5.0 COMPARISON OF PAST PREDICTIONS AND CURRENT CONDITIONS

In 1996, the BLM issued a Coal Development Status Check summarizing the current level of coal mine activity and comparing the associated environmental impacts to what had been estimated in BLM coal EISs prior to 1996. Since 1996, coal mining has expanded considerably due to the demand for low-sulfur coal by the electric power generating industry. In addition, CBNG development in the eastern PRB coal areas has gone from an industry in its infancy to a major resource extraction industry. For water resources, issues of concern in 1996 were coal mine water use and groundwater level declines due to dewatering by coal mines. For the year 2002, issues of concern included coal mine water use, CBNG water demand, and groundwater level declines due to both CBNG activity and coal mine dewatering.

Past predictions for water use and groundwater level declines related to coal mining in the eastern PRB can be found in the Coal Development Status Check (BLM 1996), coal mine groundwater model predictions summarized by GAGMO (2001), and in the USGS CHIA (Martin et al. 1988). Groundwater level decline in the Fort Union Aquifer is presented in **Table 3.6-2**. The Coal Development Status Check of 1996 (BLM 1996) estimated water use by the coal mines for year 1990 to be 5,971 acre-feet. The actual use in 1990 according to BLM (1996) was 4,679 acre-feet, which translates into 28.78 acre-feet of water per million tons of coal mined. In 1994, water use by coal mines was 6,911 acre-feet, or approximately 31.87 acre-feet per million tons of coal mined (BLM 1996). The report did not estimate groundwater level declines for coal mine water use beyond 1994. Therefore, the model predictions of individual mines, as summarized by GAGMO (2001) and the predictions of the USGS (Martin et al. 1988) have been used to compare predictions for years 1995 to 2000 to actual data.

This section serves to update the Coal Development Status Check to the year 2002, the last year with a complete database for water resources in the PRB.

5.1 Summary of Current Conditions

5.1.1 Surface Water

Surface water flow and water quality primarily are determined by irrigation practices, precipitation and runoff, and the geology of alluvium and bedrock along individual drainages. Both surface water flow and water quality vary considerably throughout the year in the PRB, so any definitive cause and effect relationship relating surface water flow or quality to either coal mining or CBNG activity requires a considerable amount of data gathered over a number of years (Martin et al. 1988). Active coal mines generally have minimal impact on surface water flow or quality because of the regulation of coal mines by the WDEQ and the requirement for WYPDES permits for any discharges that reach drainages. Following reclamation, areas of past coal mining may affect ephemeral and intermittent drainages as a result of: 1) change in slope of the reclaimed areas from the natural conditions; 2) restoration of only third-order and higher drainages; 3) decreased infiltration of precipitation in reclaimed areas; and 4) increased sediment loading to drainages during storm runoff (Martin et al. 1988). As of 2002, the impacts of coal mining on surface water flow and quality had

been minimal, limited to the coal mine lease areas, and generally not recognized in downstream USGS stream gauges. As shown in **Table 3.6-1**, coal mines in 2002 in the eastern PRB collectively were permitted to use 7,460 acre-feet of groundwater. The groundwater that was produced was discharged to the surface for dust control and reclamation, used in coal processing, and potentially discharged directly to drainages in accordance with WYPDES permit criteria.

The discharge of CBNG-produced water is an issue relative to surface water flow and quality. The volume of CBNG discharge to ephemeral and intermittent drainages has increased dramatically. The Powder/Tongue River Basin and Northeast Wyoming River Basins water plans (HKM Engineering et al. 2002a,b) estimated CBNG groundwater pumpage in 2002 at 72,500 acre-feet. In comparison, during 2002, CBNG wells in the PRB pumped approximately 73,287 acre-feet (568.8 million barrels) of water (**Table 3.5-1**). Approximately 257 million barrels (33,100 acre-feet) of this water was discharged in the Northeast Wyoming River Basins. This water was discharged directly to drainages in the eastern PRB near coal mining areas, primarily in the subdrainages of the Belle Fourche and Cheyenne rivers. The discharge of CBNG water is regulated by the WDEQ Water Quality Division. As stipulated by permit criteria, discharged water must be of a quality and quantity that will not degrade the existing water quality classification of the drainage receiving the discharge.

Studies discussed previously have shown that the conveyance loss of CBNG water discharged directly to drainages is high and varies from 70 to 90 percent, depending of the time of year. Most of this loss is through infiltration of the water into the alluvium and eventually into the upper Wasatch Formation. Water discharged directly to drainages generally is not evident beyond a few miles from the discharge point. Stream gauges maintained by the USGS in the Belle Fourche and Cheyenne River drainages have not shown statistically discernable changes in stream flow or water quality that can be attributed to CBNG discharge (BLM 2003a). In the northern part of the PRB, mainly in the Powder/Tongue River Basin, discharge of CBNG production water is to impoundments. These impoundments are mostly unlined, and the water infiltrates into the alluvium and eventually into the Wasatch Formation. Groundwater mounds around these impoundments are limited to approximately 25 feet from the impoundment. Changes in groundwater levels, stream flow, and stream water quality near the impoundments are the subject of ongoing studies in the northwestern part of the PRB. As of 2002, no statistically quantifiable impacts to surface water features had been recorded near these impoundments (BLM 2003a).

5.1.2 Groundwater

Groundwater level changes since 1996 have been the most noticeable impact to water resources in the PRB. Groundwater level declines in the Fort Union Formation coal bed aquifers near the coal mines have been in the range of 20 to 60 feet, with some mines showing up to 120-foot declines within 1 mile of the permit boundaries during the period from 1980 to 2000 (GAGMO 2001). Coal mine water use has been increasing since 1985 and increased noticeably during the 1990s (**Table 3.6-1**). Groundwater level declines within the Wasatch and Fort Union aquifers within approximately 1 mile of the coal mines have been the result of increased groundwater pumpage by the mines since 1996. Beyond approximately 1 mile from the mines, or in areas where CBNG development has approached mine permit boundaries, groundwater declines are probably due more to CBNG groundwater pumpage, as discussed in Section 4.3, Groundwater Modeling Results for Current Conditions.

CBNG development during the 1990s, and especially since about 1995, has had the greatest impact on groundwater levels in the Fort Union Formation aquifer. As shown in **Table 3.6-2**, groundwater level declines of 100 to 240 feet since about 1995 can be attributed to CBNG activity in the eastern PRB within 1 to 3 miles of the operating coal mines (GAGMO 2001). Because of CBNG activity, it is not possible to separate groundwater level declines outside of coal mine permit boundaries into CBNG- and coal mine-related effects using monitor well data alone. Groundwater models can be used to estimate the approximate effects of CBNG development and coal mine dewatering using modeled drawdown and publicly available pumping data for CBNG wells and coal mine wells and sumps. This is done by having only CBNG or only coal mine dewatering wells active in the groundwater model at any given time period. Section 4.3, Groundwater Modeling Results for Current Conditions, presents a discussion of the modeled separation of drawdown in the Wasatch and Fort Union formations due to coal mine dewatering and CBNG pumping.

5.2 Coal Mine Water Use

Permitted coal mine groundwater use is presented in **Table 3.6-1**. This table, based on WSEO (2004) information, shows that permitted coal mine groundwater use in 1990 was 2,567 acre-feet and in 1994 was 4,608 acre-feet. The Coal Development Status Check of 1996 (BLM 1996) provided total water use values of 4,679 acre-feet for 1990, with an estimate of 5,971 acre-feet and a value of 6,911 acre-feet for 1994. According to the WSEO (2004), permitted groundwater use by coal mines was less than reported in the Coal Development Status Check (BLM 1996) for 1990 and less than total water use provided for 1994. Estimates of water use per million tons of coal mined for 1990 and 1994 from BLM (1996) show values from 28 to 32 acre-feet per million tons of coal mined. Using data from WSEO (2004) and from Montgomery Watson Harza (2003), the water use per million tons of coal mined from 1990 to 2000 was in the range of 11 to 22 acre-feet per million tons of coal mined (**Table 5.2-1**).

5.3 Eastern Powder River Basin Groundwater Conditions 2002

In the eastern PRB, coal mine dewatering and CBNG development have resulted in the lowering of groundwater levels in the Fort Union Formation. Locally, discharge from CBNG wells has resulted in a rise in water levels in the Wasatch Formation. CBNG development began in earnest around 1995 and coal mine dewatering began around 1985 and increased during the 1990s as mining of the coal seams progressed to deeper levels, requiring dewatering of the overburden (Wasatch Formation) and the coal seams in the Fort Union Formation. Changes in groundwater levels (i.e., drawdown and mounding) for the Wasatch and Fort Union formations from 1990 to 2002 are presented in Section 4.3, Groundwater Modeling Results for Current Conditions. CBNG development and coal mining affect the Upper Fort Union (HSU-5 in the CMGM) because this HSU represents the Wyodak-Anderson coal, the main coal unit currently being mined in most of the active coal mines of the eastern PRB. The Lower Fort Union (HSU-6) is affected mostly by municipal pumpage near Gillette, Wyoming. The Wasatch is affected by coal mine dewatering and also by both CBNG dewatering of the underlying Upper Fort Union and CBNG discharge to drainages, which ultimately reaches the upper Wasatch and can result in local groundwater mounding in the Wasatch.

Table 5.2-1
Eastern PRB Coal Mine Groundwater Use Related to Coal Production

Coal Mine	1980			1985			1990			1995			2000		
	Coal Production (mmtons)	Water Use (acre-feet)	Water Use/Coal Production (acre-feet/mmton)	Coal Production (mmtons)	Water Use (acre-feet)	Water Use/Coal Production (acre-feet/ mmton)	Coal Production (mmtons)	Water Use (acre-feet)	Water Use/Coal Production (acre-feet/ mmton)	Coal Production (mmtons)	Water Use (acre-feet)	Water Use/Coal Production (acre-feet/ mmton)	Coal Production (mmtons)	Water Use (acre-feet)	Water Use/Coal Production (acre-feet/ mmton)
Subregion 1- North Of Gillette															
Buckskin	0.00	0.00	--	3.90	0.00	--	7.70	0.24	0.03	11.60	214.90	18.53	15.80	276.30	17.49
Eagle Butte	8.40	61.40	7.31	11.80	307.00	26.02	15.40	921.00	59.81	16.90	921.00	54.50	18.60	921.00	49.52
Dry Fork	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rawhide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Wyodak	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subregion 2-South Of Gillette															
Caballo	2.00	0.00	--	9.00	0.00	--	14.30	214.90	15.03	18.10	614.00	33.92	25.60	614.00	23.98
Belle Ayr	16.10	0.01	0.00	12.80	24.56	1.92	15.50	3.07	0.20	18.80	307.00	16.33	15.00	214.90	14.33
Cordero-Rojo	6.60	0.00	--	14.30	61.40	4.29	21.50	276.30	12.85	31.40	12.28	0.39	38.70	245.60	6.35
Coal Creek	0.00	0.00	--	2.60	0.00	0.00	0.10	92.10	921.00	4.20	614.00	146.19	4.20	61.40	14.62
Subregion 3-Wright															
Jacobs Ranch	8.20	3.07	0.37	13.00	276.30	21.25	16.80	307.00	18.27	24.60	614.00	24.96	28.30	921.00	32.54
Black Thunder	10.50	0.00	--	23.20	0.00	--	27.90	307.00	11.00	36.10	307.00	8.50	60.10	614.00	10.22
North Rochelle	0.00	0.00	--	0.00	0.00	--	13.20	0.00	0.00	0.70	921.00	1315.71	17.20	921.00	53.55
North Antelope/Rochelle	0.00	0.00	--	5.90	0.00	--	20.30	122.80	6.05	47.30	921.00	19.47	70.80	921.00	13.01
Antelope	0.00	0.00	--	0.70	0.00	0.00	5.20	0.00	0.00	10.90	307.00	28.17	23.00	307.00	13.35
Total All Mines	71.20	8.60	0.12	116.60	761.40	6.53	166.70	2566.50	15.40	248.20	2775.30	11.18	327.30	7432.50	22.71

Note: acre-feet/mmton = acre-feet per million tons
mmtons = million tons

Source: MWH 2003; WSEO 2004.