PATHFINDER

A Cogema Resources Company

June 1, 2000

Mr. Thomas H. Essig
Chief, Uranium Recovery and
Low-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20850

RE: Docket No. 40-6622
License No. SUA-442

Dear Mr. Essig:

Pursuant to your May 4, 2000 letter regarding deficiencies in the application for alternate concentration limits (ACLs), Pathfinder Mines Corporation (PMC) requested that Hydro-Engineering L.L.C. (HYDRO) develop additional materials to rectify the cited deficiencies. HYDRO has provided replacement pages for the application to amend Source Material License No. SUA-442 to satisfy those deficiencies and those pages are included in this submittal. The replacement pages (5 copies) include the cover sheet, the first page of the table of contents and pages 1.3-3 through 1.3-10. These pages are double-sided and are a direct replacement for the pages in the document.

The following describes the location of additional text to satisfy the specific deficiencies. The first deficiency regarding a lack of quantification of ground water at the site is addressed in additional text at the bottom of replacement page 1.3-4. The second deficiency regarding current and future uses of ground water is addressed in additional text on replacement pages 1.3-4 and 1.3-5. The third deficiency regarding the description of the quality of unaffected Surficial aquifer water is addressed beginning with Section 1.3.5, BACKGROUND WATER QUALITY, on replacement page 1.3-6. Additional text at the top of replacement page 1.3-8 also provides a reference to more complete tabulations of water quality. There were no modifications to the text beyond Section 1.3.5.1 on replacement page 1.3-8 other than pagination changes resulting from the additional text.

NMSS01 Public

PMC staff and their consultant HYDRO will be available to provide additional information at your request. Please don't hesitate to contact me if you have questions or comments.

Sincerely,

Thomas S. Michel for
T. W. Hardgrove

T. W. Hardgrove
Operations Manager

Enclosure

Cc: B. Spitzberg, USNRC Region IV
Gary Beach, Wyoming DEQ/WQD
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APPLICATION FOR:

ALTERNATE CONCENTRATION LIMITS
PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE

PREPARED FOR:

PATHFINDER MINES CORPORATION
SHIRLEY BASIN MINE

LICENSE NO. SUA-442

DOCKET NO. 40-6622

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range from just a few gal/day/ft to 8000 gal/day/ft. The area of greatest transmissivity or hydraulic conductivity is near the Mine Creek channel.

Figure 1.3-3 presents the contours of hydraulic conductivity for the Surficial aquifer. These contours were developed using pumping test results from area wells, and from calibration of the modeling. As indicated above, the hydraulic conductivity is greatest near the original Mine Creek channel. Directly beneath Tailings Pond #5 and the east side of Tailings Pond #4, the pre-pumping piezometric surface was relatively flat, indicating the hydraulic conductivity in this area is relatively large. Between the crest and toe of the Pond #5 dam, there is a very steep gradient in the piezometric surface, indicating very small hydraulic conductivity. The small hydraulic conductivity in this area is attributed to chemical precipitation resulting from neutralization of the tailings seepage.

To the west and southwest of the tailings area, the gradient steepens substantially, indicating a decrease in hydraulic conductivity. Slug tests on the WWL series of wells by Water, Waste and Land (1983) also indicated small hydraulic conductivity in this area. A pumping test of well TW5S-1 also indicated a dramatic decrease in hydraulic conductivity while moving to the west. The reduced hydraulic conductivity in this area results in a situation where rates of movement for seepage plumes are very slow. The small quantities of seepage that have encroached in this area are essentially stagnant.

1.3.3.2 SURFICIAL AQUIFER GROUND-WATER FLOW

Water-level elevations define the gradient and direction of ground-water flow in the Surficial aquifer. Figure 1.3-4 presents the details of the water-level elevation of the Surficial aquifer in the tailings area. Because the majority of Surficial wells within the actual tailings area have been converted to injection or collection wells, the contours in the immediate vicinity of these wells represent expected water-level elevations outside of the immediate cone of depression or water level mound around each active well.

The general shape of the piezometric surface indicates the complexity of the containment and restoration systems, as well as past artificial and natural recharge. Collection and injection operations in the middle of the tailings area have created a depression in the potentiometric surface in the middle of the tailings, with a hydraulic ridge along the line of injection wells.

The ground-water velocity equation is presented on pages 70 and 71 of Freeze and Cherry (1979). Hydraulic gradient times the horizontal permeability divided by the effective porosity yields the groundwater velocity. The recharge lines are a constructed fresh-water injection system consisting of buried and gravel-packed perforated piping with a distributed supply system. Injection through the recharge lines creates ground-water mounds that have a significant impact of gradients and the direction of ground-water flow. The ground water east of the south Mine Creek recharge line is presently moving downgradient toward Spring Creek at a rate of 3.75 ft/day based on the present hydraulic gradient and aquifer properties. An average permeability of 25 ft/day, gradient of 0.015 ft/ft and effective porosity of 0.1 were used in this estimate. The gradient on the west side of the south recharge line ranges from approximately 0.003 to 0.007 ft/ft, giving an apparent seepage velocity ranging from 0.75 ft/day to 1.75 ft/day.

The gradient in the north Mine Creek recharge area between wells MC-7 and MC-8 (northeast of the north recharge line) is 0.0065 ft/ft. The piezometric surface between these two wells is very flat and appears to steepen near Spring Creek.

The quantity of water moving in the Surficial aquifer is governed by Darcy's Law, where the rate is equal to the product of the transmissivity, gradient and the width of the aquifer. With the complexity of the piezometric surface and ongoing discharge to Mine Creek and Spring Creek, numerical modeling was used to predict discharge of ground water to Spring Creek.

The volume of water contained in the Surficial Aquifer within the area bounded by Spring Creek and the No. 5 Tailings dam is estimated at 165 Mgal using a specific yield of 0.10, the base of the Surficial aquifer and 1999 water-level elevations. A similar volume is likely present directly beneath the tailings and in the recharge area to the south of the tailings. The water-level elevation from the No. 5 dam outward to Spring Creek is artificially supported by fresh water recharge, and the volume will be reduced when recharge is discontinued.

The current usage of Surficial aquifer water within the area impacted by tailings seepage is limited to seepage containment measures including collection. There will no post-reclamation usage of Surficial aquifer ground water within the area impacted by the tailings. There are springs and small stock reservoirs north and west of the tailings that are fed by surface water and ground-water discharge from shallow sands. It is likely that this shallow ground water will be further exploited for livestock watering in the future. The elevation of the springs and the channel base for Spring Creek and its tributaries place this ground-water discharge many feet upgradient of the tailings area Surficial aquifer water levels. It is possible that there is some degree of hydraulic communication between the tailings area Surficial aquifer and upgradient springs, but the direction and magnitude of the gradient will prevent any migration of tailings seepage into this area.

1.3.4 UNDERLYING AQUIFERS

In the immediate vicinity of the tailings, the White River aquifer, Main Wind River aquifer and the Lower Wind River aquifer all have sufficient permeability, thickness and saturation to function as major aquifer systems. The Upper Wind River sand is thinner and less continuous than the overlying and underlying sands and is typically not considered a major aquifer in the tailings area. The Area 2/8 Reservoir and associated reclaimed mine pit penetrate all three aquifers, and these aquifers are currently discharging to the reservoir. Figure 1.3-5 presents cross-sections for the Surficial and White River Aquifers in the tailings area. Current ground water uses in the immediate tailings area from the White River aquifer are limited to supply for fresh water recharge. There are two stock wells located more than two miles north of the tailings area and one stock well more than two miles west of the tailings that are believed to be completed in the White River aquifer. These wells are likely far upgradient of both the Surficial and White River aquifers in the tailings area. Current ground water uses from the Lower Wind River aquifer include mine area supply and supply for fresh water recharge. There were two Wind River aquifer wells located more than four miles south of the tailings that were used to supply the now abandoned townsite. The wells may be utilized for stock water, but are isolated from any potential tailings impacts by the Area 2/8 reservoir, which falls between the wells and the tailings. There will be no post-reclamation uses of ground water from any aquifer within the tailings seepage impacted area. There will be on-going ground water exchange between the Area 2/8 and Area 3 reservoirs and ground water. The White River aquifer and the Main Wind River aquifer are discharging to the reservoirs. The Lower Wind River aquifer is currently discharging to the Area 2/8 reservoir, but eventually the gradient will reverse when the reservoir approaches final stage.

1.3.4.1 WHITE RIVER AQUIFER

The White River aquifer is typically a 30-foot thick sandstone that is separated from the overlying Surficial aquifer by a 10 to 60-foot thick clay and siltstone. Fresh-water injection supply wells WW-22 and WW-23 are completed in the White River aquifer.

1.3.4.2 MAIN WIND RIVER AQUIFER

The Main Wind River aquifer is typically a 75-foot thick sandstone that is separated from the overlying White River aquifer by a 50-foot thick clay and siltstone and other thinner sandstone/claystone sequences.

1.3.4.3 LOWER WIND RIVER AQUIFER

The Lower Wind River aquifer is an 80-foot thick sandstone that is separated from the overlying Main Wind River aquifer by a 70-foot thick clay and siltstone. The Lower Wind River sands pinch in the No. 3 Pond area and does not exist east of the pinch out.

1.3.4.4 UNDERLYING AQUIFER PROPERTIES

Transmissivity of the White River aquifer varies from a few hundred to 2,500 gal/day/foot in the mine area. Transmissivity of the Main Wind River aquifer varies from 2,500 to 25,000 gal/day/foot in the mine area with the exception of small local areas with dramatically reduced permeability. Transmissivity of the Lower Wind River aquifer varies from 1,080 to 22,400 gal/day/foot in the tailings area.

1.3.4.5 UNDERLYING AQUIFER GROUND-WATER FLOW

The present ground-water flow in the White River aquifer beneath the tailings is to the east under a relatively mild gradient. This gradient is believed to be increased slightly by the pumping of wells WW-22 and WW-23 to supply the fresh-water recharge systems. The general direction of ground-water flow in the Main Wind River is radially inward to the two recovering reclamation reservoirs in Area 2/8 and Area 3. There are no Main Wind River monitoring wells in the immediate tailings area, so the direction of ground-water flow directly beneath the tailings area is unknown. The general direction of ground-water flow in the Lower Wind River Aquifer is to the Area 2/8 Reservoir and to the WW-20 mine area supply well. There are no indications of hydraulic communication between the Surficial aquifer and any of the underlying formations.

1.3.5 BACKGROUND WATER QUALITY

The background water-quality conditions at this site have been monitored since 1979 using well MC-14, which is located north of the tailings. Based on the piezometric surface, the general ground-water flow in the Surficial aquifer is currently radially outward to the east, north and west of the center of the tailings area. However, there is no indication of movement of ground water from the tailings area north to the vicinity of well MC-14. The water quality in well MC-14 has remained relatively unchanged over the period of record. Prior to mining activity, the ground-water flow in the Surficial aquifer probably paralleled the Mine Creek channel with a tapering of saturated thickness while moving upstream.

Table 1.3-1 presents the average background water quality for Surficial aquifer well MC-14 over the period of record. One outlier was removed for uranium and thorium-230 prior to calculating the statistics.

TABLE 1.3-1. PMC SHIRLEY BASIN SUMMARY OF BACKGROUND WATER-QUALITY CONCENTRATIONS.

Constituents	No. of Samples	Concentrations in Well MC-14				Range of Typical Values
		Minimum	Maximum	Median	Mean	
Uranium	61	0.01	0.13	0.08	0.083	0.05 – 0.13
Thorium-230	49	<0.2	3	0.2	0.404	<0.2 – 1.2
Ra-226+228	24*	0.2	19.5	1.475	2.99	----
Selenium	38*	<0.001	0.015	<0.001	0.0017	----
Gross Alpha	24	<1.0	25.6	2.2	5.33	----
Barium	25*	<0.02	0.5	<0.2	0.2	----

Note: All concentrations are in mg/l, except:
Ra-226+228, Gross Alpha and Thorium-230 which are in pCi/l
* - More than 50% non-detects. Statistical analysis is compromised.

This table lists the minimum, maximum, mean and median for each of the hazardous constituents with less than 77% non-detects at this site. The remainder of the site standard constituents have 95% or more non-detects, which renders statistical analysis meaningless. For ACL constituents uranium and thorium-230, Table 1.3-1 also presents a range of typical values where 90% or more of the samples are within the range.

Well MC-14 is considered representative of background Surficial water quality with no impacts by tailings seepage. However, section 1.3.5.1 describes some water quality anomalies that may be attributed to natural variation. Hydro-Engineering L.L.C. (2000), presents the most recently tabulated water quality for the Surficial aquifer as well as the White River aquifer and Lower Wind River aquifer.

1.3.5.1 INFLUENCE OF ORE-BEARING ZONES

The proximity of PMC's tailings and former mill area to the mining area raises the question of potential impacts of the presence of natural radionuclides in shallower aquifers. Unfortunately, the evidence for the presence of naturally occurring uranium and associated radionuclides is indirect. Soil sampling in conjunction with the windblown tailings cleanup has revealed that there are significant concentrations of radionuclides in Surficial sands adjacent to Spring Creek. These samples were taken from undisturbed areas at depths of more than five feet from the surface, which precludes contamination by windblown tailings. The WWL series of wells south and west of the tailings have shown erratic results with elevated concentrations of uranium, radium-226 + radium-228, gross alpha, and selenium. However, there are some anomalies that indicate that the elevated concentrations may be natural or a combination of natural variation and some seepage impacts. These anomalies include elevated concentrations of selenium and radium-226 + radium-228, which is not typical of tailings seepage impacts on the Surficial aquifer. This is further supported by the absence of proportionate increases in chloride concentration (see Hydro-Engineering L.L.C., 2000), which is generally the first and most prominent indication of impacts by seepage from tailings.

1.3.6 EXTENT OF CONCENTRATIONS

The extent of elevated concentrations for uranium for 1999 is presented in the figures in this subsection. Concentration maps for uranium were also presented in the Annual reports for 1997 and 1998. Elevated concentrations of selenium are local phenomena and there are no distinct plumes or paths of migration. Elevated radium-226 + radium-228 activity is also a local phenomenon.

1.3.6.1 SURFICIAL AQUIFER

URANIUM

Uranium concentrations in excess of the site standard have been documented at this site since 1979. However, the extent and magnitude of elevated concentrations were not well understood until the mid 1980's, when additional wells were installed and uranium concentration was measured more routinely in existing wells. The largest measured uranium concentration in well RPI-20A was 3.5 mg/l in August of 1983. This well is located near the confluence of Mine Creek and Spring Creek and represents the "heart" of the historic Mine Creek area plume. The uranium concentration in this well began to gradually decrease after the 1983 sampling and was down to roughly one-half of the maximum value in late 1985. This decline occurred prior to the implementation of corrective action measures, which may indicate that there were some geochemical or neutralization processes which were gradually reducing the mobility of uranium. Subsequent addition of recharge and collection systems has restored the water quality in this area to background conditions.

THORIUM-230

The occurrence of elevated thorium-230 activities is much more erratic than that of elevated uranium concentration. Like uranium, the first documented exceedances of the current site standard were in 1979, and ironically, the first measured thorium-230 activity in well MC-14 was twice the site standard of 0.3 pCi/l. Early samples for well RPI-20A rarely exceeded 0.3 pCi/l, while there was no question that the well was impacted by tailings seepage until the late 1980's, when the operation of recharge and collection systems began to have an effect. A typical scenario for elevated thorium-230 activity in a sampling record for an impacted well is 2 to 4 elevated analyses interspersed in 6 to 10 samples with activities below the detection level. For this reason, a thorium-230 activity contour map is not particularly useful. Sampling in 1999 yielded only two thorium-230 levels in excess of the proposed POE activity of 0.3 pCi/l and these were in at wells MC-14 and MC-6.

RADIUM-226 + RADIUM-228

Radium-226 + radium-228 has proven to be nearly immobile in the tailings area. A modest number of samples have shown activities in excess of the site standard of 5 pCi/l. However the distribution of elevated radium-226 + radium-228 activities in the known seepage area is characteristic of natural variation rather than a seepage front. Areas that are known to be profoundly affected by seepage from the tailings, (such as wells 5A-1 and P8A) have shown little or no elevated activity. On the other hand, areas where seepage impacts are milder or non-existent have shown occasional elevated activity.

SELENIUM

Selenium has proven to be relatively immobile in the tailings area. Concentrations in excess of the EPA drinking water standard of 0.05 mg/l, (which has been substituted for the site standard), occur in only a fraction of a percent of samples for wells in the known seepage area.

1.3.6.2 WHITE RIVER AQUIFER

The White River aquifer is hydraulically separated from the Surficial aquifer by a thick clay and siltstone. There is no evidence that seepage from the tailings has impacted the water quality in the White River aquifer. Well WH-9 on the west side of the tailings has shown elevated TDS, chloride and uranium concentrations, but the well is located in close proximity to some historic underground mine workings and an early in-situ leaching test area. The gradient for the White River aquifer in this area is to the east to the pumping wells WW-22 and WW-23 and the first occurrence of noticeably elevated concentrations followed several years of pumping from the White River aquifer wells. This combination of sequence of contamination and the gradient to the east indicates that the elevated concentrations at well WH-9 likely result from some mine-related remnant contamination to the west of the well.

1.3.6.3 MAIN WIND RIVER AQUIFER

With the additional separation provided by a substantial aquitard between the Main Wind River aquifer and the overlying White River aquifer, there is virtually no potential for impacts by tailings seepage. Any local contamination of the Main Wind River aquifer is a result of mining penetration of the formation.

1.3.6.4 LOWER WIND RIVER AQUIFER

With additional separation by a massive clay and siltstone, there is no potential for tailings area seepage impacts on the Lower Wind River aquifer.