UTILIZATION OF COAL BED METHANE PRODUCED WATER AT THE NORTH ANTELOPE ROCHELLE MINE CAMPBELL COUNTY, WYOMING[1]

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Abstract. Coal bed methane production has recently begun in the vicinity of the North Antelope Rochelle Mine (NARM) in Campbell County, Wyoming, the world's largest coal mine. In order to supplement the mine's water supply and to reduce use of deep water supply wells placed in the Fort Union and Fox Hills Formations, the mine's upstream flood control system has been designed to capture and temporarily hold water produced from coal bed methane operations. Water will then be pumped into the mine and held for dust suppression operations and facilities use. Water from coal bed methane operations will also aid in the establishment of wetlands and other reclamation features and will help to raise mine backfill water levels. Water discharged from the coal bed methane operations near to NARM is expected to be of very high quality. Water discharged from the mine has also been shown to be of high quality by monitoring of flow on downstream Porcupine Creek. This should continue when coal bed methane development in the Porcupine Creek drainage reaches its full potential. The use of coal bed methane produced water at NARM will lessen the impact of coal bed methane production on the Cheyenne River, where irrigators are concerned about the detrimental impact of produced water on the surface water quality.

Key Words: Dust Suppression, Wetlands, Alluvial Valley Floors, Geochemistry, and Reclamation

Introduction

Powder River Coal Company's North Antelope Rochelle Mine (NARM) is the world's largest coal mine, producing 67.9 million metric tons of sub-bituminous coal in 2002. The mine is located on the eastern flank of the Powder River Basin in Campbell County, approximately 100 km south of Gillette, Wyoming (Figure 1). The topography is generally flat with most surface drainages flowing into ephemeral streams. Four landforms originally existed in the

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[1]Paper was presented at the 2003 National Meeting of the American Society of Mining and Reclamation and The 9th Billings Land Reclamation Symposium, Billings MT, June 3-6, 2003. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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Proceedings America Society of Mining and Reclamation, 2003 pp 844-860
DOI: 10.21000/JASMR03010844

https://doi.org/10.21000/JASMR03010844

permit area. Well-developed soils exist on the gentle sloping upland tablelands in the northern part of the permit area, which covers approximately 109 km^2. Highly erosive badlands, which have mostly been removed by mining, are characteristic of the central portion of the permit area. The most conspicuous landforms in the southern portion of the permit are erosion resistant clinker (porcelainite) hills. Lastly, sheetwash deposits, colluvium, and lesser amounts of alluvium exist along portions of the ephemeral drainages. Reclaimed portions of the permit area, as required by law, are characterized by well-vegetated gently sloping hills. A downstream section of the main drainage in the permit area, Porcupine Creek, was classified as intermittent. A portion of lower Porcupine Creek was also classified as an alluvial valley floor (AVF) not significant to farming. The mine has already reclaimed the portion of Porcupine Creek determined to be an AVF using specialized methods.

The climate of the North Antelope Rochelle Mine is cool and semi-arid and is characterized by dry cold winters and short warm summers. Factors controlling the regional climate include elevation, abundant sunshine, with mountainous moisture barriers to the west and south. The generally open terrain of the region permits free movement of wind and weather systems through the area allowing rapid and extreme weather changes. The elevation of the permit area ranges from 1,370 to 1,525 m a.m.s.l. Mean annual precipitation at NARM is approximately 25 cm with the major portion of precipitation occurring as scattered thunderstorms during the late spring or early summer. Predicted annual evapotranspiration at Douglas, Wyoming, approximately 100 km south of NARM is nearly 58 cm (U.S. Dep't Commerce, 1969).

Porcupine Creek is tributary to Antelope Creek, which is tributary to the Dry Fork of the Cheyenne River and the Cheyenne River. NARM maintains upstream and downstream gauging stations on Porcupine Creek. Generally, there has been very little flow recorded upstream of the mine. This is due to the large number of stock ponds on upper Porcupine Creek and the sandy surface soils of the upstream tributaries. Surface water quality is variable depending on flow, but is usually poor due to the amount of evapotranspiration taking place in the alluvium and pooled water, and the lack of flushing events. Most recent flow downstream of the mine recorded has been due to discharge of pumped water from NARM facilities area. This flow has been significantly reduced since 1999 due to the mine's use of water approaching the volume of available supply. Water quality downstream of the mine is generally very good due to the amount of pumped water from the coal, porcelainite, and lower Fort Union aquifers and the Porcupine Creek is tributary to Antelope Creek, which is tributary to the Dry Fork of the

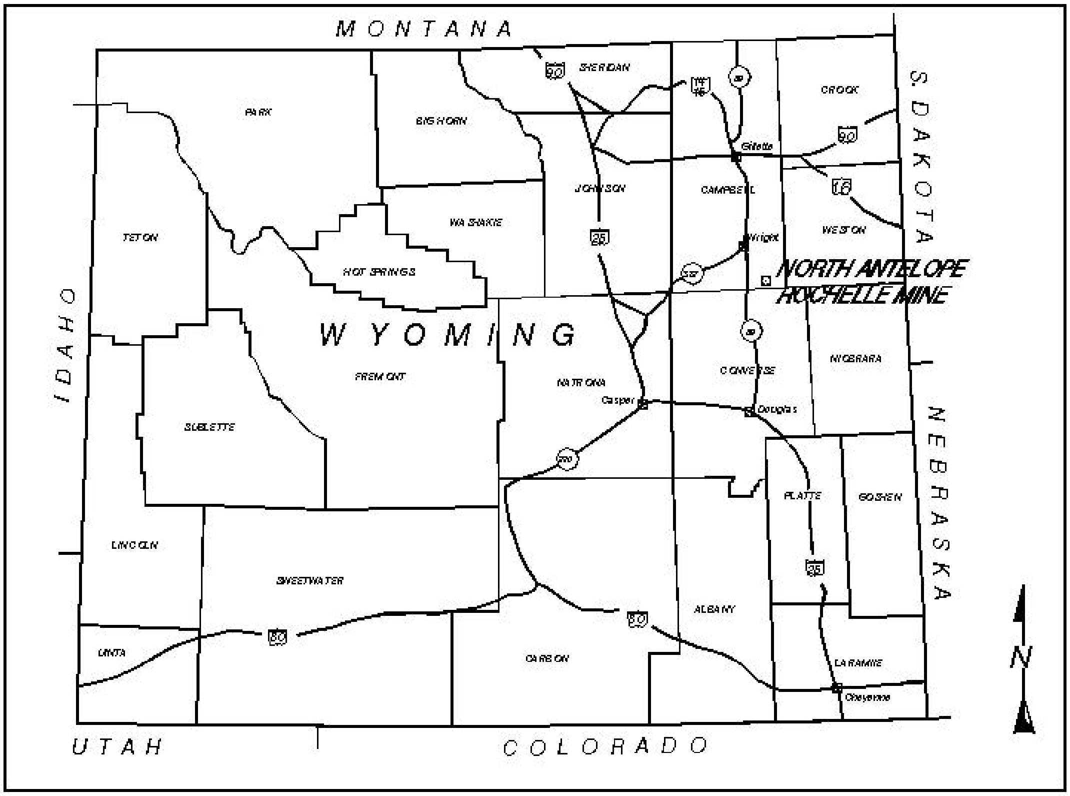

Figure 1: Location of North Antelope Rochelle Mine; Campbell County, Wyoming.

Cheyenne River and the Cheyenne River. NARM maintains upstream and downstream gauging stations on Porcupine Creek. Generally, there has been very little flow recorded upstream of the mine. This is due to the large number of stock ponds on upper Porcupine Creek and the sandy surface soils of the upstream tributaries. Surface water quality is variable depending on flow, but is usually poor due to the amount of evapotranspiration taking place in the alluvium and pooled water, and the lack of flushing events. Most recent flow downstream of the mine recorded has been due to discharge of pumped water from NARM facilities area. This flow has been significantly reduced since 1999 due to the mine's use of water approaching the volume of available supply. Water quality downstream of the mine is generally very good due to the amount of pumped water from the coal, porcelainite, and lower Fort Union aquifers and the amount of vegetation in the final mine impoundment. Downstream of the mine, at the confluence of Porcupine and Antelope Creeks, is the 407,000 m^3 Porcupine Reservoir, which is owned and operated by a local rancher. Flow to Antelope Creek from the Porcupine Reservoir has only been recorded once over the last ten years. This occurred following a storm event of greater than 100-yr 24-hr frequency on the east side of the mine, directly upstream of the reservoir.

Water used at NARM for dust suppression and by facilities currently originates from a variety of sources, including deep water supply wells, pit pumping of ground water, and surface runoff. The mine formerly operated ahead-of-mining dewatering wells placed in the overburden and coal, but has replaced the coal dewatering wells with coalbed methane (CBM) wells as gas rights were acquired and gas pipelines developed in the vicinity of the mine. Haulroad dust suppression, which may account for the use of up to 12,000 m^3 per day of water in summer, is the major use of water at NARM, followed by facilities washdown, with potable water use composing the remainder.

Prior to 2001, NARM utilized a diversion system for flood control and to route most storm water through the mine. However, operational concerns, including the limited reclamation that could be performed with the diversion in place, dictated removal of the diversion. Large reservoirs on the upstream drainages have now replaced the diversion for the purpose of flood control. The four largest of these flood control structures have been designed tocontain the 100-year 24-hour runoff event. Capacity to temporarily hold and pump water produced from nearby coalbed methane operations has also been designed into the structures. That water will be combined with flood control waters and pumped into the mine for use in dust suppression operations and for reclamation use. The use of coal bed methane water will allow NARM to reduce the use of water from deep water supply wells, while at the same time, continue to meet ever stricter air quality regulations and improve the quality of our reclamation efforts. Figure 2 shows the mine reservoirs delineated by type, current coal bed methane production area, pipelines connecting reservoirs, water loadouts, and current Porcupine Creek reclamation units. The highwall sumps are flood control reservoirs and the backfill ponds are sediment ponds constructed on backfill. The following paper describes the collection and use of CBM produced water at NARM and the variety of uses for which that water is used. The potential concerns of discharging CBM produced water from NARM are also discussed.

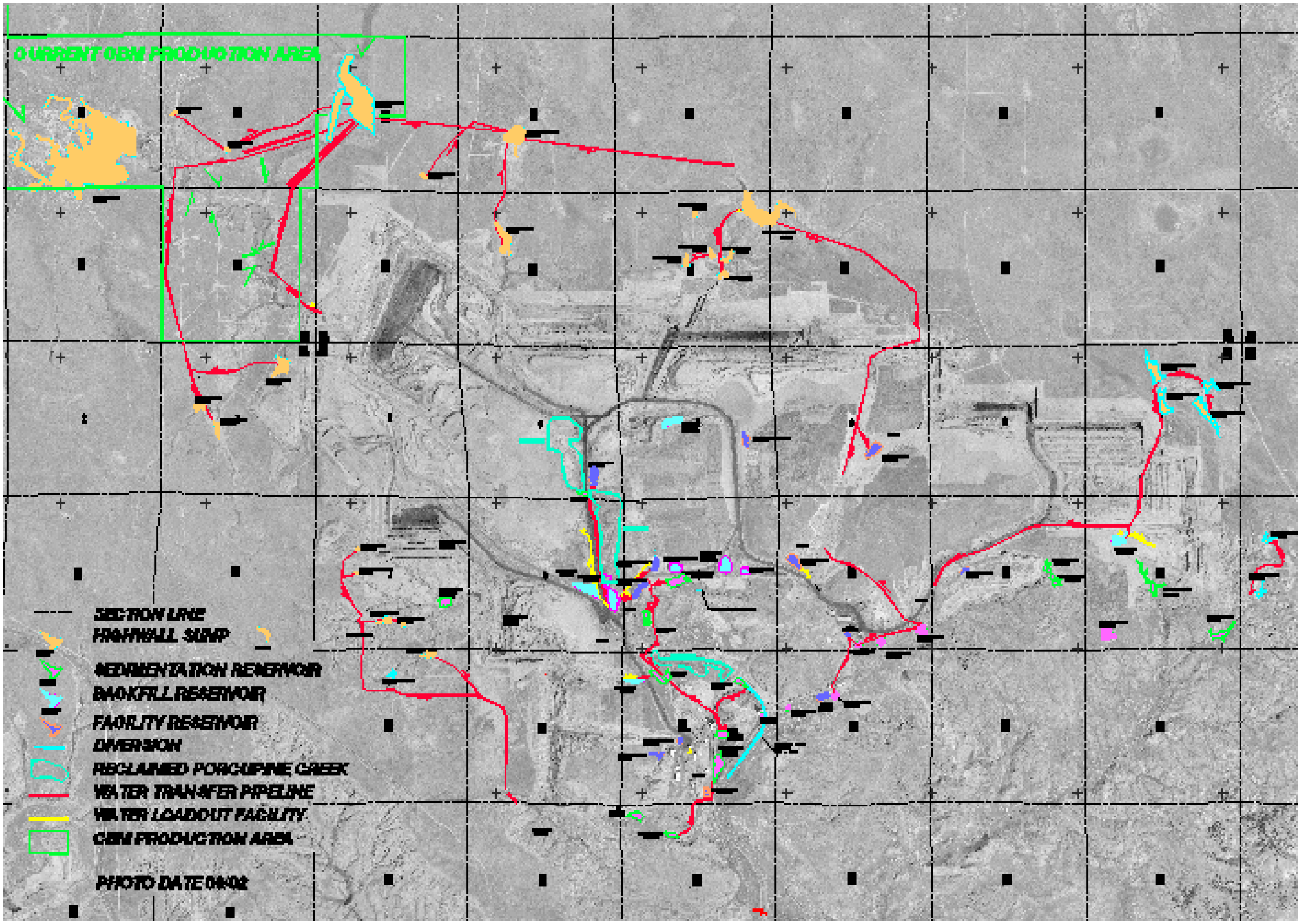

Figure 2: Reservoir Location Map and Coal Bed Methane Production Area

Current Water Supply and Use

North Antelope Rochelle uses a considerable amount of water for a variety of purposes including haulroad dust suppression, facilities washdown, and potable water. A detailed water management plan has been developed for the mine, which details water supply and use for the mine as well as contingency plans should supply fall short. Facilities washdown includes the frequent washing of all crusher and transfer facilities as well as the periodic washing of equipment and vehicles. All potable water and much of the facilities water are provided by deep water supply wells. However, only a portion of the haulroad water budget is provided by wells. There are currently four water supply wells placed in the Fort Union Formation. These wells are approximately 600 m deep and each produces approximately 1,000 m^3/day of high quality water (total dissolved solids (TDS) ~250 mg/l). These wells are separated by approximately 2.5 km to limit the influence of one well on another. A single 1,600 m deep well placed in the Fox Hills Formation provides approximately 1,900 m^3/day of lesser quality water (TDS ~750 mg/l). Facilities washdown water for the western portion of the mine is provided through a reservoir supplied by one of the Fort Union wells. Water recaptured from the mines primary downstream sedimentation pond and from the shallow wells in the clinker adjacent to the facilities area and recycled back through the water supply pond has significantly reduced use of ground water for facilities use. In 2002, due to recycling of water from the mine's main sedimentation reservoir and the adjacent clinker as well as use of CBM produced water, deep well water production at NARM was reduced by more than 378,000 m^3, with a limited set of CBM wells in operation. The reduction in deep well use is expected to increase in 2003, due to the more numerous CBM wells in operation and the volume of CBM produced water currently in storage at the mine. Table 1 shows the major water supply sources and uses at NARM.

The maximum daily use for haulroad dust suppression in the summer months is approximately 12,000 m^3 of water, while the minimum daily use in the winter is approximately 625 m^3. Prior to 1995, almost all of the water supply needs were provided by groundwater pumped to tanks or lined water supply reservoirs. Runoff water was discharged from the mine site following storm events. However, as the mine began to expand and increase production, the water use at the mine began to exceed the capacity of the wells at the mine. In order to provide a secondary source of water, sediment ponds were converted to facilities ponds to supply water trucks from runoff and mine pit pumpage. Today, most haulroad dust suppression water is provided from water supply ponds placed on the mine backfill. Total haulroad and ramp acreage is currently 0.85 km^2. Annual water use for haul roads at NARM in 2001 was 1.61 million m^3, however, as discussed later, this was reduced in 2002 due to implementation of conservation measures. However, the water use at the mine is generally expected to increase over the next few years due to the lengthening of haul roads and continuing efforts to meet strict dust control standards.

Table 1: Current Estimated Water Supply* and Use: 2003	
Supply or Use Type	**Production (m^3/day)**
Supply	
Mine Production Wells (Maximum Production)	9,250
Pit Water Production	2,200
Coal Bed Methane Produced Water	2,600
Total	14,050
Use	
Haulroad Dust Control (Summer Peak Use under Conservation Measures)	12,000
Facilities and Potable (Significant Portion is Recycled)	5,000
Evaporation and Seepage (Assuming Available Storage Reservoirs Filled)	1,500
Total	18,500
*Excludes Surface Runoff and Water Held in Storage. Current Maximum Water Storage is approximately 504,000 m^3, including flood control and storage reservoirs	

Due to the scarcity of significant runoff events and a ground water supply that is less than the peak use (Table 1), it is essential that water be accumulated in reservoirs in the relatively wet and cold winter and spring for use in the summer months. Water from wells, pit pumping, and surface runoff is combined in these ponds. The water storage reservoirs, a subset of the facilities reservoirs, at the mine differ from sediment ponds in that they either do not provide final sediment control or are large enough to store water while still maintaining their sedimentation capacity. There is approximately 294,000 m^3 of water storage available in these structures. However, historically, it has been rare to have all of the water supply reservoirs full at the same time due to the limited runoff and ground water supply. During dry and windy periods, the available water supply can be quickly depleted by dust suppression activities.

Water loadouts for loading water trucks are located at five reservoirs at NARM. The conventional loadouts are designed to load the mine's five smaller water trucks, which carry between 45.4 and 75.7 m^3. Two fast fill loadouts are designed to load the single 166 m^3 water truck (Figure 3). In 2001, a significant effort was made to connect the water supply reservoirs with each other to allow sharing of water between the pits. Water may now be moved from the eastern portion of the mine to the middle and north portions, where there is more need for the water. Water can also be returned from the middle portion of the mine to the western portion of the mine. Sediment traps and small sediment ponds have also been constructed to protect the water supply reservoirs from excessive sedimentation in order to maintain capacity.

Figure 3: 166 m^3 Water Truck in Operation in Coal Hopper Area During Windy Day.

Flood Control and the Water Distribution System

Due to removal of the upstream Porcupine Creek Diversion in 2001, five flood control reservoirs were constructed on upstream drainages. These are connected to the rest of the mine's upstream flood control system by surface HDPE pipelines. Discharging water from large flood control reservoirs usually involves pumping around the active mine due to the difficulty of finding a pipeline route from the reservoir across the active pit and through to the completed reclamation. Although Porcupine Creek has provided very little water to the mine historically due to the large number of stock ponds on its upstream reaches, CBM produced water has recently filled the stockponds and the large amount of natural pool storage available on Porcupine Creek and it is expected that this will allow floodwaters to reach the mine.

At NARM, flood waters and coal bed methane discharge water will be pumped into water supply reservoirs using four large flood control reservoirs in the northwest of the permit area. Three of these reservoirs have a large amount of capacity reserved for long-term water storage. This is very inexpensive since most of the flood storage is contained in the upper portion of the reservoir. Water from smaller upstream flood control reservoirs is pumped to these large flood control reservoirs, but coal bed methane water will not be pumped to the smaller reservoirs. Generally, capacity is maintained for the 100-year, 24-hour storm event in the larger flood control reservoirs, while the smaller flood control reservoirs are designed for the 10-year, 24-hour storm event. It is interesting to note that pumping around the mine using the flood control reservoirs consumes approximately one half of the electricity that it costs to produce water from deep production wells, for a given amount of water.

As shown on Figure 2, water collected in a large flood control reservoir in the northwest portion of the permit area can be released through a slidegate to flow approximately one mile to a large stockpond within the current primary coal bed methane production area. From this stockpond, water is pumped approximately one mile north to another of the mine's large flood control structures, which has a total capacity of 340,000 m^3 (247,000 m^3 flood control, 93,000 m^3 temporary storage). Water may then be pumped another 1.5 km east to a smaller flood control structure (75,000 m^3 flood control, 25,000 m^3 storage), and then 3 km east to another flood control structure (120,000 m^3 flood control, 92,000 m^3 storage) (Figure 3). A total of 210,000 m^3 of water storage are provided in the upstream flood control reservoirs. From the last upstream flood control structure, water is pumped nearly 5 km across a highwall in temporary cessation to a water supply reservoir in the backfill. Water can then be distributed using the mine's water distribution system.

More than 40 km of 15, 20, and 36-cm diameter HDPE pipe were added in 2001 to construct the new flood control system and upgrade the mine's water supply capacity. These pipelines can be moved and extended as flood control reservoirs are replaced by new structures, due to mine pit movement, and new water supply reservoirs are constructed.

Coal Bed Methane Production

Although coal bed methane production and development have been intensive in recent years in Campbell County, Wyoming, the first twenty-eight CBM wells drilled in the immediate contributing drainage of Porcupine Creek upstream of NARM were drilled in late-2001 and early-2002. Sixteen of these wells begin producing water in the spring of 2002, with combined production at approximately 1,500 m^3/day. Figure 4 shows CBM produced water stored in a flood control reservoir during the summer of 2002. In January 2003, the remaining twelve wells were placed into production. As well, water from a CBM well field on Porcupine Creek, approximately four miles upstream of the mine, reached the mines upstream flood control reservoir in December 2002. Current total water inflow to NARM from CBM production is now approximately 2,600 m^3/day and it appears that the mine will enter the summer of 2003 with most available water storage capacity filled. Permitting delays involving the U.S. Forest Service (much of the mine and vicinity is within the Thunder Basin National Grasslands) and the Bureau of Land Management have slowed development of the large coal bed project areas to the north and west of NARM. Eventually, it is expected that nearly 500 coal bed methane wells will be drilled in the Porcupine Creek drainage. It is difficult to estimate the amount of water that these new CBM wells will produce. Water production from CBM wells will quickly decline from peak levels and few of the wells will enter production at the same time. Upstream storage for livestock use and/or irrigation may also consume some water as will seepage into alluvial and overburden aquifers. It is hoped that the period of additional CBM well construction is long since that will reduce the volume of the expected flows and prolong the period in which CBM produced water is available to the mine.

The water quality in the coal within the CBM production area is very good. Near to the mine, the total dissolved solids (TDS) are typically 435 mg/l and the sodium adsorption ration (SAR) is about 6.4. Farther west, the TDS rises to approximately 1,500 mg/l and the SAR is approximately 7.5. However, when the CBM derived water flows through stream channels such as Porcupine Creek, it may remove salts from the stream bank and the flows may become saline. Experience with coal dewatering wells at NARM shows that this problem is limited in time and scope as long as water production is sufficient to maintain stream flow.

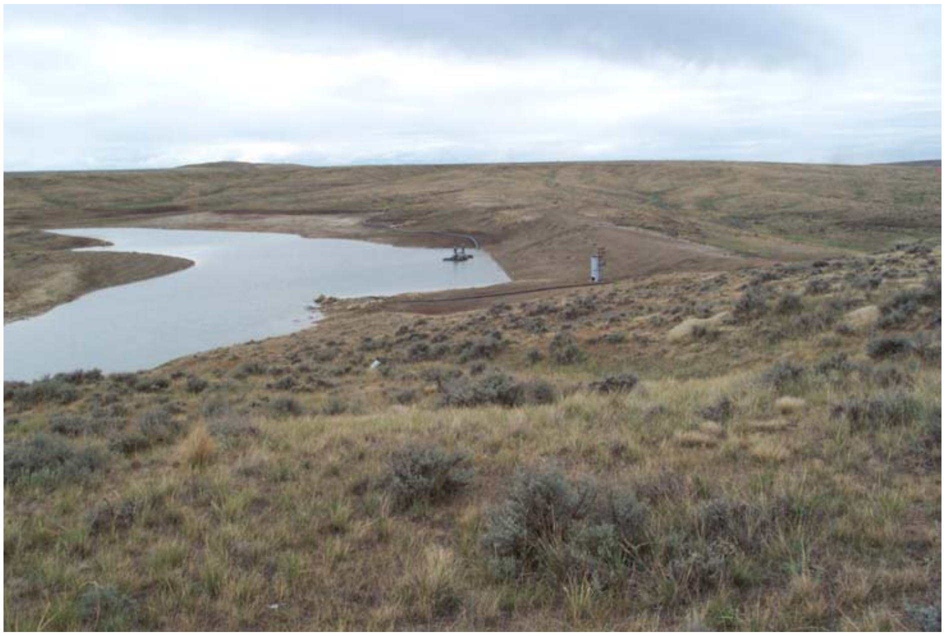

Figure 3: Coal Bed Methane Produced Water Stored in Flood Control Reservoir at North Antelope Rochelle Mine, September 2002.

North Antelope Rochelle has made agreements with coal bed methane producers upstream of the mine to handle produced water within the mine permit area. While concern has been raised that more CBM water will enter the mine than can be efficiently handled and that the mine will not be able to discharge the excess water within effluent limitations, the CBM producers will not be allowed to discharge more water to the mine than can be efficiently handled. Water produced from CBM operations must be discharged under all applicable state and federal permits. If more water is being produced from coal bed methane wells than the mine can process, other options for water discharge, including construction of upstream storage reservoirs, re-injection, or pumping around the mine, will have to be utilized by the CBM producers. Points of discharge are specified in the agreements between Powder River Coal Company and CBM producers. Wherever possible, discharges will be directly to major drainages to limit uptake of salts from soils.

Water Conservation

Water use in 2001 for haulroad dust suppression alone was 1.6 million m^3, however, during the severe drought in 2002, the mine reduced its consumptive water use considerably through conservation efforts and recycling of facilities water. Although water use will probably continue to increase due to lengthening of haul road, mine expansion, and efforts to meet ever stricter air quality standards; conservation of water will both increase the long-term viability of the mine and allow the mine to continue good relationships with its neighbors, of whom many hold senior water rights.

During the summer of 2002, when virtually all reservoir storage was depleted and ground water, including CBM produced water, was the only source of water available to the mine; the mine conserved water through a variety of methods. Firstly, use of equipment washbays was limited to necessary maintenance use. Secondly, the number of active sprayers on water trucks was reduced and increased use of chemical dust suppressants was ordered. Use of water loadout facilities was shifted to loadouts where sufficient water was available. It is estimated that these measures conserved approximately 6,000 m^3/day during the approximately three months they were in effect. The mine staff has learned from these efforts and will continue to maintain the conservation measures implemented for haulroad dust control and to look for new ways to conserve water.

Use of Produced Water for Reclamation and Aquifer Recharge

In addition to improving the dust suppression capability at NARM and reducing deep water supply well production, the CBM-derived water will be used to improve reclamation at the mine. Water held in storage during the colder and wetter winter and spring months, will be pumped out in the summer for use in dust suppression. Much of this water will flow through the reclaimed Porcupine Creek channel. As required by the mine's permit from the Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD), the reclaimed Porcupine Creek channel is underlain by an 25 m wide by 3 m deep reconstructed fill of material containing at least 60 percent sand. Water discharged from coal bed methane wells and used for dust control will also allow the mine to discharge water directly to the reclaimed stream channel, as occurred frequently in 2002.

Approximately three km of Porcupine Creek have been reconstructed. The upper section of the reclaimed Porcupine Creek (AVF Reach 2) was reconstructed using replacement alluvial material in 1999. Pools and counter-weirs were constructed on the channel in 1999 as well. Due to direct flow of water from the native Porcupine Creek through the Porcupine Creek Diversion, this area already shows good development of wetland characteristics only a few years following reclamation. Alluvial water levels are still rising in AVF Reach 2, but the reclaimed alluvial water quality is generally good and is similar to the water quality in the overburden (TDS of 1200 to 2200 mg/l) from which the replacement alluvium originated, and adjacent backfill. This is superior to the water quality in the native Porcupine Creek, where TDS often exceeded 3,000 mg/l. Surface water quality is also good since the source is primarily pit-water and surface runoff, with TDS concentrations at approximately 1,100 mg/l. Trace metal concentrations have not been a concern in this section.

Although a lower section of Porcupine Creek (AVF Reach 1) was constructed in 1985 and 1986, a diversion bypassed the section until early-2001. Flow in this section was limited to infrequent discharges from a sediment reservoir upstream of this channel. In addition, the lower creek was reconstructed using an old channel design criteria that required channelization and limited the amount of pooled water. In early-2002, the adjacent diversion was removed and pools and counter-weirs were constructed on the lower reclaimed Porcupine Creek (Figure 4). Trees have been planted on the reclaimed channels and riparian vegetation along the channel is expected to improve, as more water is available. If water is discharged from the mine to the native Porcupine Creek, it will flow through this reclaimed channel.

AVF Reach 1 was constructed from native alluvium as required by the WDEQ/LQD at the time. Water quality in the four reclaimed alluvial wells in the lower channel has been poor. Premining alluvial wells located in the general vicinity of the above wells showed generally poor quality with TDS levels ranging from approximately 750 mg/l to 5,770 mg/l. However, alluvial wells in the Powder River Basin often show native water quality much worse than that reported above. One alluvial well on upstream Porcupine Creek has a TDS level of about 37,000 mg/l. When mixing and oxidation of the highly mineralized alluvial material occurred during mining and then the material was placed in the reclaimed alluvial valley floor, the resulting water quality reflected the new mobility of the constituents. Although one shallow reclaimed alluvial well, showing seasonal variations in water level, has a range in TDS concentrations of between 1,230 and 2,652 mg/l, TDS concentrations in the three other reclaimed alluvial wells ranged from 5,500 to 12,250 mg/l. Trace metal concentrations in AVF Reach 1 have fluctuated. Selenium concentrations have reached as high as 932 μg/l, but generally have ranged from 0 to 200 μg/l.

Figure 5: Pool and Counter-Weir Sequence on AVF Reach 1 with Caged Coyote Willow (Salix exigua) Plantings

Following construction of the pools and counter-weirs (Figure 5) on AVF Reach 1 for wetland replacement purposes in January 2002, reclaimed alluvial water levels have risen approximately 1 m. Boron concentrations spiked upward as water flushed through the unsaturated zone, but rapidly declined. Selenium concentrations also declined rapidly and currently range from <5 to 33 µg/l. It is expected that with water available to the lower reclaimed Porcupine Creek channel, ground water conditions can be kept consistently reducing and the fluctuations in alluvial water levels will decrease. It is also hoped that sulfate-reducing bacteria will proliferate in the more saturated environment, thereby reducing TDS concentrations. Sulfate-reducing bacteria were detected in all of the AVF Reach 1 monitoring wells in January 2003.

Current modeled estimates of water level recovery at North Antelope Rochelle show that it may take over 1,000 years for complete recovery to premining water levels in the coal. Fifty percent of the water level recovery will take place in the first 200 years following mining. With the development of coal bed methane, these estimates will increase significantly due to the large area of coal bed methane development and the great depth of coal bed methane wells towards the center of the Powder River Basin. Around the facilities areas, estimates of recovery to premining water levels are in the hundreds of years. However, seepage from water supply and sediment reservoirs on the mine backfill and water seeping into the backfill from the reclaimed alluvial aquifers has raised backfill water levels at NARM much faster than predicted by mine and area ground water models. Water levels near the facilities area near Porcupine Creek are near premining water levels approximately 15 years following mining. It is expected that water from coal bed methane operations being held in storage reservoirs or pumped through the mine for discharge or use in operations and reclamation use will similarly seep into the backfill aquifers and allow for more rapid than predicted recharge.

The post mining land use at NARM will be rangeland grazing and wildlife habitat. Water stored in sediment and water supply reservoirs as well as in reclaimed stream channels already supplies water to abundant populations of deer and antelope as well as numerous bird species. The reclaimed Porcupine Creek supports three species of non-game fish, one frog species, and numerous insects and invertebrates (Hansen and Murphree, 2002). During the next few years, it is expected that cattle will be introduced to the reclaimed lands and water from CBM operations is expected to supplement ground water from the shallow Fort Union Formation as a water source for livestock. Tree farming, using water from streams and wells, will also be practiced to help establish upland tree species.

Release of Water from the Mine

As stated in the introduction and shown by flow records for the mine, most flow downstream of the mine has been due to discharge of pumped water from the mine's facilities area. This flow has been significantly reduced since 1999 due to the mine's use of water approaching the volume of available supply and more efficient recapture of water by the mine. Water quality downstream of the mine is generally very good due to the amount of water pumped from the coal, clinker, and lower Fort Union aquifers and the amount of vegetation in the final mine impoundment. The mean TDS concentration is 1,644 mg/l and the mean SAR is 3.23. Trace metal concentrations are not a concern. Downstream of the mine, at the confluence of Porcupine and Antelope Creeks, is the 407,000 m^3 Porcupine Reservoir, owned and operated by a local rancher. Flow to Antelope Creek has only been recorded once over the last ten years and this occurred following a storm event of greater than 100-yr 24-hr frequency on the east side of the mine.

Eventually, it is expected that some water will be discharged from Porcupine Reservoir into Antelope Creek due to mine discharges and the associated CBM produced water. Irrigators in the Cheyenne River drainage have raised concern that CBM discharges on Antelope Creek will remove salts from the stream sediments and deposit them downstream, and that the flows would detrimentally affect irrigation on the Cheyenne River. However, agreements between Powder River Coal Company and the CBM producers will limit the volume of these discharges. Water quality at Porcupine Reservoir is monitored monthly by NARM. TDS concentrations at Porcupine Reservoir average 1,088 mg/l with the mean SAR being 3.0. Water quality in the Porcupine Creek alluvium downstream of the mine has actually improved since the opening of the mine due to dilution by mine discharges and uptake of solutes by the improved vegetation. The mine's storage and use of CBM water has helped to dilute the initially saline CBM-derived flows on Porcupine Creek. In general, as long as discharges of water from the mine or CBM production are directly to major drainages and if flow to Antelope Creek is limited, water quality in Antelope Creek and the Cheyenne River should not be affected by CBM production in the Porcupine Creek drainage.

Conclusion

Coal bed methane production has recently begun in the vicinity of the North Antelope Rochelle Mine in Campbell County, Wyoming, the world's largest coal mine. In order to supplement the mine's water supply and to reduce use of deep water supply wells placed in the Fort Union and Fox Hills Formations, provision has been made to utilize the mine's upstream flood control system to capture and temporarily hold water produced from coal bed methane operations. Water will then be pumped into the mine and held for use in dust suppression operations and facilities use. Water from coal bed methane operations will also aid in the establishment of wetlands and other reclamation features. Water discharged from the coal bed methane operations near to North Antelope Rochelle is expected to be of high quality and water discharged from the mine has also been shown to be of high quality by monitoring of flow on downstream Porcupine Creek. If discharges from Porcupine Creek to Antelope Creek occur due to coal bed methane production, water quality should not be detrimentally affected. If more water is being produced from coal bed methane wells than the mine can process, other options for water discharge, including construction of upstream storage reservoirs, re-injection, or pumping around the mine, will have to be utilized by the CBM producers.

References

Hansen, B.W. and Murphree, P.A. 2002. Reclaiming for Wildlife: Habitat Conservation at the North Antelope / Rochelle Complex. Award submittal for Mine Reclamation and Wildlife Stewardship Award: Wyoming Hunting and Fishing Heritage Exposition, 2002.

U.S. Department of Commerce. 1969. Climatography of the United States No. 20-48. Climatological Summaries. Environmental Science Services Administration, Washington D.C.