The relative amounts of these lands in the Task 1 and Task 2 study area (map 4-1) is tabulated in table 4-27.

Table 4-27. PRB Land Use by Surface Ownership

	Surface Ownership (acres)				Total	
Use Category	BLM	USDA Forest Service	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
Total	873,438	254,592	628,702	6,158,638	7,915,370	100.0

Source: Task 1D Report (BLM 2005e).

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. Conflicts with some dispersed rural residences may also occur, although specific locations cannot be identified until development is proposed.

Much of the Task 3 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; all surface lands in the general analysis area are under private ownership. With nearly 80% of the overall study 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 on grazing in the Task 3 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 animal unit months (amount of forage a cow/calf unit or a single bull can eat in a month, used to determine stocking rates for livestock);
- temporary loss of water-related range improvements, such as improved springs, water pipelines, and stockponds;
- 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 large structures, 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 on 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 animal unit months 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. Animal Unit Months and Acres of Cropland Estimated Unavailable on Lands Disturbed and Not Yet Reclaimed as a Result of Development Activities

Category	2003/ Baseline	2007/ Actual	2010/ Lower	2010/ Upper	2015/ Lower	2015/ Upper	2020/ Lower	2020/ Upper
Unavailable Animal unit months[a]	18,150	22,108	19,820	20,145	22,389	22,905	22,131	22,950
Unavailable Crop Land (acres)	48	—[b]	59	60	134	139	206	289

[a] Based on an average stocking rate of 6 acres per animal unit month.

[b] Not reported.

Source: Updated Task 3D Report (BLM 2009g).

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% growth in population (between 2003 and 2020) in Campbell County. Section 4.2.13 and the 2005 Task 3C Report (BLM 2005a) 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% 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 used for grazing or agriculture.

4.2.10.3 Recreation

Accessible public lands provide diverse opportunities for recreation, including hunting, fishing, off-road vehicle 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 study areas, 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 USDA Forest Service). 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 pers. comm.). 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.

Off-road vehicle use in the study area is available on most BLM-managed lands. Much of the public land in Johnson, Sheridan, and Campbell counties has been inventoried and designated as open, limited, or closed to off-road vehicle 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 off-road vehicle use and approximately 867,534 acres were available for limited use. Limited use typically means off-road vehicles are restricted to existing roads and vehicle routes.

Recreational use of public lands in the study area has increased substantially over the past two decades, and is expected to continue to increase by about 5% every five 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% higher than the 1980 visitor days (BLM 2001). Fewer than 3% of visitor days were estimated to occur on public lands.

Few, if any, of the developed recreation sites in the 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 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 pers. comm.). A reduction in available private land for dispersed recreation would contrast with the anticipated increase in demand for recreational opportunities and would tend to push more recreationists toward public lands where the BLM has projected a 5% increase in use every five years (BLM 2001). After coal-related 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 pers. comm.). As noted in the 2005 Task 1D Report (BLM 2005e), reductions in land available for hunting also make herd management more difficult for the WGFD and reduce its hunting-derived revenues (Shorma pers. comm.).

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. Mineral development could be permitted within the Fortification Creek Planning area and the stricter Fortification Creek area of critical environmental Concern, as long as all applicable qualifications and requirements are met or exceeded.

No Wild and Scenic Rivers would be affected, because the only river segment identified as both "eligible" and "suitable" in the Task 1D Report is outside of the Task 3 study area (BLM 2005e).

4.2.11 Cultural Resources and Native American Concerns

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on cultural resources from projected development activities in that study area. The area of actual surface coal mining disturbance and reclamation for 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. Table 4-10 shows 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.

Cultural sites occur throughout the 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 descriptions 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 PRB Coal Review study area (see section 3.12 for additional discussion about the prehistoric cultural periods.) Only a small number of sites represent the earliest prehistoric cultural periods—Paleoindian through Early Plains Archaic. Archaic and later prehistoric period sites (Archaic to Protohistoric) are represented in increasing numbers as 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. Lithic scatters (scatters consisting primarily of stone tools and debris from manufacture or maintenance of stone tools) are the primary prehistoric sites in the study area. Lithic scatters expressed on the surface are typically not eligible for inclusion on the NRHP. Sites with buried dateable material such as charcoal or bone can yield important information and are often field evaluated as eligible

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

Subwatershed	Average Number of Sites per Square Mile[a]	Lower Coal Production Scenario						Upper Coal Production Scenario					
		Year 2010		Year 2015		Year 2020		Year 2010		Year 2015		Year 2020	
		Square Miles[b]	Sites[c]	Square Miles[b]	Sites[c]	Square Miles[b]	Sites[c]	Square Miles[b]	Sites[c]	Square Miles[b]	Sites[c]	Square Miles[b]	Sites[c]
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
Total		435	2,053	553	2,626	660	3,155	441	2,082	565	2,682	678	3,283

[a] Average number of sites per square mile based on previous surveys in the study area.

[b] Calculated, based on database disturbance acreages prepared for the updated Task 2 Report, Past and Present and Reasonably Foreseeable Development Activities (Appendices A and D) (BLM 2009c).

[c] 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: Updated Task 3D Report (BLM 2009g).

Five prehistoric sites are documented in the Hay Creek II general analysis area. Site 48CA857 was originally recorded in 1980 and contained a lithic scatter and a stone circle. The site was not relocated during a 1999 inventory and is listed as “destroyed” in the SHPO database. Sites 48CA 861, 48CA862 and 48CA1828 are lithic scatters containing very few artifacts originally recorded in the 1980s. None of these sites were relocated during later inventories and are determined not eligible for the NRHP. Site 48CA 2223 was originally recorded in 1985 as a lithic scatter containing a Late Prehistoric projectile point and a prehistoric pottery shard. The site is in a plowed field and was determined not eligible since buried deposits were not expected. A later inventory discovered historic trash at the location, but did not relocate any prehistoric artifacts. The Proposed Action and alternatives would destroy the above sites, although none of the sites are intact and they are all determined not eligible for the NRHP. On February 12, 2009, the BLM notified SHPO that the undertaking would result in no effect on historic properties.

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 2005 Task 1D Report (BLM 2005e). Eight historic sites documented in the Hay Creek II general analysis area fall under the context of rural settlement. 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 Big Horn 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 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 NRHP) that may be affected by development activities. In cases of split estate where the surface ownership is private and mineral ownership was retained by the US Government, surface resources such as cultural or archeological sites are the property of the surface owner. Federal agencies must ensure that undertakings associated with federal minerals development adhere to applicable cultural resource laws and regulation, although, the surface owner must be consulted about any archeological investigation, mitigation, or monitoring.

4.2.12 Transportation and Utilities

The updated Task 3D Report (BLM 2009g) discusses potential cumulative impacts on transportation and utilities systems as a result of projected development activities in that study area. The area of actual surface coal mining disturbance and reclamation for 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 2007and 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 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. 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 million tons per year in the baseline year (2003), which was just 22% of the estimated 250 million tons per year capacity of the BNSF rail line (BLM 2005b). The coal mines in the South Gillette and Wright subregions produced approximately 308 million tons per year in 2003, which was 88% of the estimated 350 million tons per year capacity of the joint BNSF and 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, 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 Task 3 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. As described in section 3.15, Kiewit does not anticipate increasing the current average annual coal production rate or hiring additional employees, so no increases in road or rail traffic are anticipated under either action alternative. 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 and UP railroads is resulting in measures to reduce coal dust emissions from loaded, moving rail cars.

The socioeconomic analysis conducted as a part of the 2005 Task 3C analysis projects a population increase of approximately 48% between 2003 and 2020 in Campbell County under the upper coal production scenario (BLM 2005a). Campbell County accounts for most of the population in the 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% by 2020. Approximately 60% 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 and UP line, would be expected to accommodate the projected coal transportation traffic through 2015 (table 4-30). The updated Task 2 Report (BLM 2009c) projects that the proposed DM&E line would be built and operational by 2015 (pending completion of additional environmental analysis), which would add 100 million tons per year in additional shipping capacity for the South Gillette and Wright subregions.

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

	2010 Projected			2015 Projected			2020 Projected		
	2010 Capacity	Rail Use Increase[a]		2015 Capacity	Rail Use Increase[a]		2020 Capacity	Rail Use Increase[a]	
Rail Line	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	381–4,392	64–732	600	417–4,552	70–762
DM&E	0	0	0	—[b]	—[c]	—[c]	—[c]	—[c]	—[c]

mmtpy = million tons per year

[a] 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.

[b] 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.

[c] 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: updated Task 3D Report (BLM 2009g).

An estimated 1,380 MW of new power plant production capacity and 250 MW of new wind energy production capacity are anticipated in the Task 2 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. 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 2005 Task 1C and 3C reports (BLM 2005d and 2005a).

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 PRB 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 2005 Task 3C Report (BLM 2005a) 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.

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% of the coal resources in the PRB are federally owned. The surface coal mines that developed during that time are now mature operations that provide 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 resource booms in the western United States.

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 coal production 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 effects 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% 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 a 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% of all jobs in the region, while mining and government accounted for 14% and 16% of all jobs, respectively. Farm employment in the region, as a share of total employment, declined from 14% in 1970 to 5.0% in 2004. However, that shift is primarily because of 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) was 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 between 2003 and 2010. Of those, more than 5,600 jobs (a 22% 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).

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[4]. 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 2005 Task 3C Report (BLM 2005a), 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% (Campbell) and 3.5% (Weston) in 2006. Statewide and national unemployment rates for the period were 3.2% and 4.6%, 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%,

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[4] 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, whereby a 16% higher production would be achieved with a 2.5% 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.

slightly above the corresponding statewide averages. Labor demand associated with CBNG development contributed to a decline in unemployment to below 3.0% in the 2001. As the pace of CBNG development stabilized, labor demand eased and unemployment rates climbed to 3.7% 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 on 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 because of 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 2006b).

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 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. Annual per capita incomes are projected to increase by approximately 27% (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 2005a).

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 had larger populations.

By 1980, Campbell County's population had increased by more than 300%, 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% 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%, 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% 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 4-3).

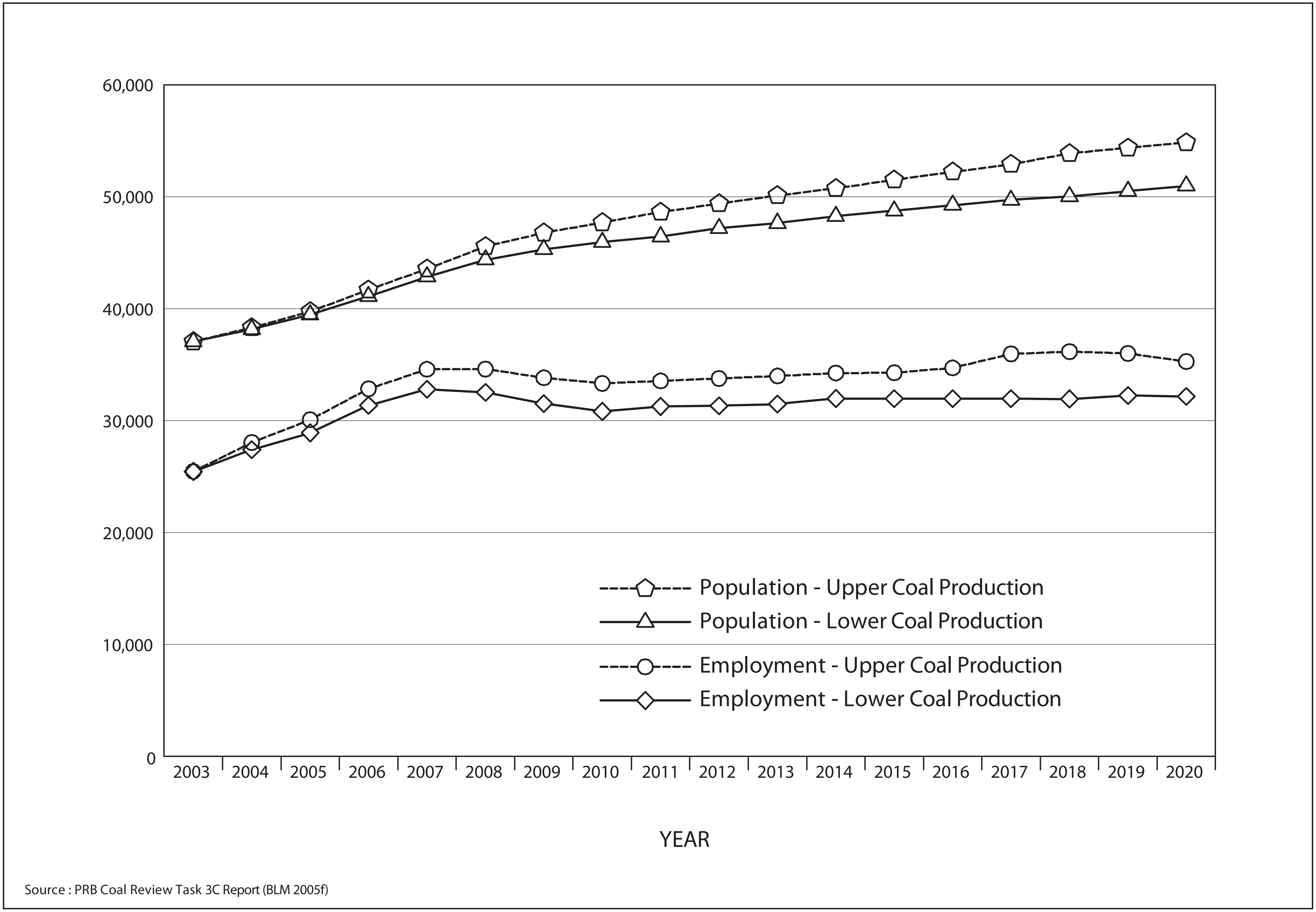
Table 4-31. Recent and Projected PRB Population

Year	Campbell County	Converse County	Crook County	Johnson County	Sheridan County	Weston County	Six County PRB Total
Census							
2000	33,698	12,104	5,895	7,108	26,606	6,642	92,053
2003[a]	36,381	12,326	5,971	7,530	27,116	6,665	95,989
2006[a]	38,934	12,866	6,255	8,014	27,673	6,762	100,504
2009[a]	43,967	13,578	6,653	8,531	29,163	7,009	108,901
Projected Lower Coal Production Scenario							
2010	45,925	13,103	6,542	8,389	28,459	7,108	109,526
2015	48,905	13,671	6,759	8,867	30,016	7,174	115,392
2020	50,995	14,193	6,989	9,326	31,467	7,208	120,178
Projected Upper Coal Production Scenario							
2010	47,662	13,160	6,570	8,424	28,579	7,137	111,532
2015	51,558	13,763	6,802	8,924	30,214	7,219	118,480
2020	54,943	14,313	7,045	9,403	31,733	7,266	124,703

[a] Projected by U.S. Census Bureau based on 2000 data.

Source: U.S. Census Bureau (2006b) and 2005 Task 3C Report (BLM 2005a).

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; Kiewit does not anticipate any new hiring under either action alternative. Growth over the next three 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 projected to gain substantial population. Population growth, like employment growth, would moderate after 2010. Projected population growth (compounded annual growth rate) between 2003 and 2020 ranges from 0.5% in Weston County to 2.0% 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% compounded annual growth rate.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Figure 4-3
Projected Campbell County Population and Employment to 2020

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 because of 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% 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 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. The growth would be higher in Wright, Douglas, and Newcastle because of 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% in the 1970s, the housing stock in the study area grew by almost 78%. Housing growth was especially rapid during the 1970s in Campbell County, where population grew by 88% and the housing stock grew by 140%. 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% in five of the six counties, and that in Johnson County at only 2.8% (table 4-32).

Table 4-32. Rental Housing Vacancy Rates

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 has not 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 2006c.

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 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% 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[a] in the PRB Study Area and Percent Change from 2004

	Apartments		Mobile Home Lots		Houses		Mobile Homes on a Lot	
County	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%	N/A	N/A	N/A	N/A
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%

N/A = Information not available because of insufficient sample size.

[a] Data are for the fourth quarter of 2006. Change is the percent change since fourth quarter of 2004.

Source: Wyoming Department of Administration and Information 2006.

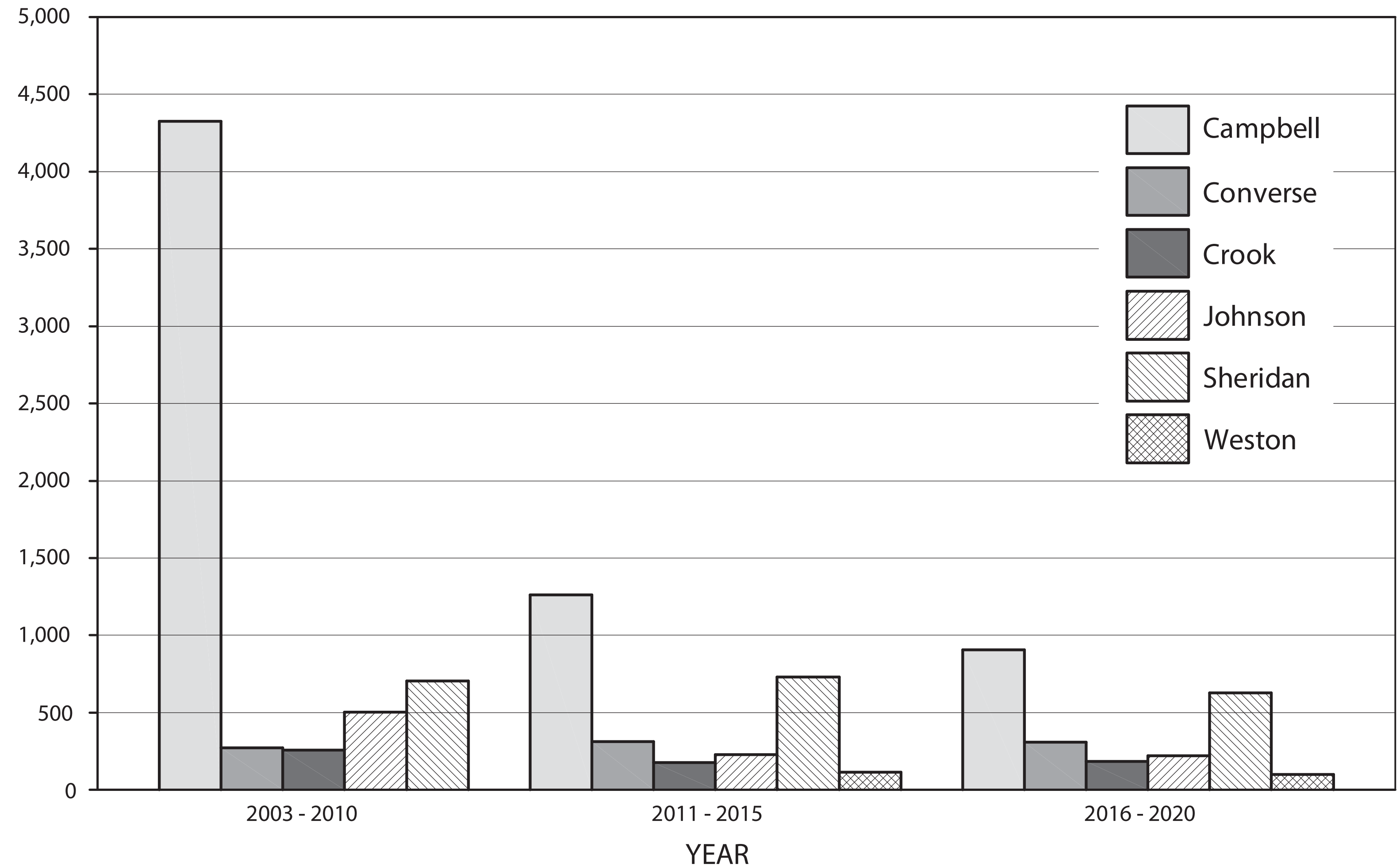
Temporary housing resources are available in the PRB in the form of hotel-motel rooms, private and public campgrounds, and vacant spaces in mobile home parks. In all, there are more than 70 lodging establishments with a total of more than 2,500 rooms. These temporary housing resources, supplemented by 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% increase above the 2006 existing inventory (figure 4-4). New housing requirements under the upper coal production scenario are estimated at 10,900 units, a 25% increase compared to the 2006 inventory and 1,790 units more than for the lower coal production scenario. Approximately 60% 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 proactively 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 be 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.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Figure 4-4
Projected Housing Demand in the PRB Study Area under the Lower Coal Production Scenario

4.2.13.6 Public Education

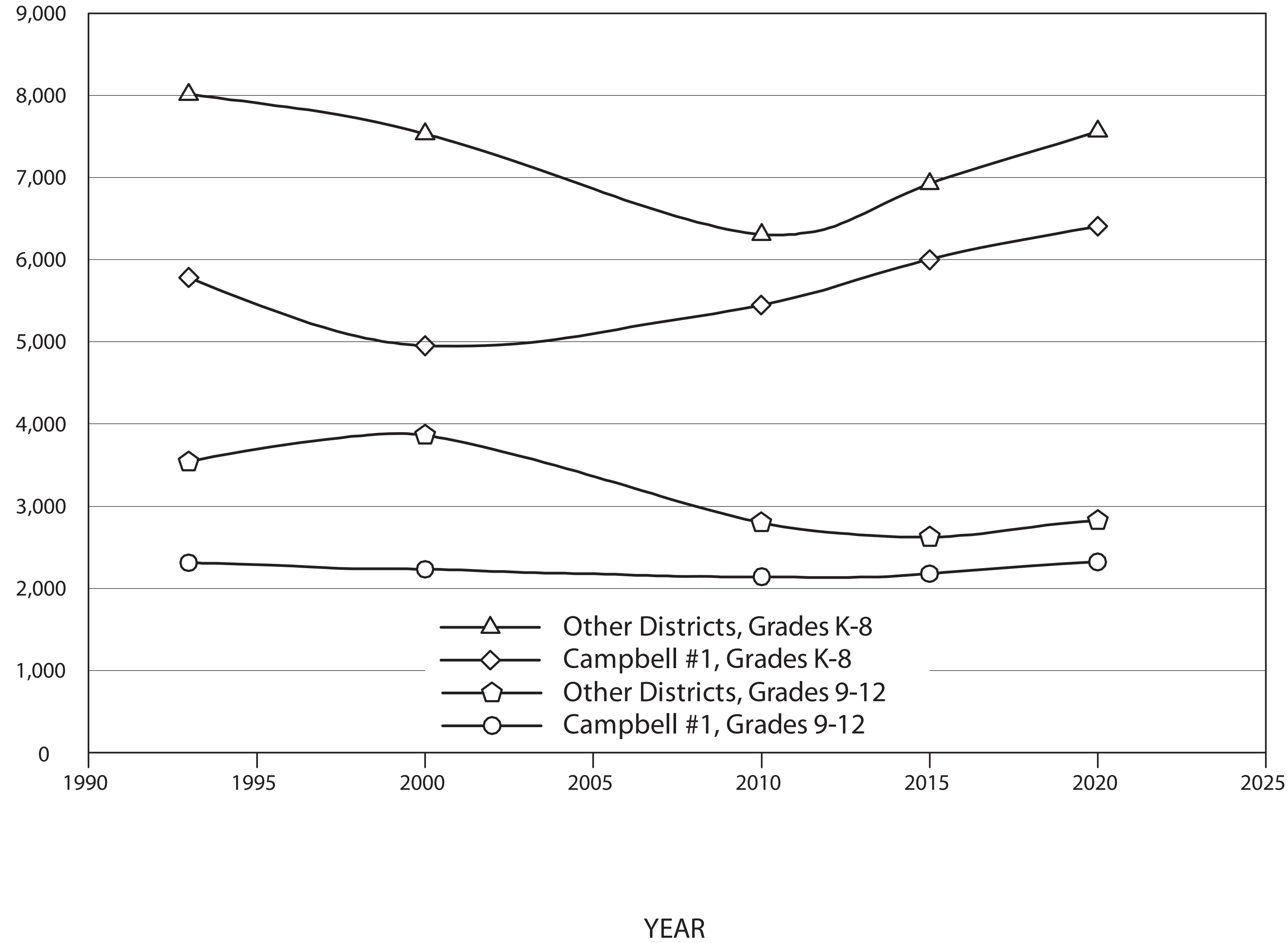
There are 10 school districts in the six-county study area, ranging in size from Campbell County School District (CCSD) #1 with 7,337 students in the 2005 school year to Sheridan County School District # 3 (based in Clearmont, Wyoming) with fewer than 100 students. CCSD #1, based in Gillette, and Converse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

Public school enrollment trends mirrored population trends during the period of rapid population growth. Districtwide enrollment in Campbell County grew by more than 4,600 students (131%) between 1975 and 1985. Enrollment increased in all districts in Converse and Sheridan counties as well. Enrollment in 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 because of 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% higher by 2020 under the upper coal production scenario, with those in the surrounding districts about 1% 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% 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 through 8 but only small increases in grades 9 through 12 (figure 4-5). 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.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Figure 4-5
Projected School Enrollment Trends to 2020 under the Lower Coal Production Scenario

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, affected school districts need to accommodate minor capacity shortages by using 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' five-year plans. The approved five-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 five-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 and Wyoming Consensus Revenue Estimating Group 2007).

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% increase in population between 2003 and 2010 under the lower coal production scenario and 30% 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% during the period. The populations of Johnson County and Buffalo would increase 10% by 2010, driven primarily by CBNG development.

Growth rates and resultant increases in service demands would slow substantially during both the 2011– 2015 and 2016–2020 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% 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% 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% to 10.5% over time. The current rate of 7.0% 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 Consensus Revenue Estimating Group 2007; Wyoming Department of Revenue 2006).

Producers pay a 12.5% 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 would climb by $3.49 billion (2004 dollars) over 2003 levels, reaching $8.54 billion by 2020, a 69% 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 $)

Industry and Taxes	2005–2010	2011–2015	2016–2020	Total
Coal[a]	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
Totals	6,648.5	6,831.7	7,659.0	21,139.3
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
Totals	6,648.6	6,831.7	7,659.1	21,139.3

[a] Does not include coal lease bonus bids because of the uncertainty regarding timing.

Source: 2005 Task 3C Report (BLM 2005a).

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

Industry and Taxes	2005–2010	2011–2015	2016–2020	Total
Coal[a]	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
Totals	7,021.7	7,355.8	8,252.7	22,630.3
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
Totals	7,022.0	7,355.6	8,253.0	22,630.6

[a] Does not include coal lease bonus bids because of the uncertainty regarding timing.

Source: 2005 Task 3C Report (BLM 2005a).

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 currently has pending applications for more than four billion tons of federal coal, including this application. The state receives 50% 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 because of 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 United States and throughout much of the world. But in addition to the broad forces that have driven social change in the United States 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. Coal mine development, continued oil and gas drilling, and power plant construction precipitated another round of growth. In all, Campbell County population grew by almost 600% 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 created energy, vitality, and a sense of economic optimism about the community. Where economic advancement had been limited before the boom, there now was 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 pers. comm.; Spencer pers. comm.). 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.

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. 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 Emissions and By-Products of Coal Mining and Coal-Fired Power Plants

As discussed in chapter 1, the 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 of coal after it is sold is determined by the purchaser and end user of the coal; 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.

As discussed in chapter 2, under the currently approved mining plan, which represents Alternative 1 (No Action Alternative), from 2009 on, the Buckskin Mine would maintain its current average coal production level of 25 million tons per year for another 14 years. Under the Proposed Action and Alternative 2, production would continue at an average of 25 million tons per year for two years and up to six years, respectively (table 2-5).

Section 3.18.2 contains estimates of GHG emissions resulting from the mining operations at the Buckskin Mine under the Proposed Action and alternatives.

4.2.14.1 Greenhouse Gas Emissions, Global Warming, and Climate Change

Climate is both a driving force and a limiting factor for biological, ecological, and hydrological processes, and has great potential to influence resource management. Climate change is a phenomenon that could alter natural resource and ecologic conditions on spatial and temporal scales. The IPCC has stated, "Most of the observed increase in global average temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic GHG concentrations." The consensus is that as atmospheric concentrations of GHGs continue to rise, average global temperatures and sea levels will rise, precipitation patterns will change, and climatic trends will change and influence earth's natural resources in a variety of ways.

Ongoing scientific research has identified the potential impacts of anthropogenic (human-made) GHG emissions and changes in biological carbon sequestration because of land management activities on global climate. Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the earth back into space. Although natural GHG levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused concentrations of these gases to increase dramatically, and are likely to contribute to overall global climatic changes (Intergovernmental Panel on Climate Change 2007).

Global mean surface temperatures have increased nearly 1.33 °F from 1906 to 2005. Models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Northern latitudes (above 24° N) have exhibited temperature increases of nearly 2.1°F since 1900, with nearly a 1.8 °F increase since 1970. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHGs are likely to accelerate the rate of climate change.

In 2001, the IPCC indicated that by the year 2100, global average surface temperatures would increase 2.5 to 10.4 °F above 1990 levels. 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 is expected to be greater than during the summer, and increases in daily minimum temperatures are more likely than increases in daily maximum temperatures. Increases in temperatures would increase water vapor retention 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.

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 climate change science are known with virtual certainty, because they are based on well-known physical laws and documents trends (EPA 2008b). Several activities contribute to climate change, including emissions of GHGs (especially CO_2 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. GHGs will have a sustained climatic impact over different temporal scales. Recent emissions of CO_2 can influence climate for 100 years (EPA 2008b; BLM 2005g).

In some cases it is difficult to discern whether global climate change is already affecting resources in the analysis area; however, information is available on potential or projected effects of global climate change on resources. It is important to note that projected changes are likely to occur over several decades to a century. Therefore, many of the projected changes associated with climate change may not be measurable within the reasonably foreseeable future. Unevenly distributed effects of climate change include altered weather patterns, sea levels, precipitation rates, wildfire occurrences, seasonal timing, desert distribution, and plant and animal distribution changes.

Climate change analyses are comprised of several factors, including GHGs, land use management practices, and the effects of reflectivity. The tools necessary to quantify incremental climatic impacts of specific activities associated with those factors are presently unavailable. Consequently, the impacts of specific anthropogenic activities cannot be assessed. Additionally, specific levels of significance have not yet been established. Therefore, climate change analysis in this document is limited to accounting and disclosing factors that contribute to it. Qualitative and quantitative evaluations of potential contributing factors within the Hay Creek II general analysis area are included where appropriate and practicable.

Chapter 3 identifies the effects of recent global climate change on the environment in the general analysis area. It is assumed that existing land and resource conditions within the general analysis area have been and would continue to be affected by climate change under all alternatives. Existing climate forecast models are not at a high enough resolution to estimate potential impacts of climate change within the PRB. Reference has been made to national and regional data that are available, including the recent comprehensive report, *The Effects of Climate Change on Agriculture, Land Resources, Water Resources and Biodiversity in the United States* (U.S. Climate Change Science Program 2008a).

To the extent that emission data were available or could be inferred from representative type data, potential GHG emissions that could result from mining of a tract under the Proposed Action or Alternative 2 have been identified, as well as emissions that would result from selection of the No Action Alternative.

The following analysis evaluates the action alternatives and their contribution to cumulative effects on the environment of past and projected development activity. This analysis assumes that coal mining would proceed in accordance with permit conditions, and that the coal would be sold in response to national and international demand. Historically, these users have been coal-fired power plants that generate electricity in the United States, although there are recent efforts towards sales outside the country; coal from the Buckskin Mine is not sold internationally. The coal market is open and competitive, and users can buy from the most cost-effective suppliers to meet their needs. The BLM does not determine the destination of this coal, and the consumer of the coal determines its use. Power plants in the United States where this coal has been used have a variety of coal combustion technologies and emission controls. All these utility companies are licensed by the appropriate regulatory authorities and operate under necessary permit requirements in compliance with regulations.

Assuming that all coal produced would be burned to generate electricity, GHG emissions that could be attributed to coal production resulting from mining the proposed tract or an alternative tract configuration, as well as from the forecast coal production from all coal mines in the Wyoming PRB, were estimated. This was done by relating the portion of coal mined to the total emission of GHG from all coal mined in the United States. Assuming that all PRB coal would be used for coal-fired electric generation as part of the total U.S. use of coal for that purpose, gives an upper estimate of the GHG expected to result from coal recovered from the proposed tract or alternative tract configuration and for total coal production forecast for the entire PRB. As mentioned previously, specific levels of significance have not been established for GHG emissions. Given the state of the science, it is not possible to associate specific actions with the specific climate impacts. Since tools necessary to quantify incremental climatic changes associated with GHG emissions are unavailable, conclusions as to the magnitude or significance of the emissions cannot be reached. The specific effects of this action are somewhat speculative given the current state of the science. The impacts of climate change represent the cumulative aggregation of all worldwide GHG emissions, land use management practices, and the effect of reflectivity. This analysis provides a meaningful context and measure of the relative significance of coal use from the mining a maintenance coal lease and overall projected PRB coal production on total GHG emissions.

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 can also affect other aspects of the environment. The Synthesis Report, the final part of the Fourth Assessment Report of the IPCC (available 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. The report included the following observations and projections.

- 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 refers to surface air temperature changes that are a response to increasing atmospheric GHG concentrations, along with other climate-influencing factors (National Oceanic and Atmospheric Administration 2007). From 1850 to present, historic trend data show an increase of 1 ° Celsius (C) (1.8 °F) in global mean temperature. However, the warming is not uniform throughout the world, and it is not 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 an average of about 20 centimeters (7.9 inches) and has resulted in changes in climate patterns on land. In some areas near the equator, temperatures have cooled by about 5 °C (8.75 °F), 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 °F) have been documented since 1900.

The IPCC Fourth Assessment Report found that the "…projected warming in the twenty-first 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[5] feedback (National Oceanic and Atmospheric Administration 2007). Because temperature is a part of climate, 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.

Human population doubled to 2 billion from 1780 to 1930, and 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.

CO_2, methane, water vapor, ozone, and nitrous oxide are the major GHGs, although there are other gases that are considered GHGs. These GHGs are released into the atmosphere and 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, 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_2 concentration of about 385 parts per million is about 30% above its highest level over at least the last 800,000 years. The average temperature in the United States has increased by about 2 °F over the last 50 years, which is more than the global average temperature increase (U.S. Global Change Research Program 2009).

The IPCC reports the following in its Synthesis Report (Bernstein et al. 2007).

- Global atmospheric concentrations of CO_2, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed preindustrial values determined from ice cores spanning many thousands of years**.**
- Atmospheric concentrations of CO_2 (379 parts per million) and methane (1,774 parts per billion) in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land use change providing another significant but smaller contribution.

[5] Albedo is a term used to describe the fraction of sunlight reflected by an object.

- Most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely because of the observed increase in anthropogenic GHG concentrations. It is possible that this type of warming has been significant 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 GHG emissions will continue to grow over the next few decades.
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the twenty-first century that would be larger than those observed during the twentieth 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 United States, southern Africa and northeast Brazil) will suffer a decrease in water resources as a result of climate change.
- Anthropogenic warming and sea level rise would continue for centuries as a result of the time scales associated with climate processes and feedbacks, even if GHG 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.
- A high level of agreement and much evidence support 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.

Relatively steep elevation gradients between valley floors and adjacent mountain ranges in the western United States 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. Patterns of historic climatic variation in these areas have occurred for more than 25,000 years, during which plant communities gradually shift to higher or lower elevations and north and south depending on the direction of temperature and precipitation changes (Tausch et al. 2004; Jackson and Overpeck 2000).

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

- The amount and seasonal variability of precipitation would increase over most areas. IPCC (2001) climate model scenarios indicate that by the year 2100, precipitation would increase about 10% in summer, about 30% in fall, and 40% in winter. Less snowfall would accumulate in higher elevations, more precipitation would occur as rain, and snowmelt would occur earlier in the spring because of higher temperatures.

- Streamflow patterns would change in response to reduced snowpack and increased precipitation. Peak flows in spring would occur earlier and be of lower magnitude because of snowpack changes. Runoff from greater amounts of winter rainfall would cause higher winter flows. Summer flows would be lower, but with higher variability depending on the severity of storm events.
- Some populations of native plants, invasive species, and pests would increase. Increasing amounts of atmospheric CO_2 and precipitation during the growing season would provide favorable growth conditions for native grasses, perennial forbs, woody species, and invasive annuals such as cheatgrass. Insect populations also would increase because milder winter temperatures would improve reproduction and survival rates.
- Fire frequency, severity, and extent would increase or decrease because of the changed availability of fine fuels (grasses, forbs, and invasive species) and altered accumulation of fuels from previous growing seasons. Higher temperatures could extend the length of fire seasons. Expansion, constriction and shifting of species ranges and changes in plant communities and densities will change the number and location of wildfires. Higher rates of insect damage and disease also may increase fuel accumulations.
- Sensitive species and overall biodiversity would be reduced. High-elevation habitats would shrink in area or disappear as lower-elevation plant communities expand. Some mammalian, avian, and other species that currently occupy these high-elevation habitats could 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_2 concentration increasing by 1% per year would be an idealized scenario. The sensitivity of any climate model is calculated as the amount of temperature change the model produces for a doubling of atmospheric CO_2 concentration. Most recent models have sensitivities of more than 2 °C for a doubling of CO_2 concentration (U.S. Climate Change Science Program 2008b). Scenarios 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 (Intergovernmental Panel on Climate Change 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 (Intergovernmental Panel on Climate Change 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 the regional details of predicting climate change (Intergovernmental Panel on Climate Change 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).

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 nationwide. Relatively little PRB coal, about 2%, is burned in Wyoming.

In 2008, Wyoming coal went to 36 states besides Wyoming, although it can also be shipped overseas. Over 95% 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. 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 because of its low sulfur content, providing a way for electric generators to achieve acid rain (SO_2) reduction requirements as well as lowering competitive mining costs when compared to delivered costs of coal from other coal-producing areas.

Wyoming coal production has increased more rapidly than other domestic coal. Coal coming out of the PRB is mined using surface mining methods which are generally safer, less labor intensive, and are easier to reclaim than underground mining. Rural rangelands are the areas that are predominately mined; they are reclaimed according to WDEQ's standards (section 3.9.4). PRB coal reserves are in thick seams, resulting in more production from the same disturbance area, and lower mining and reclamation costs.

During the coal leasing EIS process, it is difficult to predict who might purchase future PRB coal, how it would be used, and where it might be transported to. In the North American Electric Reliability Corporation power regions where PRB coal is sold, coal use ranges from 74.2% in the upper Midwest, to 15.6% in the northeast United States (EPA 2007d).

Some methods of generating electricity (e.g., natural gas, nuclear, hydroelectric, solar, wind, and geothermal resources) result in fewer GHG emissions than burning coal. The demand for power is increasing in the United States and throughout the world. According to a recent report by the North American Electric Reliability Council, peak demand for electricity in the United States is expected to double in the next 22 years (Associated Press 2007). Many developing countries, including China and India, rely heavily on coal to meet their rapidly increasing power demands, as coal is more economical and more available than other sources of electrical generation. Coal-burning power plants currently supply about 44.5% of the electric power generated in the United States as of 2009 (U.S. Energy Information Administration 2009c). The demand for power is increasing in the United States and throughout the world. In the International Energy Outlook 2010, the EIA is projecting electrical generation from coal by the year 2035 to be 44% (U.S. Energy Information Administration 2010).

The regulatory mechanisms proposed under the Climate Security Act of 2008, as well as regulation of pollutants under the CAA, are imposed at the point when coal is burned and converted to electric energy.

Coal-fired power plants have been identified as principal sources of anthropogenic CO_2 emissions. The Task 2 analysis assumed that all PRB coal is part of the total U.S. consumption for electric generation. Under that assumption, CO_2 emissions attributed to PRB coal were calculated based on the percentage of coal production in that area compared to total coal production in the United States. This approach provided estimates of CO_2 emissions from the use of the PRB coal to produce electricity under upper and lower projections for coal production scenarios in that region.

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% (U.S. Department of Energy 2007a). Wyoming coal production increased from 184.0 million tons in 1990 to 444.9 million tons in 2006, an increase of 242% (Wyoming Department of Employment 1990 and 2006). The share of electric power generated by burning coal was consistently around 50% during the 16 years between 1990 and 2006. The percentage of total U.S. CO_2 emissions related to coal consumption was consistently around 36% during that same time. The percentage of U.S. CO_2 emissions related to the coal electric power sector increased from about 30% in 1990 to about 33% in 2006 (U.S. Energy Information Administration 2009d).

In 2008, the Wyoming PRB coal mines produced approximately 451.7 million tons of coal. Using factors derived from laboratory analyses, an estimated 749.6 million metric tons of CO_2 would be generated from the combustion of all of this coal before CO_2 reduction technologies were applied. This number is based on an average Btu value of 8,600 per pound of Wyoming coal using a CO_2 emission factor of 212.7 pounds of CO_2 per million Btu (U.S. Energy Information Administration 1994). The estimated 749.6 million metric tons of CO_2 represents approximately 35.3% of the estimated 2,125.2 million metric tons of U.S. CO_2 emissions from coal combustion in 2008 (U.S. Energy Information Administration 2009d). In 2008, Wyoming PRB mines accounted for approximately 38.5% of the coal produced in the U.S. (U.S. Energy Information Administration 2009a).

The EIA's 2008 Emissions of GHGs in the U.S. report (U.S. Energy Information Administration 2009d) and EIA's 2008 U.S. Coal Report (U.S. Energy Information Administration 2009a) report the following.

- CO_2 emissions represent about 83% of the total U.S. GHG emissions.
- Estimated CO_2 emissions in the United States totaled 5,839.3 million metric tons in 2008, which was a 1.5% decrease from 2006 (which was 5,928.7 million metric tons).
- Estimated CO_2 emissions from the electric power sector in 2008 totaled 2,359.1 million metric tons, or about 40.6% of total U.S. energy-related CO_2 emissions in 2008 (which was 5,814.4 million metric tons).
- Estimated CO_2 emissions from coal electric power generation in 2008 totaled 1,945.9 million metric tons or about 33.5% of total energy-related CO_2 emissions and about 82.5% of CO_2 emissions from the U.S. electric power sector in 2008.
- Coal production from the Wyoming PRB represented approximately 43.4% 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% of the estimated U.S. CO_2 emissions in 2008.

As discussed earlier in this chapter, the Task 2 Report projects coal development for 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_2 emissions that would be produced from the combustion of all of this coal (before CO_2 reduction technologies are applied).

Table 4-37. Estimated Annual CO_2 Emissions from Projected PRB Coal Production Levels According to Task 2 Report

Projected Coal Production Scenario	Year	Coal Production Rate (million U.S. tons per year)[a]	CO_2 Emissions (million metric tons per year)[b]
Lower	2010	411	682
	2015	467	775
	2020	495	821
Upper	2010	479	795
	2015	543	901
	2020	576	956

[a] US tons (2000 pounds per ton).
[b] Metric tons (2204 pounds per ton).
Source: Updated Task 2 Report (BLM 2009c).

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 would proceed in accordance with existing permit conditions and would be sold to coal users in response to forecasts of demand. Historically these users have been electric utilities in the United States, although there is potential for sales outside the country. This coal market is open and competitive and users can buy from the most cost effective suppliers that meet their needs.

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 located throughout the United States and have a variety of coal combustion technologies and emission control systems. These systems are licensed by the appropriate regulatory authorities in their locale and operate under necessary permit requirements in compliance with regulation.

Table 4-38 shows the estimated cumulative annual CO_2e 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.

Table 4-38. Estimated Annual CO_2 Equivalent Emissions[a] from Coal Production at PRB Mines with Pending LBAs

Source	2007	With LBA Tracts
Four South Gillette Area Coal Mines/Four LBA Tracts	0.716	1.182
Three Wright Area Coal 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
Total	2.535	4.229

LBA = lease by application

[a] CO_2e in million metric tons.

Source: Love pers. comm.; Jones & Stokes 2009, WWC Engineering 2009.

Individual LBA tracts are addressed in the following EISs: West Antelope II Coal Lease Application FEIS (BLM 2008e); South Gillette Area Coal Lease Applications FEIS (BLM 2009h); Wright Area Coal Lease Applications FEIS (BLM 2010); and Hay Creek II Coal Lease Application FEIS (this document).

Under the Proposed Action and Alternative 2, the Buckskin Mine anticipates producing coal included in the proposed tract or alternative tract configuration, respectively, at currently permitted levels using existing production and transportation facilities. Estimates of GHG emissions resulting from current and projected operations at the mine under the Proposed Action and Alternative 2 are included in section 3.18.3.

The CO_2 emissions from coal purchased from the Buckskin Mine and used to generate electricity in other states would be extended; the mine does not sell coal to any foreign entities at this time. Table 4-39 shows the current (No Action) average annual coal production for the Buckskin Mine and the estimated CO_2 emissions related to burning coal at that existing level of production. The estimated annual CO_2 emissions that would be produced from burning coal recovered from the proposed tract and from an alternative tract configuration under Alternative 2 are also shown. Those estimates are based on the average current rate of annual coal production, which is not expected to change under either action alternative, and the assumption that mining would occur at that maximum permitted level until all coal resources in the leased tract are depleted. As expected, the estimate for total CO_2 emissions associated with burning new coal reserves would be greatest under Alternative 2 because of the larger potential tract size and longer mine life. Under this alternative, the Buckskin Mine could extend production by up to six years. In contrast, the average annual estimate for CO_2 emissions under Alternative 2 would be slightly lower than under the Proposed Action.

Table 4-39. Estimated Annual CO_2 Emissions Produced from Combustion of Coal Produced from the Proposed Tract or BLM Study Area

Applicant Mine/LBA Tract	Current (No Action) and Anticipated Average Annual Coal Production by Applicant Mine[a] (million tons per year)	CO_2 Emissions Related to Annual Coal Production[b] (million metric tons)	Recoverable Coal Added under Proposed Action[a] (million tons)	Mine Life Added under Proposed Action[a] (years)	CO_2 Emissions Added by Proposed Action[b] (million metric tons)		Recoverable Coal Added under Alternative 2[a] (million tons)	Mine Life Added under Alternative 2[a] (years)	CO_2 Emissions Added by Alternative 2[b] (million metric tons)	
					Total for Proposed Tract	Average per Year for Proposed Tract			Total for BLM Study Area	Average per Year for BLM Study Area
Buckskin/Hay Creek II	25.0	41.5	54.1	2	89.8	44.9	149.7	6	Up to 248.4	41.4

[a] Anticipated coal production rates at the Buckskin Mine, coal tonnages within the proposed tract and BLM study area, and anticipated number of years added to the life of the mine under each alternative are addressed in chapter 2.

[b] Determined using emission factor of 1.659 metric tons CO_2/ton of coal burned (U.S. Energy Information Administration 1994).

Despite these estimates, the actual level of CO_2 emissions produced from burning coal recovered from the proposed tract or an alternative tract configuration under Alternative 2 cannot be predicted with complete accuracy due to uncertainties about emission limits that would be in place when the new coal is mined, as well as where and how that coal would be used. As shown under the No Action Alternative in table 2-4, the Buckskin Mine projects that, after 2008, approximately 14 years of currently permitted mine life remains. More rapid improvements in technologies that provide for less CO_2 emissions, new CO_2 mitigation requirements, or an increased rate of voluntary CO_2 emissions reduction programs could result in significantly lower CO_2 emissions levels than are projected here.

The Buckskin Mine produced approximately 25 million tons of coal in 2008, or about 4% of the coal produced in the Wyoming PRB that year. Combustion of those 25 million tons of coal to produce electricity generated approximately 41.5 million metric tons of CO_2 emissions, or about 0.6% of the total estimated anthropogenic CO_2 emissions produced in the United States in 2008 (about approximately 7,052.6 million metric tons) (U.S. Department of Energy 2009d). Under the No Action Alternative, CO_2 emissions attributed to burning coal produced by the mine would continue at this approximate level for up to 14 years beyond 2008, while the mine recovers the remaining estimated 460.9 million tons of currently leased coal reserves.

Selection of the No Action Alternative would probably not result in a decrease of U.S. CO_2 emissions attributed to coal mining and coal-burning power plants in the longer term, because multiple other sources of coal are available. Although this coal does not have the cost, environmental, or safety advantages of PRB coal, it could supply the demand beyond the time that the Buckskin Mine completes coal recovery in its existing leases.

In 2006, transportation sources accounted for approximately 29% of total U.S. GHG emissions (EPA 2008c). This is the fastest growing source of U.S. GHGs, accounting for 47% of the net increase in total U.S. emissions since 1990. Transportation is also the largest end-use source of CO_2, which is the most prevalent GHG (EPA 2008c).

CO_2 is not the only GHG of concern. Methane is a component of CBNG that is released into the atmosphere when coal is mined. The other major sources of U.S. methane emissions are from agriculture and waste management. The EIA (2007a and 2007b) reports the following.

- Anthropogenic methane emissions in the U.S. totaled 737.4 million metric tons CO_2e in 2008 and 722.7 million metric tons CO_2e in 2007.
- Methane emissions from coal mining across the nation were estimated at 82.0 million metric tons CO_2e, or approximately 11.1% of the U.S. total anthropogenic methane emissions in 2008.
- Surface coal mining operations were estimated to be responsible for methane emissions of about 15.7 million metric tons of CO_2e in 2008 in the United States. This represents about 2.1% of the estimated anthropogenic methane emissions in 2008, and about 19.1% of the estimated methane emissions attributed to coal mining of all types.
- The Wyoming PRB produced approximately 55.5% of the coal mined in the United States in 2008 using surface mining techniques, which means that Wyoming PRB surface coal mines were responsible for approximately 1.7% of the estimated U.S. anthropomorphic methane emissions that year. The Buckskin Mine contributed about 4% of the Wyoming PRB coal production in 2006. Since 1990, when the BLM began using the LBA process, total U.S. anthropogenic methane emissions declined from 783.5 million metric tons CO_2e to 737.4 million metric tons CO_2e in 2008. Total coal mining related emissions declined from 106.4 million metric tons CO_2e to 82.0 million metric tons CO_2e during the same period. The EIA attributes the overall decrease in emissions of methane to increases in coal production from surface coal mines that produce relatively little methane (U.S. Energy Information Administration 2009d).

CBNG is commercially produced on a large scale by oil and gas operators from wells located within and near the Hay Creek II general analysis area. CBNG that is not recovered prior to mining is vented to the atmosphere during the mining process. Selection of the No Action Alternative would allow more complete recovery of the CBNG from the general analysis area in the short term (roughly 14 years), during the time that the applicant mine's currently leased coal is being recovered. Under Alternative 2, a large portion of the CBNG resources in the BLM study area would be recovered prior to mining as discussed in Section 3.3.2.2. Selection of the No Action Alternative would not likely directly decrease U.S. methane emissions attributed to coal mining in the long term because multiple other sources of coal are available that could supply the coal demand beyond the time that the Buckskin Mine recovers the coal in its existing leases.

Nitrous oxide is the other GHG of concern that is associated with coal mining; however, the largest source in the United States is agricultural (about 76% comes from fertilization of soils and about 24% from management of animal waste) (U.S. Energy Information Administration 2009d).

Although the effects of GHG emissions and other contributions to global climate change can be estimated, given the current state of science it is impossible to determine what effect any amount of GHG emissions from an activity might have on global warming, climate change, or the environmental effects stemming from it. Thus, it is 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, certain actions and the effects of that action may contribute to 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 (U.S. Energy Information Administration 2009e). A number of bills have been introduced in the U.S. Congress related to global climate change. At this time, no national policy or law is in place to regulate 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 GHGs that a region can emit each year and “trade” would allow companies to exchange the permission (or permits) to emit GHGs. The cap would get tighter over time, and by 2050, emissions would be reduced by 63% below 2005 levels. The Senate Environment and Public Works Committee approved the bill 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 released by the Senate Environment and Public Works Committee on May 21, 2008. The bill was 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% below 2005 levels by 2020 and 83% below 2005 levels by 2050. In November 2009, 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% 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 (U.S. Energy Information Administration 2009d).

On April 2, 2007, in *Massachusetts v. EPA*, the U.S. Supreme Court found that GHGs are air pollutants covered by the CAA. The Court held that the administrator of the EPA must determine whether emissions of GHGs from new motor vehicles cause or contribute to air pollution that may endanger public health or welfare, or whether the science is too uncertain to make a reasoned decision. The court directed the EPA to review the latest science on climate change in order to make a determination. On April 17, 2009, the EPA administrator signed the 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. The Administrator found that current and projected concentrations of the six key well-mixed GHGs—CO_2, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—in the atmosphere threaten the public health and welfare of existing and future generations and that the combined emissions of these GHGs from new motor vehicles contribute to climate change. The findings do not impose any emission reduction requirements but allow the EPA to finalize the GHG standards proposed earlier in 2009 (EPA 2009d). The agency can now regulate CO_2 as a pollutant and begin regulating GHG emissions from power plants, factories and major industrial polluters, although the details of that regulation have yet to be worked out. An endangerment finding under one provision of the CAA alone would not automatically trigger regulation under the entire Act.

Because 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_2 emissions standards to new and modified sources that emit more than 25,000 metric tons CO_2e 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 metric tons CO_2e annual level, the EPA expects that 14,000 large industrial sources, which are responsible for 70% 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 (U.S. Energy Information Administration 2009d).

The EPA signed the Final Mandatory Reporting of Greenhouse Gases Rule on September 22, 2009 (EPA 2010). The rule requires suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions to submit annual reports to the EPA. The gases covered by the rule are CO_2, nitrous oxide, HFCs, PFCs, $SF_{6,}$ and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). The 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 were required to began monitoring 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 DOE received $36.7 billion to fund renewable energy, carbon capture and storage, energy efficiency, and smart grid projects. The projects are expected to provide reductions in both energy use and GHG emissions (U.S. Energy Information Administration 2009d).

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 GHG emissions. There are federal tax incentives for energy efficiency and conservation, and some states have renewable energy and energy efficiency policies. Regional initiatives have started in the northeast (Northeast Regional Greenhouse Gas Initiative) as well as the Western Climate Initiative in the western states. 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_2 and other GHGs seems likely (National Association of Regulatory Utility Commissioners 2007). There is uncertainty about anticipated CO_2 emission limits and carbon capture/sequestration regulations. This has led some proponents to cancel or delay proposed projects that use existing and emerging technologies to produce electricity from coal (Bleizeffer 2007a and 2007b). 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 (U.S. Energy Information Administration 2009e).

Based on the coal-related and oil- and gas-related development in the PRB study area, future development of geologic carbon sequestration could occur in the area.

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. The population in the United States has increased by about 20% and energy consumption by a comparable 18% 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 (U.S. Geological Survey 2002b). One-quarter of the world's coal reserves are found within the United States; 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 (U.S. Energy Information Administration 2008c and U.S. Department of Energy 2009). Many countries are even more reliant on coal for their energy needs than is the United States. More than 70% of the electricity generated in China and India comes from coal (U.S. Geological Survey 2000). The value of coal is partially offset by the environmental impacts of coal combustion (U.S. Geological Survey 2000).

In the DOE's 2007 Annual Energy Outlook, energy-related CO_2 emissions were projected to grow by about 35% from 2006 to 2030 (U.S. Energy Information Administration 2007b). By comparison, the DOE's 2008 Annual Energy Outlook projected energy-related CO_2 emissions to grow by 16%, from 5,890 million metric tons in 2006 to 6,851 million metric tons in 2030 (U.S. Energy Information Administration 2008c). However, the DOE's 2009 Annual Energy Outlook projects energy-related CO_2 emissions to grow by 7%, from 5,991 million metric tons in 2007 to 6,414 million metric tons in 2030. The mix of sources for these generation projections include coal, natural gas, nuclear, liquids (petroleum), hydro-power, and non-hydro renewables (e.g, wind, solar). The most recent, lower projected emissions growth rate is the result of a slower demand growth combined with increased use of renewables and a declining share of electricity generation that comes from fossil fuels (U.S. Department of Energy 2009b).

Total U.S. anthropogenic GHG emissions in 2008 were 2.2% below the 2007 total. The decline in total emissions—from 7,209.8 million metric tons CO_2e in 2007 to 7,052.6 million metric tons in 2008—was largely the result of a 177.8 million metric tons CO_2e drop in CO_2 emissions. Emissions of other GHGs increased by small percentages, but those increases were more than offset by the drop in CO_2 emissions. The decrease in U.S. CO_2 emissions in 2008 resulted from higher energy prices, economic contraction, and lower demand for electricity (U.S. Energy Information Administration 2009e).

Energy-related CO_2 emissions dominate (about 81% in 2008) the total U.S. GHG emissions. Petroleum is the largest fossil fuel source for energy-related CO_2 emissions, contributing 41.9% of the total, whereas coal is the second-largest fossil fuel contributor, at 36.5%. Petroleum made up 44.6% of total fossil fuel energy consumption in 2008, as compared with coal's 26.8%. Natural gas accounted for 28.5% of the fossil fuel energy use in 2008, but only 21.4% of total energy-related CO_2 emissions. Energy-related CO_2 emissions account for 98% of the total U.S. CO_2 emissions (U.S. Department of Energy 2009a).

The United States emits about 1,900 million metric tons annually from coal-fired power plants, 33% of total energy-related CO_2 emissions, and 81% of CO_2 emissions from the U.S. electric power sector (U.S. Department of Energy 2009a). If public sentiment results in changed electric demand, or if GHG emissions are 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 will affect planning decisions for new power plants, particularly coal-fired facilities.

To assess the national electric generation portfolio (mix of electric generation technologies) and the mix of future electric generation technologies, the BLM reviewed the Annual Energy Outlook 2010 Report (U.S. Energy Information Administration 2009b). 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. 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 coal-fired domestic electric generation at 44% by 2035, based on a slowing in electric demand through 2035, and a doubling, to 17%, of renewable electric generation 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 are available for producing cleaner, more efficient, and more reliable power from coal. These include advanced pulverized coal, circulating fluidized bed, coal gasification or integrated gasification combined cycle, and carbon sequestration or carbon capture and storage technologies. Systems that use carbon capture technologies are designed to capture at least 90% of emitted CO_2, which would be stored within geological formations (i.e., oil and gas reservoirs, saline formations, unmineable coal seams). These technologies are not used commercially because of the extremely high capital costs and low system reliability—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 carbon capture and storage equipment they could incur higher costs as a result of higher expenses for siting and permitting. Nuclear and renewable power plants would not be directly affected by regulatory uncertainties because they do not emit GHGs

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 a national policy required CO_2 emissions to be reduced to 1990 levels (James 2007). EPRI updated this research in an October 2009 report, The Power to Reduce CO_2 Emissions: The Full Portfolio (EPRI 2009), which used the EIA's Annual Energy Outlook 2009 Report for comparison.

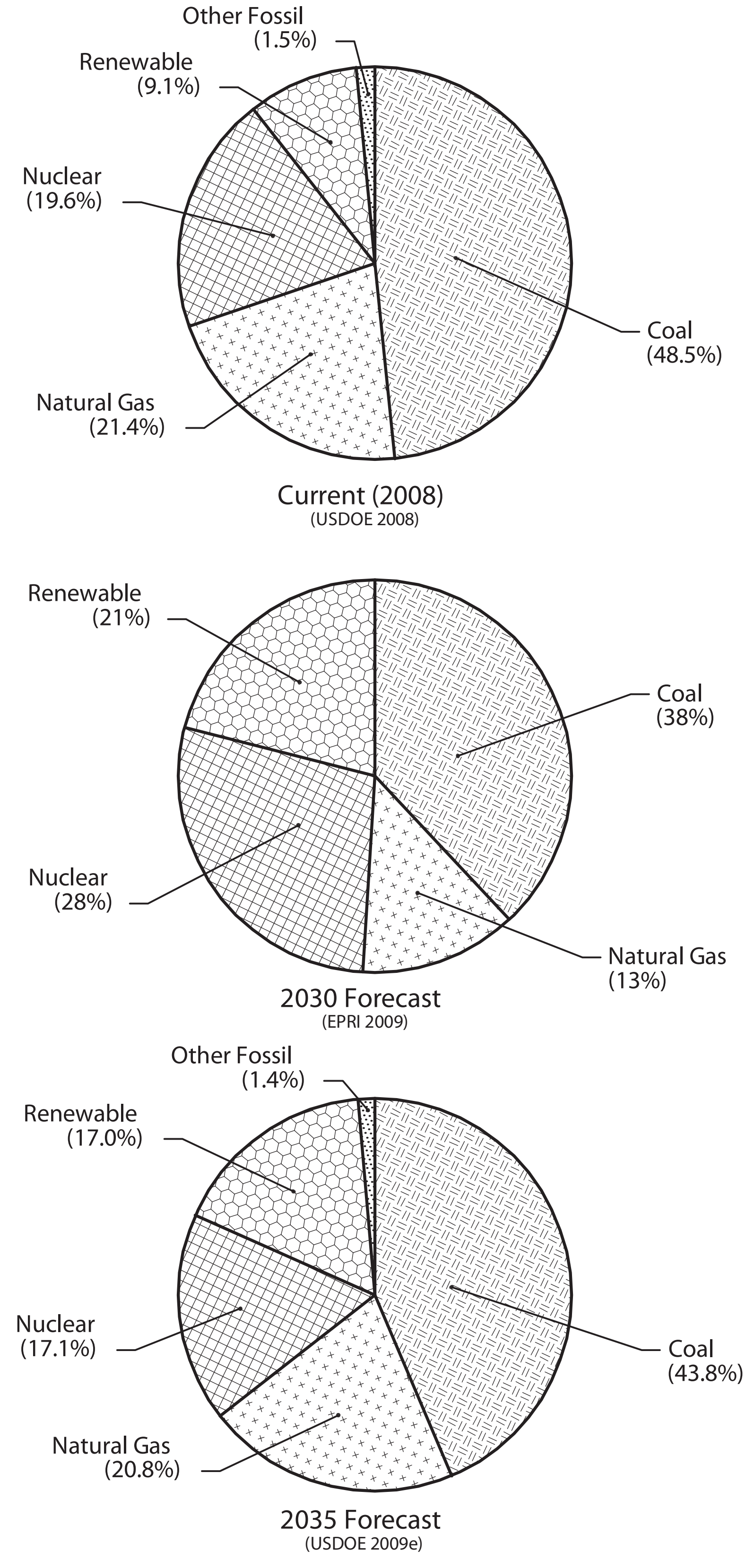
The EPRI study predicts that a national policy that forces a reduction of CO_2 emissions to 1990 levels would promote increased energy efficiency, and the growth of “non carbon” sources such as nuclear and renewable. Renewable sources include wind and solar, as well as emerging technologies like tidal 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 gas and petroleum are less than forecasted by the 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 the EIA and EPRI forecast an increase in electricity cost.

Figure 4-6 shows the 2008 electric generation mix, compared to the 2035 EIA forecast (U.S. Energy Information Administration 2009b) as well as the older 2030 EPRI forecast (EPRI 2009). Both forecasts agree that the amount of coal-fueled electric generation is expected to drop from nearly 50% of the present total to about 40% 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 DOE initiated the FutureGen project, a first of its kind, commercial-scale coal-fired, near-zero-emissions power plant incorporating integrated gasification combined cycle with carbon capture and storage. This is the first facility of its kind to combine and test several cutting-edge technologies. FutureGen is a public-private partnership between the DOE and the FutureGen Alliance, a non-profit organization representings some of the world’s largest coal producers and electric utilities. The FutureGen Alliance and the DOE 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_2 from the waste stream, and then sequester the CO_2 underground. The Alliance is responsible for design, construction, and operation of the facility, and the DOE is responsible for independent oversight and coordinating participation of international governments. The DOE’s financial contribution will come from the American Recovery and Reinvestment Act. The DOE issued a NEPA ROD on July 14, 2009, to move forward (U.S. Department of Energy 2009b). 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. When operational the FutureGen facility will produce 275 MW of power and capture 90% of the carbon emissions; however, it may be operated at a 60% capture rate in the first three 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_2 annually (U.S. Department of Energy 2009b).

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% of the nation’s energy, with natural gas currently supplying about 22% of the total. The percentage contribution of natural gas to the U.S. energy supply is expected to remain constant for the next 20 years. According to EIA’s 2010 Annual Energy Outlook (U.S. Energy Information Administration 2009b), concerns about GHG emissions have little effect on construction of new capacity fueled by natural gas.



No warranty is made by the Bureau of Land Management for the use of the data for purposes not intended by BLM.

Figure 4-6
Current and Forecast Mix of Electric Generation Sources

Unconventional natural gas resources are expected to play a larger role in the demand for natural gas for electricity generation (U.S. Department of Energy 2009b). 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% (U.S. Department of Energy 2009b).

EPRI (2009) projects the nuclear share of power generation to increase to about 28% by 2030 as the addition of new power plants and upgrades at existing units increases overall capacity and generation. The nuclear power share of total electricity generation remains somewhat constant between 17 and 19% by 2035 according to EIA (2009b).

The nation's total electricity generation from renewable resources, hydroelectricity, geothermal, solar, wind, ethanol, bio-fuels, and bio-mass, supported by federal tax incentives and state renewable programs, was expected to increase from 9% in 2008 to 17% in 2035 (U.S. Department of Energy 2009d). EPRI (2009) is more optimistic with renewable sources reaching 21% by 2030.

The estimated cumulative CO_2 emissions that would be produced annually from the conventional combustion of the coal produced from the proposed tract or an alternative tract configuration under Alternative 2 (see 4.2.14.2) is based on the Buckskin Mine's projected future mining rates. That estimate presents a scenario that assumes the demand for coal in the future would not differ from current demand. The scenario also assumes, technologies for producing cleaner, more efficient and more reliable power from coal (i.e., advanced pulverized coal, circulating fluidized bed, integrated gasification combined cycle, and carbon capture and storage) would not yet be commercially established, and an explicit federal policy would not yet have been enacted to limit or reduce U.S. GHG emissions. However, if generation shifted strongly toward natural gas, nuclear, and renewable power, as well as fossil technologies using carbon capture and storage equipment, those estimates of CO_2 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 to produce electricity is the release of elements from coal to the environment (U.S. Geological Survey 2002b). 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 2009e). 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 burning (U.S. Geological Survey 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 (U.S. Geological Survey 2000). Some coal mined in China contained high levels of arsenic, fluorine, selenium, and polycyclic aromatic hydrocarbons. This coal has caused severe, lifethreatening health impacts on some residents that burned the coal in unvented stoves in their homes (U.S. Geological Survey 2000).

Coal that is burned in the United States generally contains low to modest concentrations of potentially toxic trace elements and sulfur (U.S. Geological Survey 2000). Specifically, PRB coal is recognized as being a clean burning coal because of its low sulfur and low ash properties. An analysis conducted by the USGS (2002b) found that PRB coal contained, on average, approximately eight times less sulfur than coals being used 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 parts per million), seven times less arsenic (17 parts per million), five times less lead (19 parts per million), and three times less cadmium (1.1 parts per million) when compared to Appalachian and Illinois basin feed coals. When burned, PRB coal produced, on average, 38% less fly ash than Appalachian and Illinois basin coals (U.S. Geological Survey 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 (U.S. Geological Survey 2002b).

Additionally, many U.S. coal-burning power plants use sophisticated pollution-control systems that efficiently reduce the emission of hazardous elements (U.S. Geological Survey 2000). The EPA conducted a detailed study of possible health impacts from exposure to emissions of approximately 20 potentially toxic substances from U.S. coal-burning power plants (U.S. Geological Survey 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 (U.S. Geological Survey 2000).

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

When fossil fuels burn, mercury vapor is released into the atmosphere where it may drift for a year or more, spreading with air currents over vast regions of the globe (U.S. Department of Energy 2006). In 1995, an estimated 5,500 tons of mercury was emitted globally from both natural and human sources (U.S. Department of Energy 2006). Coal-fired power plants in the United States contributed to less than 1% of that total (U.S. Department of Energy 2006).

Mercury is a global problem. It can travel thousands of miles in the atmosphere before it is deposited back to the earth in rainfall or in dry gaseous forms. The EPA estimates that about one-third of the U.S. anthropogenic mercury emissions are deposited within the contiguous United States and the remainder enters the global cycle (EPA 2009f).

Table 4-40 summarizes how the various continents contributed to worldwide human-caused mercury emissions in 2004. The 2004 emissions were estimated to account for about 3% of the global total (EPA 2009f). The EPA (2009e) estimates that 83% of the mercury deposited in the United States originates from international sources, with the remaining 17% coming from the United States and Canada. These figures include mercury from natural and anthropogenic sources.

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

Continent	Percent
Asia	53
Africa	18
Europe	11
North America	9
Australia	6
South America	4

Source: EPA 2009f.

In 2006, the EPA estimated that 50% to 70% of global 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 2006b.)

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

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 about a million times the methyl mercury concentration in the water (EPA 2006b). The primary way humans are exposed is by eating fish containing methyl mercury (EPA 2006b).

Other animals that consume fish and shellfish can also be adversely affected. Birds and mammals that eat fish may be more exposed to mercury than other animals in water ecosystems (EPA 2008d). Exposure to high levels of methyl mercury may include death, reduced reproduction, slower growth and development, and abnormal behavior (EPA 2008d). 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 2006b).

The DOE’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 (U.S. Department of Energy 2006). The Office of Fossil Energy manages the largest funded program for developing an understanding of mercury emissions and developing emission control technologies for the coal-fired electric generating industry in the United States (U.S. Department of Energy 2006). Research on advanced and improved mercury control technology is ongoing (U.S. Department of Energy 2006).

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

Coal production from the Wyoming PRB represented approximately 42% of the coal used for power generation in 2006, or about 0.4% of the global anthropogenic mercury emissions. The Buckskin Mine produced about 5.2% of the coal produced in the Wyoming PRB in 2006, which would represent about 0.005% of the global mercury emissions. Under the No Action Alternatives, mercury emissions attributable to burning coal produced by the Buckskin Mine would be extended at current levels up to approximately 14 years, while the mine recovers the remaining estimated 344.3 million tons of currently leased coal reserves. Under the Proposed Action or Alternative 2, the Buckskin Mine's contribution to global mercury emissions would be extended from two to six additional years, respectively. Uncertainties about future regulatory requirements and the use of the coal mined under either of the action alternatives make it difficult to project the impacts of mercury emissions produced by burning the coal.

Additionally, burning coal in electric utility boilers generates residual materials called 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 the site-specific characteristics of where the coal originated. Coal-fired boilers are required to have control devices to reduce the amount of emissions that are released into the atmosphere (EPA 2007e). 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 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 2002c). Buckskin Mine does not dispose of combustion residues. 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.

As stated, the Buckskin Mine produced about 5.2% of the coal produced in the Wyoming PRB in 2006. Under the No Action Alternative, production of coal combustion residue attributed to burning coal from the Buckskin Mine would be extended at about current levels for approximately 14 years, while the mine recovers the remaining estimated 344.3 million tons of currently leased coal reserves. Coal combustion residue related to burning coal mined under the Proposed Action or Alternative 2 would be extended from two to six additional years, respectively. Uncertainties about future regulatory requirements and the use of the coal mined under either action alternative make it difficult to project the impacts of disposing of the related coal combustion residues.

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 (e.g., sand, gravel, or gypsum) (EPA 2007e).

Coal combustion products (CCPs) are produced primarily from the combustion of coal in coal-fired power plants (EPA 2007e) and can include the following materials: fly ash, bottom ash, boiler slag, and flue gas desulfurization material (EPA 2007e). Studies and research conducted or supported by the EPA, EPRI, other government agencies, and universities have indicated that the beneficial uses of CCPs have not been shown to present significant risks to human health or the environment (EPA 2009g).

Fly ash is a by-product 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 round. Fly ash is a siliceous material that, in the presence of water, reacts with calcium hydroxide at ordinary temperatures to produce cement-like compounds. Because of its shape and properties, fly ash can be useful in cement and concrete applications. (EPA 2007h.)

Bottom ash is agglomerated ash particles, formed in furnaces burning pulverized coal that are too large to be carried in the flue gases. Bottom ash is coarse with grain sizes 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. (EPA 2007g.)

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 melting snow. (EPA 2007h.)

Flue gas desulfurization material is a product of a process typically used for reducing SO_2 emissions from the exhaust gas system of a coal-fired boiler. These materials can be used as embankment and road base material, wallboard manufacturing, and in place of gypsum to produce cement. Currently, the largest single market for flue gas desulfurization material is in wallboard manufacturing. (EPA 2007i.)

Using CCPs can generate significant environmental and economic benefits (EPA 2009f). CCPs can be used for raw feed for cement clinker, 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 (EPA 2009f).

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 2009g). High coal ash content concrete is used for building 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 (EPA 2007f). Using coal fly ash in concrete can also produce stronger and longer-lasting buildings (EPA 2007f). This not only reduces the costs of maintaining buildings, but also 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 2007f).

In 2005, demand had become so strong for coal ash that some power plants were selling all the ash they produced (EPA 2005d). The EPA estimated that by using 15 million tons of coal fly ash, the United States 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, the EPA has sponsored the Coal Combustion Products Partnership (C2P2) Program to further the beneficial use of these coal combustion by-products (EPA 2003b). With more than 170 private and public partners (EPA 2009c), the C2P2 Program is a cooperative effort between the EPA and various organizations to promote the beneficial use of CCPs and the environmental benefits which can result from the proper use of these potentially recyclable materials (EPA 2003b). The C2P2 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 2009c).

In 2007, the United States used approximately 43% of its CCPs (EPA 2009c). The C2P2 program aims to reduce adverse effects on air and land by increasing the use of CCPs to 50% in 2011 from 32% in 2001 (EPA 2009d). The program also plans to increase the use of CCPs as a supplementary cement-like material in concrete by 50%, from 12.4 million tons in 2001 to 18.6 million tons in 2011 (EPA 2009d). This would decrease GHG emissions by avoiding cement manufacturing of approximately 5 million tons of cement (EPA 2009d).

Table 4-41 summarizes the magnitude and duration of cumulative impacts in the PRB based on the upper and lower estimates for coal production in the region. The Proposed Action and Alternative 2 are within the upper and lower coal production estimates used to project reasonably foreseeable impacts for the PRB Coal Review and to provide a basis for quantification of related impact-causing parameters. As described in section 4.0, the PRB Coal Review is not an analysis of the impacts associated with the development of a specific project in the PRB, such as the Hay Creek II coal lease application discussed in this EIS.

Table 4-41. Summary Comparison of Magnitude and Duration of Cumulative Impacts[a,b]

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Topography and Physiography		
Alteration of topography following reclamation of coal disturbance areas	Permanent topographic moderation following reclamation	Same as Alternative 1
Alteration of topography to accommodate coal-related, oil and gas, and oil- and gas-related facilities	Long-term to permanent limited changes in discrete, scattered areas	Same as Alternative 1
Geology and Mineral Resources		
Recovery of coal resulting in reduction in coal resources and disturbance and replacement of overburden and topsoil	Moderate, permanent	Same as Alternative 1
Surficial disturbance and reclamation on oil and gas well sites and associated facilities	Moderate, long-term	Same as Alternative 1
Paleontology		
Coal, coal-related, oil and gas, and oil- and gas-related development disturbance of PFYC Class 5 Wasatch and Class 3 Fort Union formations	Permanent potential adverse effects to scientifically significant fossils that are present but not visible prior to disturbance	Same as Alternative 1
Air Quality		
Impacts to Wyoming near-Field Receptors 24-hour PM_{10} and $PM_{2.5}$	Maximum modeled impacts occurring at isolated receptors show localized exceedances of the WAAQS and NAAQS for the base year (2004) as well as for both coal production scenarios for 2015 and 2020	Same as Alternative 1
Annual PM_{10}	Maximum modeled impacts at peak receptors show 20% increase from base year (2004); exceed the WAAQS for both coal production scenarios for 2015 but in compliance with WAAQS for both coal production scenarios for 2020	Same as Alternative 1
Annual $PM_{2.5}$	Maximum modeled impacts at peak receptors show 20% increase from base year (2004) and localized exceedances of the WAAQS and NAAQS for both coal production scenarios for 2015 and 2020	Same as Alternative 1

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
All other parameters	Modeled impacts in compliance with WAAQS and NAAQS for both coal production scenarios for 2015 and 2020	Same as Alternative 1
Impacts to Montana near-Field Receptors All parameters	Impacts at all Montana receptors would be in compliance with NAAQS and Montana AAQS (MAAQS) for most pollutants and averaging periods. 1-hour NO_2 concentrations for all years and development scenarios were predicted to exceed NAAQS. 1-hour NO_2 concentrations were predicted to exceed MAAQS in 2015 at isolated locations because of CBNG development in Wyoming but drop below MAAQS by 2020. Impacts are predicted to decrease for annual NO_2, PM_{10} and $PM_{2.5}$ relative to the base year (2004) because of anticipated southward progression of nearby CBNG wells	Same as Alternative 1
Non-regulatory PSD Impacts at Class I and Sensitive Class II Areas Class I Northern Cheyenne Indian Reservation	Modeled impacts above Class I increment levels for 24-hour PM_{10} for all years and coal production scenarios; for 24-hour SO_2 for both coal production scenarios for 2020; for 3-hour SO_2 for upper coal production scenario for 2020	Same as Alternative 1
Class I Badlands National Park	Modeled impacts above Class I increment levels for 24-hour PM_{10} for both coal production scenarios for 2020	Same as Alternative 1
Class I Wind Cave National Park	Modeled impacts above Class I increment levels for 24-hour PM_{10} for all years and coal production scenarios	Same as Alternative 1
All Sensitive Class II Areas (including Cloud Peak Wilderness Area and Crow Indian Reservation)	Modeled impacts below Class II increments for all Sensitive Class II areas for base year (2004) and both coal production scenarios for 2020	Same as Alternative 1
Visibility Impacts Class I Areas	Modeled impacts show 200 or more days a year during the base year (2004) with a change of 1.0 dv or greater at the Northern Cheyenne Indian Reservation, Badlands National Park, and Wild Cave National Park.; the same three Class I areas have the highest predicted visibility change in 2020	Same as Alternative 1
Sensitive Class II Areas	All but four areas have more than 100 days a year during the base year (2004) with a change of 1.0 dv or greater	Same as Alternative 1
Acid Deposition Impacts	All modeled impacts below the deposition threshold values for nitrogen and sulfur compounds	Same as Alternative 1

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Florence Lake	Modeled impact above 10% ANC threshold for both coal production scenarios for 2015 and 2020	Same as Alternative 1
Upper Frozen Lake	Modeled impact above 1 μeq/L ANC for both coal production scenarios for 2015 and 2020	Same as Alternative 1
All other modeled sensitive lakes	Modeled impact below 10% ANC threshold values for both coal production scenarios for 2015 and 2020	Same as Alternative 1
Groundwater Resources		
Removal of coal aquifer and replacement with backfill material	Moderate, long-term to permanent for mining areas	Same as Alternative 1
Lowering of water levels in aquifers around the mines	Moderate, long-term in area immediately west of mines	Same as Alternative 1
Water level decline in sub-coal aquifers as a result of all development	No cumulative impacts anticipated	Same as Alternative 1
Change in groundwater quality as a result of all development	No cumulative impacts anticipated	Same as Alternative 1
Overlapping drawdown in the coal aquifer caused by surface mining and CBNG development	Additive, long-term in area immediately west of surface coal mines	Same as Alternative 1
Surface Water Resources		
Surface disturbance of intermittent and ephemeral streams and scattered ponds and reservoirs as a result of coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short-term	Same as Alternative 1
Discharge of coal mining and CBNG produced waters into intermittent and ephemeral streams	Moderate, short-term	Same as Alternative 1
Sediment input into intermittent and ephemeral streams and scattered ponds and reservoirs as a result of coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short term	Same as Alternative 1
Alluvial Valley Floors		
Coal mining disturbance of AVFs determined to be significant to agriculture	Not permitted by regulation	Same as Alternative 1
Coal mining disturbance of AVFs determined not to be significant to agriculture	AVFs disturbed by mining must be restored to essential hydrologic function; no cumulative impacts anticipated	Same as Alternative 1

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Soils		
Coal mining, coal-related, oil and gas, and oil- and gas-related disturbance and replacement of soil resources	Moderate, short-term and long-term impacts through accelerated wind or water erosion, declining soil quality factors through compaction, reduced microbial populations and organic matter, and potential mixing of soil zones	Same as Alternative 1
CBNG water disposal impacts to soil resources	Potential increase in soil alkalinity depending on SAR levels in water and method of water disposal	Same as Alternative 1
Wetland and Riparian Vegetation		
Removal of jurisdictional wetlands and loss of wetland function until reclamation occurs	Moderate, short-term; no net loss	Same as Alternative 1
CBNG-related discharge of produced water	Moderate, short- to long-term creation of wetlands in areas that previously supported upland vegetation	Same as Alternative 1
Vegetation		
Coal mining, coal-related, oil and gas, and oil- and gas-related removal and replacement of native vegetation	Moderate, short- to long-term impacts because of potential differences in species composition and presence and size of woody species on reclaimed lands	Same as Alternative 1
Coal mining, coal-related, oil and gas, and oil- and gas-related impacts to Special Status Plant Species	Potential incremental loss or alteration of potential or known habitat	Same as Alternative 1
Coal mining, coal related, oil and gas, and oil- and gas-related dispersal of noxious and invasive species	Potential displacement of native species and changes in species composition	Same as Alternative 1
Wildlife and Fisheries		
Direct and indirect coal mining, coal-related, oil and gas, and oil- and gas-related development impacts to game and non-game species, including direct mortality, habitat fragmentation, animal displacement, noise and increased human presence	Moderate, short-term	Same as Alternative 1
Coal mining, coal-related, oil and gas, and oil- and gas-related disturbance of game and nongame species habitat during project development and operation	Moderate, short-term loss of all types of habitat present in disturbed areas	Same as Alternative 1

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Coal mining, coal related, oil and gas, and oil- and gas-related habitat changes after reclamation	Moderate, long-term change in habitat with potential changes in associated wildlife populations	Same as Alternative 1
Alteration or loss of habitat because of coal mining, coal-related, oil and gas, and oil- and gas-related development	Negligible to moderate, short- to long-term	Same as Alternative 1
Changes in water quality as a result of surface disturbance or introduction of contaminants into drainages caused by coal mining, coal-related, oil and gas, and oil- and gas-related development	Minor to moderate, short- to long-term	Same as Alternative 1
Changes in available habitat as a result of water withdrawals or discharges related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short-term	Same as Alternative 1
Special Status Species		
Direct and indirect coal mining, coal-related, oil and gas, and oil- and gas-related development impacts, including direct mortality, breeding area, nest or burrow abandonment, sage-grouse lek abandonment, noise and increased human presence	No effect on threatened or endangered species; moderate, short- to long-term effects on candidate vertebrate species	Same as Alternative 1
Coal mining, coal-related, oil and gas, and oil- and gas-related disturbance of habitat (breading and nesting) during project development and operation	No effect to moderate, short- to long-term loss of all types of special status species habitat present in disturbed areas	Same as Alternative 1
Coal mining, coal related, oil and gas, and oil- and gas-related habitat changes after reclamation	No effect to moderate, short- to long-term change in habitat with potential changes in associated populations of special status species	Same as Alternative 1
Land Use and Recreation		
Loss of forage and range improvements and restriction of livestock movement because of coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short-term	Same as Alternative 1
Disturbance of developed recreation sites by coal mining, coal-related, oil and gas, and oil- and gas-related development	Negligible, short-term	No additional impacts, private surface

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Reduction or degradation of opportunities for dispersed recreation activities related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short-term on existing mine areas	No additional impacts, private surface
Cultural Resources and Native American Concerns		
Disturbance of cultural resource sites	Ineligible sites could be destroyed without protection or further work; no impact on known sites; impacts on eligible sites discovered during operations would be avoided or mitigated through data recovery prior to mining; no impact on known unevaluated sites; impacts on unevaluated sites are not permitted; unevaluated sites would be evaluated prior to mining	Same as Alternative 1
Transportation and Utilities		
Movement of segments of existing public roads, pipelines, transmission lines, or railroads to accommodate coal mining development	Moderate, long-term to permanent, disruptive effects would be minimized	Same as Alternative 1
Increased vehicular traffic on roads and highways because of coal mining, coal-related, oil and gas, and oil- and gas-related development, and associated impacts including traffic accidents, road wear, air emissions, dust, noise, and vehicle collisions with wildlife and livestock	Moderate, short-term	Same as Alternative 1
Construction and operation of additional railroad and pipeline facilities and transmission lines to transport coal, oil and gas, and electricity	Moderate, short- to long-term	Same as Alternative 1
Socioeconomics		
Increases in employment related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Significant, short- to long-term	Negligible added with Hay Creek II LBA
Increases in personal income because of employment increases related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Significant, beneficial, short- to long-term	Negligible added with Hay Creek II LBA
Increase in population because of employment increases related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Significant, short- to long-term	Negligible added with Hay Creek II LBA

Table 4-41. Continued

Description of Potential Impact by Resource	Magnitude, Type, and Duration of Impact	
Resource Name	Alternative 1 (No Action)	Proposed Action, Alternative 2
Expansion of housing supply because of employment increases related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Significant, short- to long-term	Negligible added with Hay Creek II LBA
Increases in school enrollment because of employment increases related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short-term	Negligible to minor added with Hay Creek II LBA
Need for additional local government facilities and services because of employment increases related to coal mining, coal-related, oil and gas, and oil- and gas-related development	Moderate, short- to long-term	No impacts added with Hay Creek II LBA
Increased federal, state, and local revenues related to coal mining, coal-related, oil and gas, and oil-and gas-related development	Significant, beneficial, short- to long-term	Same as Alternative 1

[a] Cumulative impacts discussion and table are based on the PRB Coal Review analyses (BLM 2005a–f, 2006c–e, 2008a, 2009c–g). The Proposed Action and alternatives fall within those impact projections.

[b] All impacts are assumed to be adverse unless noted otherwise.