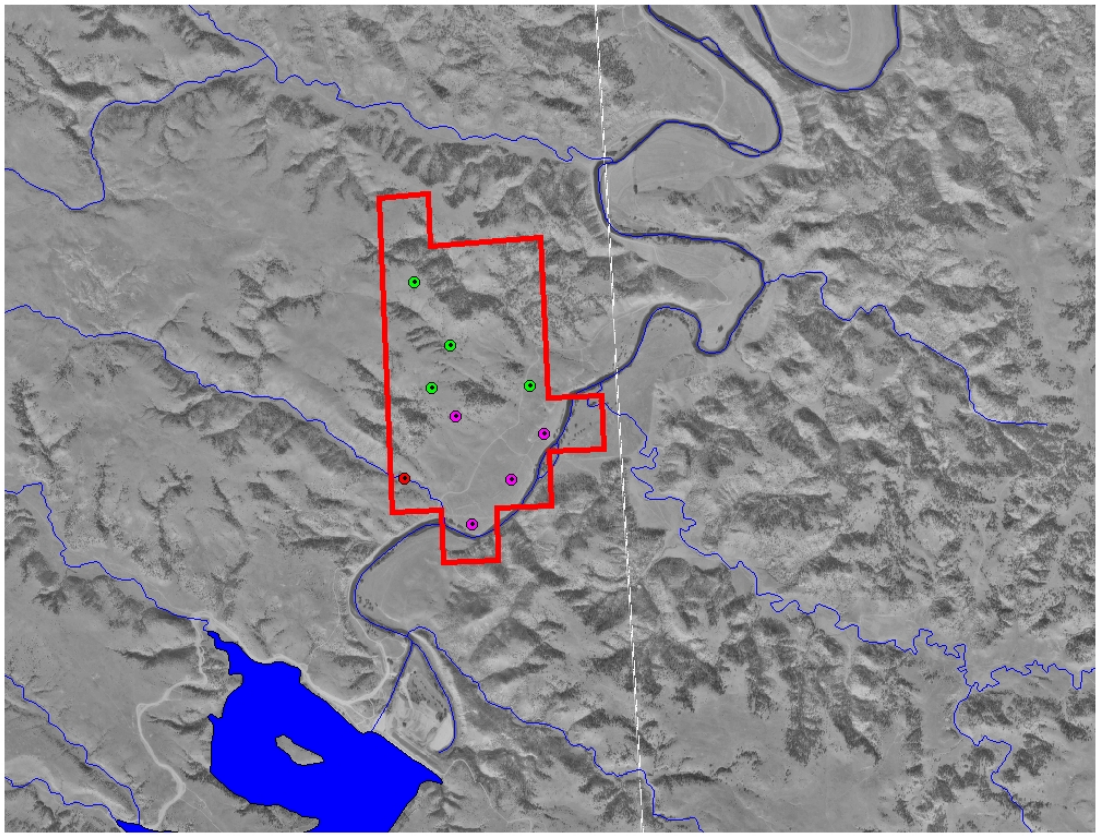
Powder River Gas L.L.C.
Coal Creek CBNG POD

Hydrology Technical Report

November, 2004



Bureau of Land Management
Miles City Field Office
Miles City, MT

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INTRODUCTION/AREA DESCRIPTION:

Powder River Gas, LLC has proposed a Project Plan of Development (POD) to drill and test for coal bed natural gas (CBNG) in eight federal and eight fee wells at 8 locations (2 wells per location) in an area northeast of the Tongue River Reservoir, Big Horn County of southeastern Montana. Two existing fee wells at one site would also be tested.

It is anticipated that this testing procedure will require up to 6 months to complete. No production facility, compressor or other infrastructure for the production of CBNG is proposed. After testing is completed, the wells will be shut-in and groundwater pumping will cease. These proposed wells would be finished in the Wall and Flowers-Goodale coal zones at depths varying from approximately 250 to 1,500 feet below ground surface.

A Higgins Loop type ion exchange water treatment facility will be used to manage the produced water, and the treated effluent will be mixed with untreated CBNG water to the degree allowable without causing the SAR to exceed 3. This mixed effluent will be discharged directly into the Tongue River via a dissipater. The residual brine produced through this process has been determined to be a hazardous waste and will be disposed of at a properly permitted Class I UIC injection well in Wyoming. Removal and transport of brine will be in accordance with all state, local and federal regulatory requirements.

These proposed well sites are located in T. 8 S., R. 41E., Sections 6 and 7. This project area is located approximately 1 mile down stream from the Tongue River Dam, and on the west side of the Tongue River. Approximately 6.5 miles of existing two-track trails, and 1.5 miles of improved road will be needed to access the POD facilities. (See Map 1)

All of these well sites are located in the Upper Tongue River 4th Order Watershed and all of the sites either drain directly into the Tongue River, or drain to the Tongue River via ephemeral drainages. (See Map 1)

According to the climatic data provided by the MAPS Atlas website prepared by MSU Bozeman (http://stone.msu.montana.edu/ma6/basemap/viewer.htm) this area (MAPS cell 16976) receives an average of 12”-14” of precipitation per year, and has the potential for 43 inches of evaporation (Penman Method).

Three of the new fee well sites (11-7, 7-7, and 1-7) are located on alluvial deposits adjacent to the Tongue River. One new fee well site (3-7), one existing fee well site (5-7), and one of the new federal well sites (15-6) are located on the Tongue River Member of the Fort Union Formation. Three new federal well sites (5-6, 13-6, and 11-6) are located on the clinker deposits associated with the burned coals from the Tongue River Member of the Fort Union Formation. The Tongue River Member of the Fort Union Formation is a terrestrial deposit composed of interbedded sand, silt, clay, and coal. Large portions of this unit are covered by “clinker” deposits, which form due to coal fires baking overlying clastic materials. Clinker is resistant to erosion, fractured, and typically bright red. Many of the ridge tops are capped with clinker, and clinker also occurs on hillsides where coal seams have burned. (See Map 2)

ALTERNATIVES ANALYZED:

The following is a summary of the alternatives analyzed. Complete descriptions are found within the Powder River Gas Coal Creek POD EA (MT-020-2004-58).

No Action by Any Agency (No Action):

This alternative would have no MDEQ, MBOGC, and BLM approved actions and none of the private and federal wells in the POD would be drilled or tested, nor would any of the associated infrastructure be constructed. The entire Powder River Gas, Coal Creek POD would be denied and not take place at any level. It should be noted that under the proposed POD the BLM could not issue APDs without state action, therefore this alternative also addresses the possibility of "No State Action."

No Federal Action:

In this alternative, there would be no BLM approved actions and none of the federal wells in the POD would be drilled and tested. This alternative would include the drilling of eight private CBNG wells on four locations. The eight new wells and two existing wells would be used to test the Flowers-Goodale and Wall coal zones for CBNG potential.

All of the wells and associated infrastructure would be located on private surface. The road and pipeline routes are proposed as agreed to by the appropriate private surface owner. Where possible the roads would serve as a common corridor for the gas, electric, and water.

No earthwork would be needed to prepare the proposed drilling locations. Each well location would have a 25' by 40' reserve pit for the disposal of cuttings.

CBNG potential will be determined by pumping groundwater from the coal seams, thereby reducing hydrostatic pressure and causing the methane to become desorbed from the coal surface and flow to the wells. Produced gas will be vented approximately 10' from ground level. In areas where there is a safety concern or a possible ignition source the gas will be flared. Groundwater pumping would last no longer than 6 months. The daily volume of produced gas would not exceed 30 thousand cubic feet (mcf) per well, and the total cumulative volume produced per well would not exceed 1,260 mcf. After testing, the gas will be shut off, groundwater pumping will cease, and gas pressures will be monitored.

Under this alternative the water produced from the wells would be treated using a Higgins Loop treatment facility prior to discharging it to the Tongue River. The construction of this treatment facility will require the disturbance of an area 200' by 200' (0.92 acres) of private surface. Within this facility concentrated HCl and residual Na-Cl brine will be stored. All chemical containment facilities will be surrounded by a shallow spill containment burm to prevent any accidental chemical spill from leaching into the surrounding soil profile and eliminate transmission to groundwater. A total containment impoundment will also be located within Higgins Loop treatment facility complex. This impoundment would have a total storage capacity of 0.5 acre-feet. When completed, the pit will be separated into two chambers, each measuring 125' long by 62.5' wide by 10' deep. In addition, the entire structure will be lined with a 20 mil polyethylene liner to insure that no infiltration occurs. Shallow wells (~20-25' deep) will be installed within 50' of the impoundment to monitor for leakage. Once produced water leaves the CBNG wells it will be piped to the treatment complex and discharged directly into one pit chamber to allow for settling of suspended sediments that may be present due to the production process and to release any residual natural gas. Once settling has occurred, the produced effluent will then enter the Higgins Loop for the treatment process.

The primary objective in treating CBNG produced water is removal of sodium (Na^+) in order to reduce SAR levels. In addition, some situations may require the removal of barium and other heavier cations in order to meet MPDES discharge requirements. A strong acid cation exchange resin is used to scavenge the cations from the water as it is passed through the Higgins Loop. The cations are replaced by hydronium ions from resin beads. The hydronium ions are released in the treated water, which lowers the pH of the water. This will allow the bicarbonate ions in the water to react with the hydonium ions to form carbon dioxide gas. The treated water is then discharged to a neutralizing bed where excess hydronium ions and

residual bicarbonate ions can react with selected calcium to achieve the desired pH. Note that neutralizing agents other than calcium may be used should the need arise. Once the pH has been stabilized the effluent will then enter the remaining pit chamber prior to discharge to the plunge pool.

Concurrent with the sodium and other cation loading that is taking place in the absorber section of the Loop, cations are stripped from the resin in the regeneration section. Dilute hydrochloric acid is injected into the loop and moves counter-current to the resin to the spent brine discharge, leaving the resin restored to the hydronium form. Concentrated brine volumes average approximately 1.0% of the total Loop feed volume, depending on the cation loading that is removed from the treated water. The residual Na-Cl brine produced through this process has been determined to be a hazardous waste and will be disposed of at a Class I UIC permitted injection well in Wyoming. Removal, transport, and injection of brine will be in accordance with all state, local and federal regulatory requirements. The waste stream from the treatment process, at maximum flow, will generate approximately 86 barrels of brine or reject water per day. These disposal wells must be permitted and approved by all state, local and federal regulatory agencies. Precautionary measures will be taken to ensure safe transport of brine from the facility to the disposal well, especially when transporting adjacent to water bodies of the State. During periods of adverse weather and driving conditions, transportation efforts may be suspended until more favorable conditions exist. In the event of an accidental spill, all pertinent governing agencies will be immediately notified.

The blended effluent water would be discharged at one outfall location to the Tongue River. The outfall structure will consist of a rock riprap plunge pool lined with an anti-erosion fabric. An energy dissipation device would be installed to decrease erosion potential. Based upon the operators POD book submission, under this alternative ten wells would discharge under this alternative at an average rate of 25 gpm per well, for a total discharge of 250 gpm (0.56 cfs). For additional construction details please see the POD book for this project.

Reclamation of the surface would begin after construction is completed. Completion of reclamation would occur within one year (or sooner) of the construction (depending on the weather). The disturbed areas would be disked and seeded with a seed mix approved by the Natural Resource Conservation Service and the surface owner.

No production facility, compressor, or other infrastructure for the production of CBNG is proposed. After testing is completed the sites would be shut-in, and groundwater pumping will cease. This testing period will not exceed 6 months.

Additionally, the Operator has committed to:

- Comply with all applicable Federal, State, and local laws and regulations.

- Obtain the necessary permits for the drilling and testing the wells.

- Provide water well agreements to the owners of record for permitted water wells within the area of influence of the action.

- Provide water analysis from the Paradox 3-7W and Paradox 3-7F wells, which are the designated reference wells for each coal seam for this POD.

Proposed Action:
Powder River Gas proposes to drill 16 CBNG new CBNG wells in the Coal Creek Project Area. Eight federal wells would be drilled at four locations, and eight private wells would be drilled on four locations. The 16 new wells and two existing wells would be used to test the Wall and Flowers-Goodale coal seams for CBNG potential.

All of the wells and associated infrastructure are proposed on private surface. The road and pipeline routes are proposed as agreed to by the appropriate private surface owner. Where possible the roads would serve as a common corridor for the gas, electric, and water.

At seven of the eight sites no earthwork would be needed to prepare the proposed drilling locations. Each drilling location would have a 25' by 40' reserve pit for the disposal of cuttings. At one of the federal drilling locations (11-6) pad construction will be needed prior to drilling.

CBNG potential will be determined by pumping groundwater from the coal seams, thereby reducing hydrostatic pressure and causing the methane to become desorbed from the coal surface and flow to the wells. Produced gas will be vented approximately 10' from ground level. In areas where there is a safety concern or a possible ignition source the gas will be flared. Groundwater pumping would last no longer than 6 months. The daily volume of produced gas would not exceed 30 mcf per well, and the total cumulative volume produced per well would not exceed 1,260 mcf. After testing, the gas will be shut off, groundwater pumping will cease, and gas pressures will be monitored.

Part of this alternative is to treat water produced from the wells as described under the No Federal Action Alternative. Based upon the operators POD book submission, under this alternative 18 wells would be tested under this alternative, producing on average 25 gpm of water per well, for a total discharge of 450 gpm (1.0 cfs) of blended water. This would result in the production of 154 barrels of brine per day.

Reclamation of the surface would begin after construction is completed. Completion of reclamation would occur within one year (or sooner) of the construction (depending on the weather). The disturbed areas would be disked and seeded with a seed mix approved by the Natural Resource Conservation Service and the surface owner.

No production facility, compressor, or other infrastructure for the production of CBNG is proposed. After testing is completed the sites would be shut-in, and groundwater pumping will cease. This testing period will not exceed 6 months.

Additionally, the Operator has committed to:

- Comply with all applicable Federal, State, and local laws and regulations.

- Obtain the necessary permits for the drilling and testing the wells.

- Provide water well agreements to the owners of record for permitted water wells within the area of influence of the action.

- Provide water analysis from the Paradox 3-7W and Paradox 3-7F wells, which are the designated reference wells for each coal seam for this POD.

AFFECTED ENVIRONMENT:

Surface Water:

All of the proposed well sites are located in the Upper Tongue River 4th Order Watershed (Hydrologic Unit Code (HUC) 10090101; water body number MT42B001-2). This reach of the Tongue River is classified as "B-2" water according to the Montana Surface Water Use Classification [ARM 17.30.611(1)(c)(vii)]. Waters classified B-2 are suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Discharges to B-2 waters must comply with the specific water quality standards in ARM 17.30.624, as well as numeric water quality standards in Department Circular WQB-7 (DEQ). The Tongue River is considered high quality water pursuant to Montana's Nondegradation Policy and degradation of high quality water is not allowed unless authorized by the Department under 75-5-303(3), MCA.

This reach of the Tongue River was listed as impaired for aquatic life support, and cold-water fishery for trout on the 1996 303(d) list. The identified probable cause of impairment was flow alteration. The identified probable sources were agriculture, flow regulation and/or modification and irrigated crop production. This reach of the Tongue River has been removed from the 2000, 2002, and the 2004 303(d) lists based on reassessment of the water quality.

The portion of the Tongue River from the diversion dam just above Pumpkin Creek (12-mile diversion dam for the TY irrigation ditch) to the mouth is currently listed on the 303(d) list, and has been listed since 1996. This portion of the Tongue River is located approximately 90 miles NNE from the project area (~130 river miles downstream). The MDEQ has identified flow alteration as the probable cause of the impairment, and dam construction and flow regulation/modification as the probable sources of impairment along this downstream reach. As this project would not cause flows to be reduced, and this reach is impaired due to a lack of flow, none of the alternatives will contribute to this impairment, and flow along this portion of the Tongue River will not be analyzed in detail.

The entire length of the Tongue River below the Tongue River Dam, including the reach below Pumpkin Creek, is affected by the presence of the Tongue River Dam. The presence of this dam causes sediment to be trapped behind the dam, and causes the magnitude of peak flows to be reduced, thereby altering the riparian environment (Collier, et al., 1996). The flow along the reach below Pumpkin Creek is also substantially reduced during the irrigation season by the diversion of water into the TY irrigation ditch. During low flows the majority of the water in the Tongue River is diverted at this point, and any measurements taken below this point are more representative of Pumpkin Creek and other minor tributaries than they are of the Tongue River.

Flow along this portion of the Tongue River is regulated by the Tongue River dam, which is owned by the Montana Department of Natural Resources and Conservation (DNRC). The dam is operated and maintained by the Tongue River Water Users Association (TRWUA) for the purpose of fulfilling water use contracts to all downstream users. In 1978, a flood damaged the spillway resulting in conservative operation of the reservoir until 1999 when the spillway and other improvements were made to the dam. The improvements at the dam included raising the height of the embankment by 4 feet to increase the storage capacity. Water is released from the reservoir to satisfy irrigation demand with a minimum of 175 cfs or inflow maintained for fish and wildlife through the winter (DNRC, 1996). According to the Operating Plan for the Tongue River Reservoir, flow may drop below this level for essential maintenance, dam inspections, drought conditions or other emergency purposes. According to recent flow measurements, releases from the reservoir are routinely below 175 cfs. The minimum observed flow for the last five years at the USGS station has been has been 70 cfs. Following the rational laid out in the MDEQ Statement of Basis (SOB) for the MPDES permit associated with this project (MT0030660), 70 cfs will be used as the 7Q10 flow for this analysis.

The Tongue River is the only perennial river in the project area. None of the ephemeral tributaries to the Tongue River in this area have been listed as impaired. The TMDL process for the Tongue River watershed (4th Order HUCs 10090101 and 10090102) is currently underway. The completion of the

TMDL process may require reassessment of all permits existing at that time. This reassessment may require changes in the subject permits.

The proposed action for the PRG Coal Creek project includes one discharge into the Tongue River downstream from the Tongue River Reservoir Dam. There is a USGS Gaging Station located just upstream of this discharge point and below the Tongue River Dam. This station is shown on Map 1. Data from this station should be representative of this reach of the Tongue River.

Electrical Conductivity (EC) and Sodium Adsorption Ratio (SAR) are the parameters most likely to be affected by CBNG development (MDEQ, 2003), therefore, the discussion in this document will focus on these parameters. The primary parameters of concern (POC) identified in the SOB for the MPDES permit for this project (Hydrology Technical Report, Appendix B) are elevated sodium and incidental metals such as arsenic, selenium, and zinc, ammonia, nutrients (nitrogen and phosphorous) and organic constituents present in the coal formation. A full analysis for all pollutants of concern (POCs), and an analysis of the potential for exceedence of all surface water quality criteria is included in the SOB (Hydrology Technical Report, Appendix B).

EC is the ease with which water will transmit a current, and is proportional to salinity or total dissolved solids (TDS). SAR is a complex ratio of sodium vs. calcium plus magnesium, and is an important parameter for determining the usability of water for irrigation (See CBM-EIS; BLM, 2003, for further information). SAR is defined as:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

where all constituents are in milliequivalents per liter (meq/L).

It has also been suggested that bicarbonate be included in the analysis of impacts from CBNG. For this reason the potential for bicarbonate to exceed the non-degradation threshold, or to impact aquatic life was considered. The maximum potential discharge rate (2.5 cfs) was added to 7Q10 flows (70 cfs). Discharge water quality values were obtained from the PRG MPDES application (average discharged HCO_3=475 mg/l when mixed such that SAR does not exceed 3). Tongue River water quality data was obtained from the SOB (HCO_3=243 mg/l). From this analysis it was determined that for these conditions (7Q10 flow) the resulting in stream bicarbonate concentration (251 mg/l) would only be 3.3% over background levels. This increase does not exceed the non-degradation threshold of 15%, and is well below the 530 mg/L threshold recommended by Horpstead et. al (2001), which was based on the potential to cause impacts to aquatic life (Mount et al., 1997). As such it is not felt that further analysis of bicarbonate is necessary.

There are currently 3 existing or proposed CBNG discharge permits to the Tongue River. These discharges are summarized below. The one existing permit (MT0030457) is for untreated discharge, while the permit for this project (MT0030660), and the pending application (MT0030724) are both for treated discharges. The Fidelity discharges are, or are proposed to be, located upstream of the Tongue River Reservoir.

Table 1: MPDES Permits for CBNG Discharges

Permit Number	Owner/Operator	Permit Status	Volume (gpm)	Treated (Y/N)
MT0030660	Powder River Gas, LLC	Required for this POD	1,120	Y
MT0030457	Fidelity Exploration & Production Company	Issued, in review	1,600	N
MT0030724	Fidelity Exploration & Production Company	Application Pending	1,700	Y

The historical Pre-CBNG water quality, as measured by EC and SAR, at the Tongue River station below the dam, and at Birney Day School are shown in the table below. Water quality was calculated at 7Q10 flows (the lowest flow that would statistically be anticipated to occur for 7 consecutive days over any 10 year period), low mean monthly flows (LMM), and high mean monthly flows (HMM). This historical water quality data was determined based upon historical USGS data and the analysis contained in the MDEQ's Statement of Basis for the MPDES permit (see Appendix B). This Pre-CBNG data do not accurately represent the existing conditions however, since there is an existing untreated CBNG discharge occurring upstream from the reservoir (MT0030457). For this reason the effects of this discharge are modeled as described in Appendix A of this report, to depict existing conditions. The result of this modeling is shown in Table 2 below. It should be noted that a noticeable increase in either EC or SAR have not been observed in USGS monitoring data since the start of CBNG production when values are plotted vs. flow. Baseline data for all parameters for which surface water criteria exist are included in the SOB in Appendix B of the Hydrology Technical Report for this project.

Table 2: Comparison of Historical Surface Water Conditions to Modeled Existing Conditions

		Historical Conditions+			**Modeled Existing Conditions***		
	Flow Conditions	Discharge (cfs)	EC (μS/cm)	SAR	Discharge (cfs)	EC (μS/cm)	SAR
Tongue River Below Dam	7Q10	70.0	809	0.97	73.6	832	1.27
	LMM	179.0	646	0.78	182.6	664	0.98
	HMM	1429.0	392	0.49	1432.6	398	0.55
Tongue River at Birney Day School	7Q10	49.0	1134	1.56	52.6	1157	1.87
	LMM	173.0	719	1.02	176.6	737	1.23
	HMM	1119.0	377	0.56	1122.6	383	0.62

+ The historical conditions for the station Below the Dam were determined from USGS data collected from 1975-1998. Birney Day School historical conditions were determined from USGS data collected from 1978-1998.

* The modeled existing conditions include historical values, plus modeled effects from the existing 3.57 cfs discharge of untreated CBNG water upstream from the Tongue River Reservoir.

In addition to the discharges which are currently taking place, it is also necessary to address the potential impacts of the discharge permits which exist or have been applied for, and are therefore reasonably foreseeable (see Table 3). The results of this analysis will provide for comparison of the cumulative impacts for each alternative.

Table 3: Comparison of Historical Surface Water Conditions to Foreseeable Conditions

		Historical Conditions+			Foreseeable Conditions* (Non-Project) (0 gpm from PRG)		
	Flow Conditions	Flow (cfs)	EC (µS/cm)	SAR	Flow (cfs)	EC (µS/cm)	SAR
Tongue River Below Dam	7Q10	70.0	809	0.97	77.4	824	1.30
	LMM	179.0	646	0.78	186.4	664	1.01
	HMM	1429.0	392	0.49	1436.4	401	0.56
Tongue River at Birney Day School	7Q10	49.0	1134	1.56	56.4	1149	1.90
	LMM	173.0	719	1.02	180.4	736	1.25
	HMM	1119.0	377	0.56	1126.4	386	0.63

+ The historical conditions for the station Below the Dam were determined from USGS data collected from 1975-1998. Birney Day School historical conditions were determined from USGS data collected from 1978-1998.

* The foreseeable conditions include historical values, plus modeled effects from the existing 3.57 cfs discharge permit for untreated water, and the proposed permit for 3.79 cfs of treated CBNG water upstream from the Tongue River Reservoir.

The Montana Board of Environmental Quality has established surface water standards for EC and SAR. These standards have been reviewed and approved by the EPA, and therefore have Clean Water Act standing. The Northern Cheyenne Tribe has also adopted surface water quality standards for EC and SAR. The Northern Cheyenne Tribe has not been granted "Treatment as a State" (TAS) status by the EPA, and therefore the EPA has not reviewed these standards. As such the Northern Cheyenne numerical standards do not have Clean Water Act standing; however they do set out the Tribe's considered determination of the water quality needed to protect irrigated agriculture on the Reservation (Northern Cheyenne Tribe, 2002), and to protect native plant species that have cultural significance and are integral in ceremonial and traditional aspects of the Northern Cheyenne Tribe. Therefore the Northern Cheyenne standards provide reasonable criteria against which to compare the resulting water qualities. The MDEQ standards were expressly developed to protect the agricultural uses of the Tongue River, which has been determined to be the most sensitive beneficial uses of the Tongue River (BLM, 2003a). Any changes in EC and SAR that do not cause these standards to be exceeded would not be anticipated to impair the beneficial uses of the Tongue River. These various standards are summarized in Table 4.

Table 4: Surface Water EC and SAR Standards for the Tongue River

	Monthly Mean SAR	Inst. Max SAR	Monthly Mean EC (µS/cm)	Inst. Max EC (µS/cm)
MT-DEQ Irrigation Season[1] Standards	3.0	4.5	1000	1500
MT-DEQ Non-Irrigation Season[1] Standards	5.0	7.5	1500	2500
Northern Cheyenne Irrigation Season[1] Standards; Southern Boundary	---	2.0	1000	2000
Northern Cheyenne Non-Irrigation Season[1] Standards; Southern Boundary	---	2.0	---	2000

1: The Irrigation Season specified by the MT-DEQ is from March 1st to October 31st while the Irrigation Season specified by the Northern Cheyenne is from April 1st to November 15th.

For the purposes of this impact analysis the high mean monthly and low mean monthly results will be compared to the mean monthly standards, while the 7Q10 result will be compared to the instantaneous maximum standards. This is appropriate since the 7Q10 is the lowest flow that would be expected to occur for 7 consecutive days over any 10 year period. It should be noted that this approach is being used for this impact analysis, however, the same approach would not be used for a regulatory determination. The reason for this difference is that it is felt that this impact analysis will more closely depict the actual impacts that would be anticipated.

For more general information regarding surface water, please refer to the CBM EIS Chapter 3, Affected Environment, pages 3-22 through 3-31 (BLM, 2003), the Water Resources Technical Report (ALL, 2001), and the Surface Water Quality Analysis Technical Report (SWQATR) (Greystone and ALL, 2003). Real time and historical monitoring data for the Tongue River is also available from the USGS at http://tongueriver monitoring.cr.usgs.gov/index.htm.

Groundwater:

The wells to be drilled under the Proposed Action are to be between approximately 250' and 1500' into the Wall and Flowers-Goodale coal zones. Eight new wells would be completed in each of the coal seams, one well is currently completed in each coal seam. The Wall and the Flowers-Goodale coal zones are contained within the Tongue River Member of the Fort Union Formation. In this area, the top of the Wall coal is between approximately 2560 and 3414 feet above mean sea level (ft-amsl) (dipping to the SSE) and it is approximately 55 feet thick. The top of the Flowers-Goodale coal is between approximately 1771 and 2591 ft-amsl (dipping to the SSE) and it is approximately 20 feet thick.

Based upon water analysis from the existing CBNG wells in the POD area the SAR of the raw CBNG water is expected to be approximately 53.2, and the EC is expected to be approximately 1,355 μS/cm. This water will be treated using the Higgins Loop ion exchange method developed by EMIT Technology such that the effluent EC will be approximately 493 μS/cm and the SAR approximately 0.03. The treated water would then be mixed with untreated water, resulting in the discharged water having an EC of approximately 742 μS/cm and SAR of 3.0.

Due to the common clay rich layers in the Tongue River Member of the Fort Union Formation the vertical hydraulic conductivity in these units is very low. Based upon the results of 370 aquifer tests, Wheaton and Metesh (2002) have calculated that the horizontal hydraulic conductivity values of the coal seam aquifers in the Fort Union Formation are typically between $9.8x10^{-2}$ and $1.3x10^{1}$ feet per day, with a geometric mean of 1.1 feet per day. Mean storativity values of these coals are approximately $9x10^{-4}$ (storativity is unitless) (Wheaton and Metesh, 2002). It is also known that faults are present in this area with the major faults trending to the northeast (Vuke et al., 2001). It has been shown that faults are typically barriers to groundwater flow in this area (VanVoast and Reiten, 1988).

The Montana Bureau of Mines and Geology (MBMG) maintains the Groundwater Information Center (GWIC) database of known wells, springs, and borings in Montana. Under current Montana law drillers are required to provide well logs for all wells drilled to MBMG, or indirectly to DNRC, within 60 days of drilling the well. This database is used to determine the wells or springs which are located within the potential drawdown area. PRG has also identified a developed spring within the project area which is not in the GWIC database. This spring emits from the base of the clinker, and so does not acquire its water from either the Wall or Flowers-Goodale coal seams. Only those wells that are finished within the coal seams being developed, and are located within the potential drawdown area, would be anticipated to be impacted by groundwater drawdown. Only those springs which emit from the developed coal seams, and are located within the potential drawdown area would be anticipated to be impacted by groundwater drawdown.

The Operator has certified that for each well "All potentially affected landowners having existing water wells within the circle of influence for the proposed well will be offered a Water Well Agreement." This is in compliance with the requirements of the Powder River Basin Controlled Groundwater Area (MT-BOGC, 1999).

Additional general information on groundwater is found in the MT FEIS (BLM, 2003), Chapter 3, Affected Environment pages 3-22 through 3-39 (ground water), the 2D modeling report (Wheaton and Metesh, 2001) and the 3D modeling report (Wheaton and Metesh, 2002). Groundwater monitoring information relating to CBNG (CBM) development is also available at MBMG's online GWIC database at http://mbmggwic.mtech.edu/ and using the Ground-Water Projects link. The year one Groundwater Monitoring Report for CBNG (Wheaton and Donato, 2004) is also available at http://www.mt.blm.gov/mcfo/cbng/CBNG-Monitoring.htm. This monitoring data indicates that "After 4 years of production from the CX field, water levels have been lowered by 20 feet at distances of less than 1 mile to as much as 2 miles outside the production area. Within the production area water levels are as much as 150 feet lower than baseline conditions. As production continues, and as field sizes enlarge, greater drawdown is expected to occur, and at greater distances from the well fields. Drawdown of 20 feet may eventually reach 4 or more miles outside production areas." (Wheaton and Donato, 2004).

ENVIRONMENTAL CONSEQUENCES:

The operator has submitted a comprehensive Water Management Plan (WMP) for this project. It is incorporated-by-reference pursuant to 40 CFR 1502.21. Qualified hydrologists, in consultation with the BLM, developed the water management plan. This WMP is summarized in the alternatives section of this report. Adherence with the plan should minimize project area and downstream potential impacts from the proposed water management strategies. The MDEQ has assumed primacy from the United States Environmental Protection Agency for issuing waste water discharge permits in the state.

PRG has suggested that the produced water could be utilized for a variety of beneficial uses; however none of these proposed uses have been submitted for detailed analysis. As such PRG must manage the water produced from Federal wells in accordance with the WMP that has been submitted. If at some point in the future PRG wishes to manage the produced water from Federal CBNG wells in a different manner, PRG must submit a request to the BLM (typically via Sundry Notice), and obtain approval from the BLM for this change in the WMP prior to implementation. Appropriate water right permits must be in place prior to the diversion of waters for beneficial uses.

Direct and Indirect Impacts:

Direct impacts address the short term direct impacts from an alternative. Indirect impacts are those impacts which occur in the same area as the proposed action, but occur over a longer period of time than the direct impacts. As these types of impacts are closely related for this project they will be addressed together.

Direct Surface Water Impacts:

For this analysis it is assumed that most of the produced water will be treated and then mixed with untreated water to the degree allowable (~71% treated and 29% untreated) without causing the SAR to exceed 3. This mixed water would then be discharged into the Tongue River. Based upon a mixing analysis of the major ions, this mixed water would have a major ion chemistry as shown in Table 5.

Table 5: Major Ion Chemistry of Discharged CBNG Water

	Treated CBNG	Untreated CBNG	Discharge Water
Ca	126	1.9	90
Mg	1.2	0.5	1.0
Na	1.1	364	106
K	2.5	2.5	2.5
HCO_3	289	932	475
SO_4	1.6	1.6	1.6
Cl	4.2	4.2	4.2
SAR	0.03	61	3.0
EC (µS/cm)	493	1355	742
Flow (gpm)	798	324	1122
Flow (cfs)	1.78	0.72	2.50
%	71%	29%	

all values in mg/l unless otherwise noted

A mass balance spreadsheet type surface water model was used to provide a comparison of impacts from the alternatives. Appendix A contains a description of this model. It should be noted the approach used is not a regulatory compliance analysis, but rather an impact analysis. The standards in this analysis provide a context to gauge significance. A regulatory compliance analysis would use median water chemistry and a specific flow to determine compliance with standards. This analysis uses a different approach to better depict the actual impacts that would be anticipated. The direct impact results for this model are summarized in Table 6 below.

No Action:
Under the No Action alternative no MPDES permit would be issued by the MDEQ. No discharge to surface waters would occur, therefore no direct impacts to surface water resources are anticipated to result from the discharge of produced water under the No Action alternative.

No Federal Action:
The direct impacts from the No Federal Action alternative result from the discharge of 0.56 cfs of CBNG water with an EC of approximately 742 μS/cm, and an SAR of 3.0. During LMM flows below the Dam the flow of the Tongue River would increase from 181.3 cfs to 181.9 cfs, the EC would increase slightly from 658 μS/cm to 659 μS/cm, and the SAR would increase from 0.91 to 0.92 (SAR is unitless). At the Birney Day School station during LMM flow this alternative would increase flow from 175.3 cfs to 175.9 cfs, the EC would increase slightly from 730.6 to 731.5 μS/cm (both of which round to 731), and the SAR would increase slightly from 1.15 to 1.16.

Proposed Action:
The direct impacts from the Proposed Action alternative result from the discharge of 1.0 cfs of CBNG water with an EC of approximately 742 μS/cm, and an SAR of 3.0. During LMM flows below the Dam the flow of the Tongue River would increase from 181.3 cfs to 182.3 cfs, the EC would increase from 658 μS/cm to 659 μS/cm, and the SAR would increase from 0.91 to 0.92. At the Birney Day School station during LMM flow this alternative would increase flow from 175.3 cfs to 176.3 cfs, the EC would increase from 731 μS/cm to 732 μS/cm, and the SAR would increase from 1.15 to 1.17.

Comparison of the resultant water quality values for all alternatives to the standards shows that during HMM and LMM flows none of the mean monthly standards are exceeded. During 7Q10 flows the instantaneous maximum standards are not exceeded. These standards were expressly adopted by the Montana Board of Environmental Quality, and the Northern Cheyenne Tribe to protect the beneficial uses of the Tongue River. As such, the results of this analysis indicate that neither the proposed action, nor any of the alternatives, would directly impair the beneficial uses of the Tongue River due to increases in EC or SAR.

The MDEQ has also conducted an analysis of this discharge in relation to the MPDES permit. This analysis is documented in the SOB, which is included in Appendix B of the Hydrology Technical Report. This analysis included consideration of a wide range of parameters, and the conclusion of this analysis was that the discharge would not cause exceedance of any surface water quality criteria. Chemical monitoring of the discharge, and in stream water quality, are also required in the permit. If monitoring shows that any standards are exceeded the MPDES permit may be reopened by the MDEQ. The MPDES permit also requires chronic whole effluent toxicity (WET) testing of the CBNG discharge water from this project to ensure that adverse impacts to aquatic life will not result from this discharge. According to the EPA one sample of CBNG water from the Big George coal seam in Wyoming has failed the EPA WET protocol. The MDEQ may require additional monitoring, a toxicity identification evaluation (TIE) analysis, and may reopen the permit if WET testing demonstrates toxicity of the effluent.

Table 6: Comparison of Direct Impacts to Surface Water from the Alternatives

		Modeled Existing Conditions			No Federal Action (250 gpm from PRG)			Proposed Action (450 gpm from PRG)		
	Flow Conditions	Flow (cfs)	EC (µS/cm)	SAR	Flow (cfs)	EC (µS/cm)	SAR	Flow (cfs)	EC (µS/cm)	SAR
Tongue River Below Dam	7Q10	72.3	824.6	1.17	72.9	825.0	1.18	73.3	825	1.18
	LMM	181.3	658	0.91	181.9	659	0.92	182.3	659	0.92
	HMM	1431.3	396	0.53	1431.9	397	0.53	1432.3	397	0.53
Tongue River at Birney Day School	7Q10	51.3	1149	1.76	51.9	1150	1.77	52.3	1150	1.78
	LMM	175.3	730.6	1.15	175.9	731.5	1.16	176.3	732	1.17
	HMM	1121.3	381	0.60	1121.9	381	0.60	1122.3	381	0.60

Note: The Direct result of the No Action alternative would be no discharge, thus the result would be no different than existing conditions.

Direct Groundwater Impacts:

Under the right conditions natural gas (CH_4; methane) is adsorbed onto coal surfaces. In order to develop or test CBNG the methane must desorb from the coal so that it can flow to the well. This is typically accomplished by reducing the hydrostatic pressure within the coal seam by pumping groundwater to near the top of the coal seam. Dewatering of the coal seam is not desired since this would cause the cleat to close up, inhibit the flow of methane, and require much larger volumes of water to be pumped. This pumping of groundwater has the potential to adversely affect water wells and springs which receive their water from the coal seam being developed. Due to the confined nature of the coal seam aquifers it is anticipated that drawdown will be limited to the developed coal seam and not extend to the adjacent overburden or underburden units, or to effect surface water bodies. Effects to wells which obtain their water from the developed coal seam may take the form of decreased yields resulting from lower static water levels or migration of methane into wells. Spring yield may also be impacted if the spring receives its water from the produced coal seam, and the spring is within the area drawdown by CBNG activities.

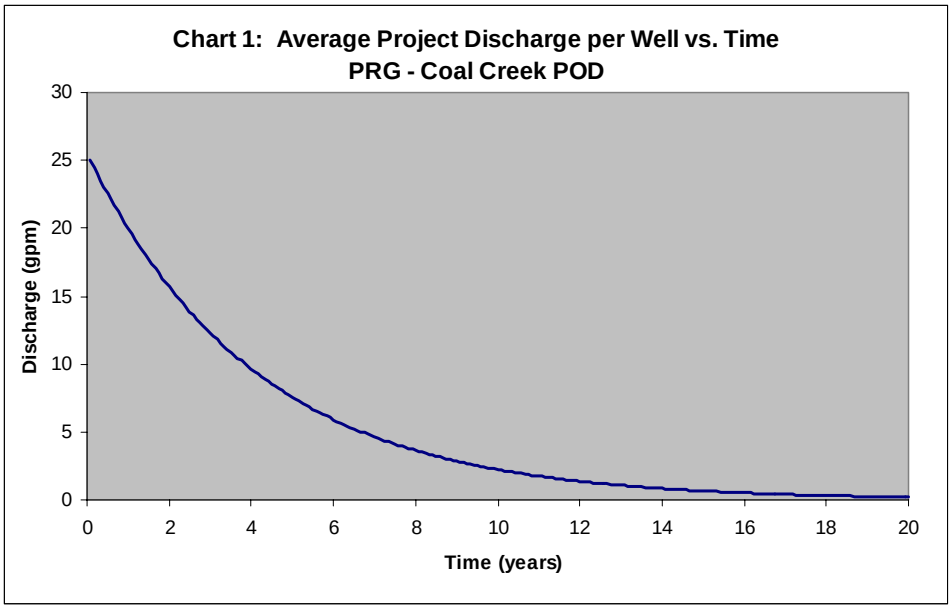
No Action:

Under the No Action alternative none of the wells would be drilled, tested, or produced therefore no impacts to groundwater would occur.

No Federal Action:

Under the No Federal Action alternative the eight proposed fee wells would be drilled. These new wells and the two existing fee wells would be tested for CBNG potential. This testing may last for up to 6 months. The removal of water from the Wall and Flowers-Goodale coal seams would cause a cone of depression to form around each well.

In order to analyze the potential drawdown associated with this action a Theis equation type groundwater drawdown model was prepared assuming that the coals are confined aquifers, that regional hydrologic properties apply (K= $9.8x10^{-2}$ to 13 feet/day (geometric mean =1.1 feet/day) and S=$9x10^{-4}$), that the aquifers are isotropic and homogeneous, and that there are no flow boundaries. Since flow limiting faults are known to exist in this area (Wheaton and Metesh, 2002; VanVoast and Reiten, 1988) these conditions would not be anticipated to be met in all cases, however since the location of all faults is not known this analysis does provide a reasonable analysis of the average distance that drawdown could reach from the well field. In cases where the drawdown cone intersects a fault the cone will be limited in the fault direction, and would extend asymmetrically away from this flow boundary. In cases where drawdown is within an isolated fault block (flow boundaries on all sides) the drawdown within the block would be greater than calculated due to the lack of recharge, but the drawdown would be limited to the block.



Based upon the drilling prospectus data contained in the POD the thickness of the Wall coal is assumed to be 55 feet, and the thickness of the Flowers-Goodale coal is assumed to be 20 feet. It is predicted in the POD that the initial production rate for these wells will be 25 gpm, with a reduction in yield of 20% per year (see Chart . A more detailed description of this drawdown analysis may be found in Appendix C of this report.

As shown in Table 6 this model indicates that with the 10 fee wells pumping (5 from each seam) the 20' drawdown contour may extend up to approximately 0.86 miles from the development area after 6 months of pumping.

Table 7: Summary of Direct Predicted 20 Foot Drawdown - No Federal Action

Time Pumped	Average Pumping Rate per Well (gpm)	Number of Wells per Seam	Average Pumping Rate per Coal Seam (gpm)	Coal Seam	Hydrologic Conductivity (K)		
					9.8×10^{-2} ft/day	1.1 ft/day	13 ft/day
6 Months	24	5	119	Wall	0.54	0.86	0.07
				Flowers-Goodale	0.19	0.37	0.24

Recent monitoring data from the existing CBNG fields in Montana (Wheaton and Donato, 2004) is also available online at http://www.mt.blm.gov/mcfo/cbng/CBNG-Monitoring.htm. This monitoring data indicates that "After 4 years of production from the CX field, water levels have been lowered by 20 feet at distances of less than 1 mile to as much as 2 miles outside the production area."

The groundwater modeling conducted in support of the CBM EIS anticipated that for a hypothetical CBNG field with 1,082 wells producing for 20 years, the produced coal seams will recover 70% of their hydrostatic head within 5-12 years after the end of production. It is anticipated that due to the shorter duration of pumping, and the lower number of wells, that recovery for this area will be more rapid.

A 2D MODFLOW model was prepared to assess the effects of the proposed action of this project on the Wall coal seam. Although not directly applicable to this alternative this analysis does provide an indication of the types of impacts that may be expected, and the approximate magnitude and duration. This analysis showed that after 180 days of testing the coal seams it would require 160 days for the static water levels to return to within 20' of pre-testing levels.

Those wells and springs, which are located within the area of drawdown, and which receive their water from the coal seam being pumped, may be affected by this drawdown. As shown on Map 3, according to MBMG's GWIC database (http://mbmggwic.mtech.edu/), 1 well, and no springs exist within this potential drawdown area. As shown in Appendix C this is the Bill Musgrave well in T. 8 S., R. 41 E., Section 7. Based upon the reported well depth (146 feet), and the elevation of this site based upon topographic maps (3,700 ft-amsl), this well is finished at an elevation of approximately 3,554 ft-amsl. The top of the Wall coal in this area is at approximately 3,100 ft-amsl. Because of the difference in depth of the wells, and the low vertical hydrologic conductivity of the intervening formations, it is not anticipated that the Musgrave well will be impacted as a direct effect of this alternative. Methane migration to this domestic well is also not likely to occur as a direct result of this alternative since the well is not completed in the coal seams to be produced. One spring was identified in this area by Powder River Gas in the POD book for this project. This spring is located in the NW corner of the SW corner (CB) of Section 6, Township 8S, Range 41E (see Map 1.3-2), and has been developed for livestock use. This spring is fed by the clinker deposits along the ridge top in this area. As such it does not receive its water from the coal seams being developed. This spring is located at an elevation of ~3,820 ft-amsl while the top of the Wall coal seam (the uppermost unit being tested) is at an elevation of ~3,100 ft-amsl in this area. As such it is not anticipated that this spring will be affected by this alternative.

The operator has also certified that "all land owners within the proposed CBNG well's circle of influence are being offered a Water Well Mitigation Agreement. If a water well mitigation agreement is not reached with the landowners, the company agrees to mitigate the impacts of the CBNG wells in accordance with Montana State Water Laws" this is in compliance with the Powder River Basin Controlled Groundwater Area Order by the MT-DNRC (1999). This Order requires that operators offer water mitigation agreements to owners of water wells or natural springs within one mile of a CBNG field, or within the area that the operator reasonably believes may be impacted by CBNG production, whichever is greater and to extend this area one-half mile beyond any well adversely affected. These mitigation agreements apply to any spring or well adversely impacted by CBNG wells. As such, these agreements would apply to those wells which experience an impact to their use whether it is due to decreased yields, the production of methane, or a change in water quality. The replacement of water required by these agreements is anticipated to take the form of reconfiguring existing wells, re-drilling wells, or drilling new wells. These processes would be effective for replacing water sources since the drawdown from CBNG activity is anticipated to be confined to the coal seam aquifers and not noticeably affect other aquifers (such as sandstones) within the Tongue River Member of the Fort Union Formation. Any such lost water sources would be replaced with a permanent source before the termination of the agreement. The order also requires the monitoring of water sources by the CBNG operator. Data from monitoring would be provided to the affected water source owner. Impacts would not be expected after the cessation of CBNG development since the aquifer would then be in the recovery phase, with groundwater levels rising in the area that had been drawn down by CBNG development. Therefore, it is anticipated that these required water mitigation agreements would mitigate the potential impacts from groundwater drawdown, methane migration or changes in groundwater quality.

The exact radius of the drawdown cone, and the time required for the head to recover, would depend on the site specific aquifer properties, the precise timing of the pumping of each of the wells, and the overall nature of CBNG development in this region. For additional general discussion of the anticipated drawdown related impacts, see pages 4-61 to 4-63 of the MT FEIS (BLM, 2003), and the associated groundwater modeling reports (Wheaton and Metesh 2001, Wheaton and Metesh, 2002).

The potential for cross contamination of aquifers will be avoided by cementing from the top of the produced coal zone to the surface. For further details on the drilling and cementing program see the Master Surface Use Plan and Drilling Plan in the individual APDs.

Shallow groundwater is not anticipated to be impacted by this alternative since proper well completion techniques and lining of the proposed impoundment with a 20 mil liner will prevent the introduction of produced CBNG water into shallow aquifers.

The injection of the residual brine into Class 1 injection wells is not anticipated to have adverse impacts since the proposed wells have already been analyzed and properly permitted by the WDEQ for this purpose.

Proposed Action:
Under the Proposed Action alternative the impacts to groundwater will be similar to those depicted for the No Federal Action alternative except that the 8 proposed federal wells would also be tested.

As shown on Table 8 the groundwater model indicates that with 18 wells (9 from each seam) the 20 foot drawdown contour may extend approximately 1.11 miles from the POD area after 6 months of pumping. Since the vertical hydrologic conductivity of the Tongue River Member of the Fort Union Formation is very low (Wheaton and Donato, 2004), the effects of drawdown are expected to be limited to the coal seams being developed and not extend to the adjacent overburden or underburden units, or to effect surface water bodies.

Table 8: Summary of Direct Predicted 20 Foot Drawdown - Proposed Action

Time Pumped	Average Pumping Rate per Well (gpm)	Number of Wells per Seam	Average Pumping Rate per Coal Seam (gpm)	Coal Seam	Hydrologic Conductivity (K)		
					$9.8x10^{-2}$ ft/day	1.1 ft/day	13 ft/day
6 Months	24	9	214	Wall	0.60	1.11	0.39
				Flowers-Goodale	0.20	0.44	0.48

As discussed above recent monitoring data from the existing CBNG fields in Montana indicates that "After 4 years of production from the CX field, water levels have been lowered by 20 feet at distances of less than 1 mile to as much as 2 miles outside the production area" (Wheaton and Donato, 2004).

The groundwater modeling conducted in support of the CBM EIS anticipated that for a hypothetical CBNG field with 1,082 CBNG wells field, wells finished in 3 coal seams, producing for 20 years, the produced coal seams will recover 70% of their hydrostatic head within 5-12 years after the end of production. It is anticipated that due to the lower number of wells and the shorter duration of pumping, that recovery for this area will be much more rapid.

A 2D MODFLOW model was prepared to assess the effects of the proposed action of this project on the Wall coal seam. This analysis showed that after 180 days of testing the coal seams it would require 160 days for the static water levels to return to within 20' of pre-testing levels.

Those wells and springs, which are located within the area of drawdown, and which receive their water from the coal seam being pumped, may be affected by this drawdown. As shown on Map 3, according to MBMG's GWIC database (http://mbmggwic.mtech.edu/), three wells and two springs are located within the direct drawdown area for this alternative. Of these wells none are completed at an elevation that would be consistent with being finished in the Wall coal. Since the nearest known outcrop of the Wall Coal seam is approximately 11 miles away, it is not anticipated that any of the springs emit from the coal seams being tested, and they are not anticipated to be impacted by groundwater drawdown.

As discussed under the No Federal Action alternative Water Well Mitigation Agreements will also be offered. These agreements are anticipated to mitigate groundwater drawdown related impacts.

The exact radius of the drawdown cone, and the time required for the head to recover, will depend on the site specific aquifer properties and the precise timing of the pumping of each of the wells. For additional discussion of the anticipated drawdown related impacts please see pages 4-61 to 4-63 of the CBM EIS (BLM, 2003), and the associated groundwater modeling reports (Wheaton and Metesh 2001, Wheaton and Metesh, 2002).

Shallow groundwater is not anticipated to be impacted by this alternative since proper well completion techniques will prevent cross contamination, and lining of the proposed impoundment with a 20 mil liner will prevent the introduction of produced CBNG water into shallow aquifers.

The injection of the residual brine into Class 1 injection wells is not anticipated to have adverse impacts since the proposed wells have already been analyzed and properly permitted by the WDEQ for this purpose.

Cumulative Environmental Impacts:

Cumulative impacts address all potential impacts from past, present and reasonably foreseeable future actions that may combine with the action to create environmental impacts, regardless of which agency or person undertakes such actions. Cumulative impacts address both on-site and off-site impacts.

The analysis in the effected environment section includes those past and present actions that may combine with the proposed action to create environmental impacts. These past actions include the discharge of untreated CBNG water upstream from of the Tongue River Reservoir, and the discharges from the East Decker and West Decker coal mines on the east and west sides of the Tongue River Reservoir.

Other reasonably foreseeable actions which could combine with the proposed action to create environmental impacts include increasing the existing untreated discharge up to its permitted limit, the proposed discharge of treated CBNG water upstream from the Tongue River Reservoir, and use of the proposed Powder River Gas permit up to its proposed limit. Other projects were considered for inclusion in this analysis, however as described in Appendix D of this report, these were the only known specific projects which had the potential to overlap with the proposed action or any of the alternatives to create environmental impacts.

The addition of these Foreseeable discharges, without any discharge from the PRG project provides for comparison of the cumulative impacts from the alternatives. The Foreseeable Conditions were determined by increasing the discharge from the existing untreated discharge up to the permitted limit (1600 gpm), and including the proposed treated CBNG discharge upstream from the reservoir (1700 gpm).

Cumulative Surface Water Impacts:

It is reasonably foreseeable that if the wells associated with this project are productive a portion of the MPDES permit relating to the wells tested would be used. The total MPDES permit application is for 2.5 cfs. For the No Federal Action alternative it is assumed that the cumulative total discharge from the PRG Coal Creek project would be 1.39 cfs of treated CBNG water. Under the Proposed Action a discharge of 2.5 cfs of treated CBNG water is assumed. The results for these different alternatives are shown on Table 9.

Comparison of the cumulative resultant surface water quality values for all alternatives to the appropriate standards shows that none of the appropriate standards are exceeded under any of the alternatives. These standards were adopted for the express purpose of protecting all beneficial uses of the Tongue River. As such, the results of this analysis indicate that the neither the proposed action, nor any of the alternatives, would be anticipated to cumulatively cause the beneficial uses of the Tongue River to be impaired.

The MDEQ has also conducted an analysis of this discharge in relation to the MPDES permit. This analysis is documented in the SOB, which is included in Appendix B of the Hydrology Technical Report. This analysis included consideration of a wide range of parameters, and the conclusion of this analysis was that the discharge would not cause exceedance of any surface water quality criteria. Chemical monitoring of the discharge, and in stream water quality, are also required in the permit. If monitoring shows that any standards are exceeded the MPDES permit may be reopened by the MDEQ. The MPDES permit also requires chronic whole effluent toxicity (WET) testing of the CBNG discharge water from this project to ensure that adverse impacts to aquatic life will not result from this discharge. According to the EPA one sample of CBNG water from the Big George coal seam in Wyoming has failed the EPA WET protocol. The MDEQ may require additional monitoring, a toxicity identification evaluation (TIE) analysis, and may reopen the permit if WET testing demonstrates toxicity of the effluent.

Table 9: Comparison of Cumulative Impacts to Surface Water from the Alternatives

		Foreseeable Conditions (Non-Project) (0 gpm from PRG)			**No Federal Action** (624 gpm from PRG)			**Proposed Action** (1,122 gpm from PRG)		
	Flow Conditions	Flow (cfs)	EC (µS/cm)	SAR	Flow (cfs)	EC (µS/cm)	SAR	Flow (cfs)	EC (µS/cm)	SAR
Tongue River Below Dam	7Q10	77.4	824	1.30	78.8	825	1.32	79.9	826	1.34
	LMM	186.4	664	1.01	187.8	665	1.03	188.9	667	1.04
	HMM	1436.4	401	0.56	1437.8	402	0.56	1438.9	402	0.57
Tongue River at Birney Day School	7Q10	56.4	1149	1.90	57.8	1150	1.92	58.9	1150	1.93
	LMM	180.4	736	1.25	181.8	738	1.27	182.9	740	1.28
	HMM	1126.4	386	0.63	1127.8	386	0.64	1128.9	387	0.64

Note: The Cumulative result of the No Action alternative would be no discharge, thus the result would be no different than foreseeable conditions.

Cumulative Groundwater Impacts:

If the wells associated with this project are productive it is reasonably foreseeable that these leases would be produced. This would require pumping the groundwater for up to 20 years at ever lessening rates (See Chart 1 above). Additionally it would require the installation of additional wells. 26 wells total (16 more than the current No Federal Action alternative) would be installed under the No Federal Action alternative (13 per coal seam), and 46 wells total (28 more than the current Proposed Action alternative) would be installed under the Proposed Action alternative. Using this information the extent of the 20 foot contour was calculated for the No Federal Action and the Proposed Action alternatives. The No Action alternative would not result in any drawdown. The results of this analysis for 1 year, 5 years, 10 years and 20 years are shown in Tables 10 and 11. More detailed discussion of the model used to determine these results is provided in Appendix C of this report.

No Federal Action:

The results of the drawdown analysis indicate that for the No Federal Action alternative with 13 wells pumping from each coal seam, cumulative drawdown may extend, on average, up to 4.0 miles from the project area after 20 years.

Table 10: Summary of Predicted 20 Foot Drawdown from the PRG - Coal Creek CBNG Project - Alternative B - No Federal Action

Time Pumped	Average Pumping Rate per Well (gpm)	Number of Wells per Seam	Average Pumping Rate per Coal Seam (gpm)	Coal Seam	Hydrologic Conductivity (K)		
					9.8×10^{-2} ft/day	1.1 ft/day	13 ft/day
1 Year	22	13	291	Wall	0.89	1.76	0.98
				Flowers-Goodale	0.62	1.39	1.82
5 Years	15		190	Wall	1.86	3.38	0.93
				Flowers-Goodale	1.30	2.81	2.75
10 Years	9		123	Wall	2.43	3.94	0.35
				Flowers-Goodale	1.74	3.51	2.34
20 Years	5		67	Wall	3.04	3.85	0.02
				Flowers-Goodale	2.23	4.02	1.04

The groundwater modeling conducted in support of the CBM EIS anticipated that for a hypothetical CBNG field with 1,082 wells producing for 20 years, the produced coal seams will recover 70% of their hydrostatic head within 5-12 years after the end of production. It is anticipated that due to the lower number of wells, that recovery for this area will be more rapid.

Map 3 in the Figures section of this report shows that area which may be drawn down as a cumulative result of the No Federal Action alternative. Since the vertical hydrologic conductivity of the Tongue River Member of the Fort Union Formation is very low (Wheaton and Donato, 2004), the effects of drawdown are expected to be limited to the coal seams being developed and not extend to the adjacent overburden or underburden units, or to effect surface water bodies. According to MBMG's GWIC database (http://mbmggwic.mtech.edu/), there are 22 wells and 15 springs located within the cumulative drawdown area that results under this alternative with 20 years of pumping. These wells and springs are listed in the Appendix C. These wells are finished at elevations between approximately 3220 ft-amsl and 3,904 ft-amsl. The elevation of the top of the Wall coal in this area varies between approximately 2614 and 3414 ft-amsl, and it is approximately 55 feet thick. The top of the Flowers-Goodale coal is, at its shallowest, approximately 2,591 ft-amsl and it is approximately 20 feet thick. As such 9 of these wells are finished at elevations where they are within the overall range of the Wall coal seam. Site specific calculations of the elevation of the Wall coal at each of these well sites show that for all of these wells the elevations at which they are finished are not consistent with being finished in the Wall coal. Because of the difference in depth

of the wells, and the low vertical hydrologic conductivity of the intervening formations, it is not anticipated that any of these wells will be impacted as a cumulative result of this alternative. Since the nearest known outcrop of the Wall Coal seam is approximately 11 miles away, it is not anticipated that any of the springs emit from the coal seams being tested, and they are not anticipated to be impacted by groundwater drawdown.

As discussed under the No Federal Action alternative Water Well Mitigation Agreements would be offered as required by the MT-DNRC (1999). These agreements are anticipated to mitigate groundwater drawdown related impacts.

The exact radius of the drawdown cone, and the time required for the head to recover, will depend on the site specific aquifer properties and the precise timing of the pumping of each of the wells. For additional discussion of the anticipated drawdown related impacts please see pages 4-61 to 4-63 of the CBM EIS (BLM, 2003), and the associated groundwater modeling reports (Wheaton and Metesh 2001, Wheaton and Metesh, 2002).

Proposed Action:
The results of the drawdown analysis indicate that for the Proposed Action, with 23 wells pumping from each coal seam, cumulative drawdown may extend, on average, up to 5.4 miles from the project area after 20 years. Since the vertical hydrologic conductivity of the Tongue River Member of the Fort Union Formation is very low (Wheaton and Donato, 2004), the effects of drawdown are expected to be limited to the coal seams being developed and not extend to the adjacent overburden or underburden units, or to effect surface water bodies.

Table 11: Summary of Predicted 20 Foot Drawdown from the Coal Creek CBNG Project - Alternative C - Proposed Action

Time Pumped	Average Pumping Rate per Well (gpm)	Number of Wells per Seam	Average Pumping Rate per Coal Seam (gpm)	Coal Seam	Hydrologic Conductivity (K)		
					$9.8x10^{-2}$ ft/day	1.1 ft/day	13 ft/day
1 Year	22	23	516	Wall	0.97	2.07	2.04
				Flowers-Goodale	0.66	1.56	2.55
5 Years	15		336	Wall	2.03	4.11	2.72
				Flowers-Goodale	1.40	3.21	4.43
10 Years	9		218	Wall	2.69	5.03	1.80
				Flowers-Goodale	1.87	4.10	4.60
20 Years	5		118	Wall	3.42	5.44	0.42
				Flowers-Goodale	2.44	4.91	3.13

The groundwater modeling conducted in support of the CBM EIS anticipated that for a hypothetical CBNG field with 1,082 wells producing for 20 years, the produced coal seams will recover 70% of their hydrostatic head within 5-12 years after the end of production. It is anticipated that due to the lower number of wells, that recovery for this area will be more rapid.

Map 3 in the Figures section of this report shows that area which may be drawn down as a cumulative result of the Proposed Action alternative. There are 35 wells and 24 springs located within the cumulative drawdown area that results under this alternative with 20 years of pumping. These wells and springs are listed in Appendix C. These wells are finished at elevations between approximately 2,897 ft-amsl and 3,973 ft-amsl. The elevation of the top of the Wall coal in this area varies between approximately 2614 and 3414 ft-amsl, and it is approximately 55 feet thick. The top of the Flowers-Goodale coal is, at its shallowest, approximately 2,591 ft-amsl and it is approximately 20 feet thick. As such 17 of these wells are

finished at elevations where they are within the overall range of the Wall coal seam. Site specific calculations of the elevation of the Wall coal at each of these well sites show that for all but two of these wells the elevations at which they are finished are not consistent with being finished in the Wall coal. The two wells that are within the appropriate range are the two Peterson wells located along the Tongue River in T7SR41E, Section 22. These Peterson wells are 43 and 44 feet deep, and are reported as being finished in the alluvium rather than in a coal. Because of the difference in depth of the wells, and the low vertical hydrologic conductivity of the intervening formations, it is not anticipated that any of these wells will be impacted as a cumulative result of this alternative. Since the nearest known outcrop of the Wall Coal seam is approximately 11 miles away, it is not anticipated that any of the springs emit from the coal seams being tested, and they are not anticipated to be impacted by groundwater drawdown.

As discussed under the No Federal Action alternative Water Well Mitigation Agreements would be offered as required by the MT-DNRC (1999). These agreements are anticipated to mitigate groundwater drawdown related impacts.

The exact radius of the drawdown cone, and the time required for the head to recover, will depend on the site specific aquifer properties and the precise timing of the pumping of each of the wells. For additional discussion of the anticipated drawdown related impacts please see pages 4-61 to 4-63 of the CBM EIS (BLM, 2003), and the associated groundwater modeling reports (Wheaton and Metesh 2001, Wheaton and Metesh, 2002).

Relation of the Alternatives to Cumulative Impacts Predicted in the CBM-EIS:

The cumulative impacts from CBNG development have also been addressed in general in the CBM EIS (BLM, 2003). The Hydrology sections of the Statewide FEIS identified the following potential cumulative impacts:

- Surface water quality will be slightly altered, however downstream uses will not be diminished.
- Surface water flows will be moderately increased.
- Groundwater drawdown will extend 4 to 5 miles from the edge of production.
- Shallow groundwater quality may be slightly altered.

No Action:

No Action would not cause any discharge to surface waters to occur, and pumping of coal seams would not occur, therefore this alternative would not contribute to the impacts predicted in the CBM-EIS (BLM, 2003).

No Federal Action:

In table 4-46 of the CBM-EIS (BLM, 2003; page 4-85) impacts to surface waters are depicted numerically for the USGS station on the Tongue River at Birney Day School during minimum mean monthly flows (LMM). Table 4-46 in the CBM-EIS depicts an increase in EC of 49 μS/cm. This alternative would directly cause the EC during LMM flow to increase by 0.8 μS/cm, or 1.6% of that depicted in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 19.1 μS/cm, or 39.1% of that projected in the EIS. Table 4-46 also depicts an increase in SAR during LMM flows at the Birney Day School Station of 1.43 units. This alternative would directly cause the SAR during LMM flow to increase by 0.006 units, or 0.4% of that depicted in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 0.209 units, or 14.6% of that projected in the EIS.

Table 4-46 of the EIS also shows that stream flow at the Birney Day School Station during LMM flows would increase by 7 cfs. This alternative would directly account for a flow increase of 0.56 cfs, or 8.0% of that projected in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 4.13 cfs, or 59.0% of that projected in the EIS.

Groundwater drawdown directly resulting from this alternative may cause 20’ drawdown contour in the coal seam aquifer to extend on average 0.86 miles from the POD Area. The cumulative drawdown resulting from pumping of these wells for 20 years would cause the 20’ drawdown contour to extend approximately 4.0 miles from the POD area. These results are similar to that predicted in the CBM EIS.

Shallow groundwater is not anticipated to be effected by this alternative.

Proposed Action:
In table 4-46 of the CBM-EIS (BLM, 2003; page 4-85) impacts to surface waters are depicted numerically for the USGS station on the Tongue River at Birney Day School during minimum mean monthly flows (LMM). Table 4-46 in the CBM-EIS depicts an increase in EC of 49 μS/cm. This alternative would directly cause the EC during LMM flow to increase by 1.4 μS/cm, or 2.8% of that depicted in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 19.7 μS/cm, or 40.3% of that projected in the EIS. Table 4-46 also depicts an increase in SAR during LMM flows at the Birney Day School Station of 1.43 units. This alternative would directly cause the SAR during LMM flow to increase by 0.011 units, or 0.8% of that depicted in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 0.214 units, or 14.9% of that projected in the EIS.

Table 4-46 of the EIS also shows that stream flow at the Birney Day School Station during LMM flows would increase by 7 cfs. This alternative would directly account for a flow increase of 1.0 cfs, or 14.3% of that projected in the EIS. When this increase is combined with the increase caused by existing CBNG discharge the total increase is 4.57 cfs, or 65.3% of that projected in the EIS.

Groundwater drawdown directly resulting from this alternative may cause 20’ drawdown contour in the coal seam aquifer to extend on average 1.11 miles from the POD Area. The cumulative drawdown resulting from pumping of these wells for 20 years would cause the 20’ drawdown contour to extend approximately 5.4 miles from the POD area. These results are similar to that predicted in the CBM EIS.

Shallow groundwater is not anticipated to be effected by this alternative.

SUMMARY:

Impacts to hydrological resources would be greatest under the Proposed Action alternative, less under the No Federal Action alternative, and would not occur under the No Action alternative.

The discharge of treated CBNG water would slightly increase the SAR and EC of the Tongue River during higher flows (LMM and HMM), and increase the SAR but decrease the EC during very low flows (7Q10). Surface water standards would not be exceeded under any of the alternatives, therefore, it is not anticipated that the beneficial uses of the Tongue River would be impacted by any of the alternatives.

Groundwater may be drawn down up approximately 0.86 mile from the producing field as a direct result of No Federal Action alternative, or 1.11 miles as a direct result of Proposed Action. Cumulative drawdown would be anticipated to extend approximately 4.0 miles and 5.4 miles from the field under the No Federal Action and Proposed Action alternatives, respectively, assuming 20 years of pumping. Wells and springs which draw their water from the produced coal seam and are located within this potential drawdown area would have the potential to be affected by this drawdown. Based upon the information contained in the GWIC data base no wells would have potential to be directly or cumulatively impacted by either of the action alternatives. It is not anticipated that any of the springs in the area would be impacted by groundwater drawdown since they do not emit water from the coal seams being developed. Water mitigation agreements, as required by the Powder River Basin Controlled Groundwater Area designation, will be put in place to mitigate potential impacts from groundwater drawdown. After testing is completed (not longer than 6 months) groundwater levels would be expected to return to within 20' of pre-testing levels after approximately 160 days.

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