To: Kane, NMSS
Appropriate Action

OFFICE OF THE SECRETARY
CORRESPONDENCE CONTROL TICKET

Date Printed: Sep 01, 2000 16:07

PAPER NUMBER: LTR-00-0561 **LOGGING DATE:** 09/01/2000

ACTION OFFICE: EDO

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ADDRESSEE: Dan Gillen

SUBJECT: Concerns the restoration of Mine Unit 1 at the Crow Butte Mine

ACTION: Appropriate

DISTRIBUTION:

LETTER DATE: 08/28/2000

ACKNOWLEDGED No

SPECIAL HANDLING:

NOTES:

FILE LOCATION: ADAMS

DATE DUE: **DATE SIGNED:**

Template: SECY-017 E-RIDS: SECY-01

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August 28, 2000

U.S. Nuclear Regulatory Commission
Mr. Dan Gillen, Chief
Uranium Recovery Section
Fuel Cycle Licensing Branch
Division of Fuel Cycle Safety and Safeguards
Office of Nuclear Material Safety and Safeguards
Mail Stop T8A-33
Washington, D.C. 20555-001

Re: Source Materials License SUA-1534
Docket No. 40-8943
Restoration Status

Dear Mr. Gillen:

Thank you for taking time to meet with Fletcher Newton and me on August 17, 2000 to discuss the status of the restoration of Mine Unit 1 at the Crow Butte Mine. During the meeting I referred to the Environmental Assessment for the renewal of the Crow Butte Source Material License which issued in February 1998 and the renewal license application submitted in December 1995 (revised 6-24-97). You noted that these are on microfiche at present and are not readily available to the staff for review. In order to facilitate your review, I have included copies of the section on groundwater restoration, pages 39-44, from the Environmental Assessment and Section 6.1.3 Restoration Goals, pages 6-5 to 6-9. The environmental review clearly recognized that "if a return to pre-operational baseline is not reasonably achievable using best practicable technology, the secondary goal is to return the groundwater quality to a use consistent for which the water was suitable prior to the ISL operations, based on the class-of-use standards established by NDEQ." Crow Butte Resources believes (and the regulatory authorities in the State of Nebraska agree) that we have fully complied with these requirements and met these objectives. As noted in the License Renewal application, page 6-5, " the restoration values set by NDEQ are consistent with this secondary goal."

This is the basis on which Crow Butte Resources has submitted an amendment request to the NRC for approval of Mine Unit 1 restoration at the Crow Butte Mine which was previously approved by NDEQ on November 22, 1999. For the NRC to now argue that the restoration goals should be different or, as Mr. Ford suggested, to raise issues that have already been resolved under the EPA's Underground Injection Control program (e.g. migration of ground water after the project has been restored) is arbitrary, unreasonable and without apparent statutory authority. We wish to resolve this issue as quickly and as cooperatively as possible, indeed, the enclosed documents make clear, we thought we had done so long ago. Please help us cut through this tangled web so that we can follow the guidelines the NRC itself already established as our goals of restoration. If you have any questions on this matter, please contact me.

Sincerely,

Steve Collings

Stephen P. Collings
Senior Vice President Operations

Cc: Chairman Meserve
Commissioner Diaz
Commissioner Dicus
Commissioner McGaffigan
Commissioner Merrifield
Tony Thompson, Esq.

ENVIRONMENTAL ASSESSMENT FOR RENEWAL OF SOURCE MATERIAL LICENSE NO. SUA-1534

CROW BUTTE RESOURCES, INCORPORATED
CROW BUTTE URANIUM PROJECT
DAWES COUNTY, NEBRASKA

FEBRUARY 1998

DOCKET NO. 40-8943

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Division of Waste Management

Should CBR decide in the future to begin land application of treated effluents, the staff recommends that it also should implement vegetation sampling within the land-applied areas so that assumptions in the MILDOS-AREA modeling concerning soil and plant uptake can be verified.

CBR is required, by license condition, to document the sampling and monitoring results, and to maintain such documentation for a period of at least five years. In addition, under 10 CFR 40.65, CBR is required to submit the results of the environmental and effluent monitoring program to NRC on a semiannual basis.

Finally, to ensure that a high quality sampling and analytical program is maintained, CBR is required, and will continue to be required, by license condition, to establish, review, and update standard operating procedures for all environmental monitoring required for the operation. These procedures are required to be reviewed by the CRSO on at least an annual basis, to determine that proper radiation protection principles are being applied.

4.0 GROUNDWATER RESTORATION, RECLAMATION, AND DECOMMISSIONING

4.1 Groundwater Restoration

After ore extraction is complete in a wellfield, groundwater restoration begins in the depleted ore zone, with the intent of reducing the concentration of mobilized constituents remaining in the groundwater. By license condition, the primary goal of restoration is to return the affected groundwater quality, on a MU average, to baseline conditions. This will continue to be so required in the renewal license.

If it is determined that a return to the pre-operational baseline is not reasonably achievable using best practicable technology, the secondary goal is to return the groundwater quality to a use consistent for which the water was suitable prior to the ISL operations, based on the class-of-use standards established by NDEQ.

4.1.1 Establishing Pre-operational Baseline Water Quality

As discussed in Section 3.3.2, CBR will collect baseline groundwater quality data prior to mining in each MU. This data is collected for the purposes of establishing both UCLs (see Section 3.7.1) and restoration standards for the MU. For the purposes of setting restoration standards, the data is required to be collected from the MU at a minimal density of one production or injection well per 1.6 ha (4 acres). As stated previously, the primary goal of restoration is to return the affected groundwater quality, on a MU average, to baseline conditions. Average pre-operational baseline water quality for MUs 1–5 is provided in Table 2-3.

With the issuar.ce of a performance-based license, t·e SERP will have the responsibility of reviewing the baseline groundwater data and establishing restoration standards for subsequent MUs prior to mining in those MUs. CBR will continued to be required, by license condition, to collect the appropriate data at the required density.

4.1.2 Groundwater Restoration Methodology

A schematic of the groundwater restoration process is shown in Figure 4-1. Based on experience gathered during the R&D project and the on-going restoration of MUs 1 and 2, CBR has outlined in the LRA and in the NRC-approved groundwater restoration plan (CBR, 1996a), four basic methods for groundwater restoration that will be used at the Crow Butte Uranium Project:

a. Groundwater Transfer

In this method, pre-operational groundwater is recovered from an MU starting production and injected into the MU where restoration is commencing in order to dilute the higher TDS groundwater. In return, higher TDS groundwater from the MU in restoration is recovered and injected into the MU that will be starting production. The intent of this direct transfer is to lower the TDS in the MU being restored by displacing water affected by ISL operations with baseline quality water.

b. Groundwater Sweep

In this process, water is pumped without injection from the wellfield, causing an influx of baseline quality groundwater from the perimeter of the MU which sweeps the affected portion of the aquifer. This step is also intended to draw in the plume of affected water at the edges of the MU. This water is not returned to the wellfield, but instead is disposed through the waste water disposal system.

c. Groundwater Treatment

This process consists of extracting water from the ore zone, treating it to improve the water quality and either re-injecting the cleansed water (the permeate) into the ore zone or disposing it in a manner described in Section 3.6.2. IX and reverse osmosis (RO) will be the methods used to treat the water, with IX used to remove uranium. After IX, if the permeate is re-injected, a reductant is added periodically to the permeate to induce, in the ore zone, the precipitation and immobilization of uranium and other trace elements that were dissolved during the extraction process.

A portion of the recovery water can be sent to an RO unit. Prior to treatment by RO, the water is filtered, radium is settled out by treatment with barium chloride (BaCl), and the pH is lowered to prevent calcium carbonate from plugging the RO membranes. The permeate from the RO unit is either re-injected or, like the concentrated brine that is also produced, disposed in a manner described in Section 3.6.2. CBR demonstrated the effectiveness of RO during the R&D phase of operations.

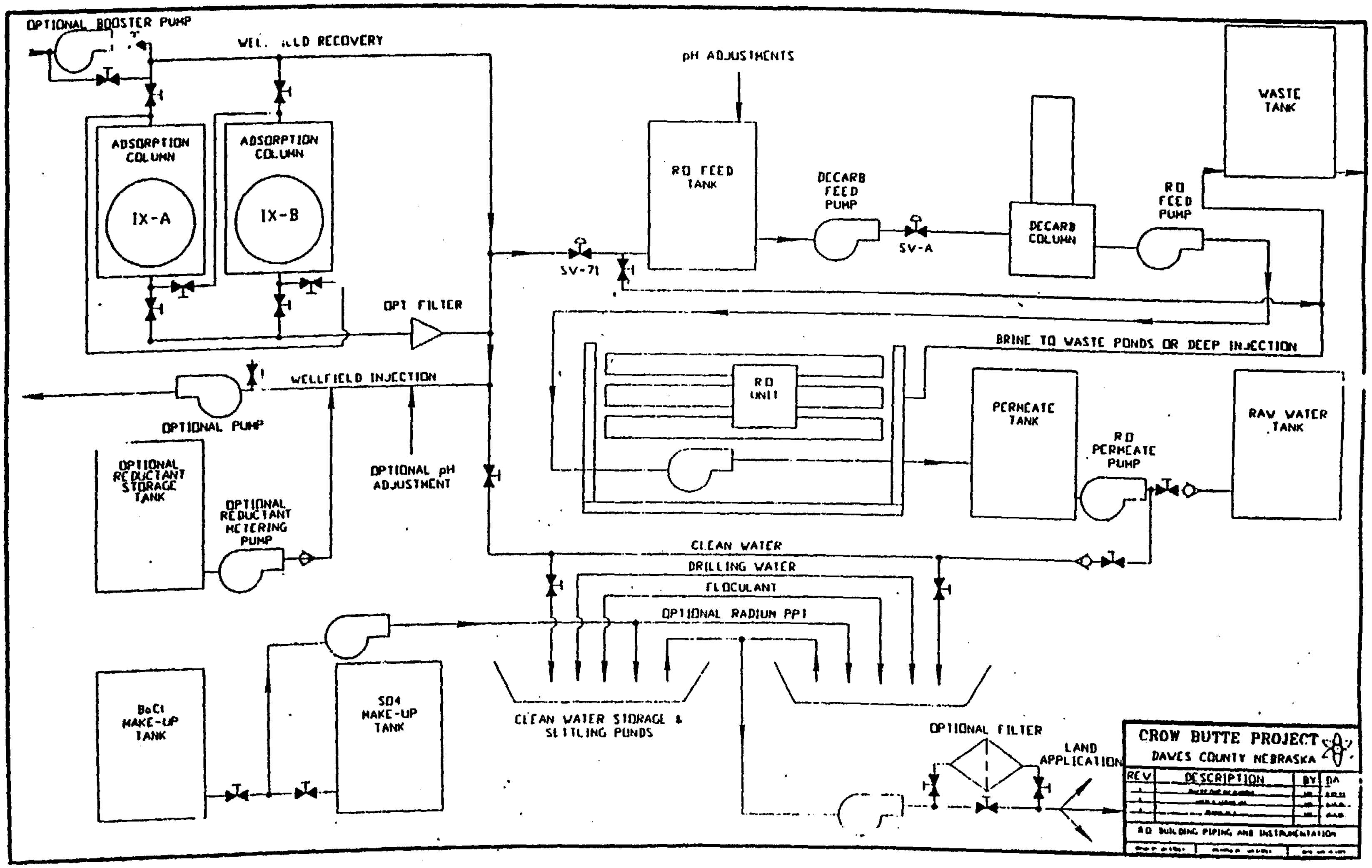

Figure 4-1. Schematic of the groundwater restoration process at the Crow Butte Uranium Project (from CBR, 1995)

d. Wellfield Recirculation

Following completion of all or some of the methods above, the treated groundwater is recirculated through the ore zone, by pumping from production wells and re-injecting the recovered solutions into the injection wells, to homogenize the groundwater.

Upon the completion of restoration in an MU, CBR will implement a groundwater stabilization monitoring program in which the restoration wells and any monitoring wells on excursion status will be sampled and assayed. Samples will be collected at a frequency of one sample per well per month for a period of six months. If all six samples show that restoration values for all wells are maintained during this period, CBR will consider restoration complete and will request of NRC and NDEQ that the MU be declared restored. If water quality is not stabilized, further restoration work may be required.

CBR will continue to be required, by license condition, to perform groundwater restoration in accordance with the currently approved groundwater restoration plan (CBR, 1996a).

4.1.3 Effectiveness of Groundwater Restoration

The typical rejection efficiency of the membranes used in the RO unit are provided in the LRA, with most of the analyzed constituents rejected at a 90 to 99 percent efficiency. The water is circulated through the unit several times to maximize efficiency. Data from the R&D operations indicate that the combination of IX, radium settling with BaCl, and RO reduces the concentration of most metals below detection limits, and common ions to below drinking water standards.

The success of R&D restoration efforts are discussed in detail in the staff's 1989 EA (NRC, 1989a), and are summarized here. The R&D restoration criterion was to return the affected groundwater to a class-of-use standard rather than to the average baseline value as currently required. Table 4-1 shows the groundwater quality data for 30 groundwater parameters monitored during restoration of the R&D wellfields. Of these parameters, 21 were restored to equal or less than their baseline minimum value, but 9 were not (ammonia, manganese, molybdenum, two forms of nitrogen, lead, radium-226, uranium, vanadium, and zinc). However, the staff determined that the overall change in water chemistry was very small, and that the water from the R&D operation was suitable for any pre-operational use. On April 12, 1988, the staff approved the completion of restoration in R&D Wellfield No. 2. The total number of pore volumes (PV) required during the R&D restoration was approximately 19, with approximately 16.4 PV being re-injected.

As part of its annual surety update, CBR provides estimates for the quantity of groundwater to be treated and groundwater restoration costs. CBR currently estimates (CBR, 1997a) that groundwater restoration for the commercial MUs will involve the circulation of a total of only 6 PV. This value differs considerably from the 19 PV used in the R&D restoration, in part because CBR was exploring different treatment techniques during the R&D program and because it has gained additional restoration experience with two of its commercial MUs.

MU-1 was placed into restoration on March 14, 1994. To date, the restoration program has involved (1) groundwater sweep to control mining solutions, (2) groundwater transfer (0.78 PV [51.1 million L (13.5 million gal.)]) from MU-4 into MU-1), (3) groundwater treatment with IX and RO (2.28 PV [148 million L (39.1 million gal.)]); and (4) the addition of sodium sulfate (Na_2S) to the RO permeate as a reductant. As of May 31, 1997, 20 of 39 well patterns in MU-1 have been returned to baseline conductivity. Treatment is anticipated to continue until April 30, 1998, at which point the restoration progress relative to other target parameters will be evaluated (CBR, 1997f).

MU-2 was placed in restoration on January 2, 1996. Restoration to date in MU-2 has involved treatment with IX to lower uranium concentrations. Treatment with RO will begin once restoration of MU-1 has been completed and is expected to take approximately two years (CBR, 1997f).

4.2 Reclamation and Decommissioning

4.2.1 Surface Reclamation

A certain level of reclamation activities will take place at the Crow Butte Uranium Project while new MUs are being developed. Reclamation activities in individual MUs will consist of returning disturbed lands to their pre-mining use.

All injection, production, and monitor wells will be plugged and abandoned prior to final closure of the site and after the groundwater restoration has been successfully completed. CBR uses an approved abandonment mud in well plugging. This mud is mixed in a cement unit and then pumped down a hose, which has been lowered to the bottom of the well casing using a reel.

When the hose is removed, the casing is topped off and a cement plug is placed on top. Then, a hole is dug around the well and, at a minimum, the top meter (3 ft) of casing is removed. Finally, the hole is backfilled and the surface is re-vegetated.

In decommissioning wellfields, CBR first removes surface equipment, such as injection and production feed lines, electrical conduits, well boxes, and wellhead equipment. Some wellhead equipment, such as valves, meters, or control fixtures, is salvaged. All buried wellfield piping is removed. Piping that is not reusable is considered contaminated and is disposed at a licensed byproduct waste material disposal site.

The plant site and solar evaporation pond areas will experience more disturbance than the wellfield areas. The plant and pond areas will be reclaimed in a fashion similar to the wellfield areas after groundwater restoration has been successfully completed. Treatment and disposal of pond water will depend on its chemical and radiological characteristics at the time of decommissioning. Pond sludges and sediments will be removed from the evaporation ponds and loaded into dump trucks or drums for disposal at the licensed byproduct disposal site. The pond liners will then be cleaned to the degree possible. If, after cleaning, they are below the surface contamination limits, the liners will be released to an unrestricted area. If contamination limits are exceeded, pond liners will be cut into strips and transported to the byproduct disposal site. Materials in the leak detection system will be excavated and surveyed for contamination. If the leak detection system is not contaminated, it will be released for unrestricted use; otherwise, it will be disposed at the byproduct disposal site.

Table 4-1. Baseline water quality and restoration quality for the Crow Butte R&D site (NRC, 1989a). All units in mg/L unless otherwise noted.				
Parameter	**Baseline Minimum**	**Baseline Maximum**	**Baseline Mean**	**Stabilization Mean**
As	<0.001	0.003	0.001	0.001
B	0.87	0.95	0.93	0.84
Ba	<0.1	<0.1	0.1	0.1
Ca	10.4	16.4	14.1	10.5
Cd	<0.001	<0.001	0.001	0.001
Cl	176	301	202.6	169
Cr	<0.005	<0.005	0.005	0.005
Cu	<0.01	<0.01	0.01	0.01
F	0.62	0.74	0.68	0.55
Fe	<0.03	0.05	0.03	0.03
Hg	<0.0002	<0.0002	0.0002	0.0002
K	10.2	15.4	12.0	8.7
Mg	2.45	4.2	3.351	2.41
Mn	<0.005	0.013	0.0065	0.023
Mo	0.02	0.02	0.02	0.04
Na	387	470	404	333
NH_4 as N	0.17	0.40	0.29	0.62
Ni	<0.01	<0.01	0.01	0.01
NO_2 as N	<0.001	<0.001	0.001	0.014
NO_3 as N	<0.01	0.21	0.05	0.03
Pb	<0.005	<0.005	0.005	0.006
pH (standard units)	8.30	8.64	8.39	7.91
Ra-226 (pCi/L)	32.8	1451.0	858.7	236.7
Se	<0.001	<0.001	0.001	0.001
SO_4	316	356	343	275
TDS	1106	1270	1153	972
Total Carbonate	347.6	374.9	362.8	306.1
U	0.053	0.245	0.111	1.316
V	<0.01	<0.01	0.01	0.03
Zn	<0.01	0.02	0.01	0.02

6.1.2.5 ORGANICS

Organic materials are generally not present in the Crow Butte ore body at levels greater than 0.1 to .02%. Where present their effect is to increase the oxidant consumption and make uranium leaching a bit more difficult. On longer flow paths, organic material could potentially reprecipitate uranium, should all of the oxidant be consumed and conditions become reducing. Another potential impact of organics could be the coloring and fouling of leach solutions should the organics be mobilized. As the plant is operated in the pH range of 6.5 to 9.0, mobilization of the organics and coloring of the leach solution is avoided.

6.1.3 RESTORATION GOALS

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to baseline values on a mine unit average. A secondary goal is to return the groundwater to a quality consistent with premining use or uses. The restoration values set by the Nebraska Department of Environmental Quality (NDEQ) are consistent with this secondary goal. Restoration values, secondary goal, for each mine unit have been specified by the NDEQ for groundwater restoration efforts. Prior to mining in each mine unit, baseline groundwater quality data is submitted. This data is established in each mine unit at the following minimal density:

- One production or injection well per four acres;
- One upper aquifer monitor well per five acres; and
- All perimeter monitor wells.

The baseline data support establishment of the upper control limits and restoration standards for each mine unit. The restoration values, secondary goal, are established as the average plus two standard deviations for any parameter that exceeds the applicable drinking water standard. If a drinking water standard exists for a parameter, and baseline is below that standard, the drinking water standard is used to establish the restoration value. If there is no drinking water standard for an element, for example vanadium, the restoration value will be based on best practicable technology. The restoration value for the major cations (Ca, Mg, K) should allow for the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criteria should allow for the total carbonate to be less than 50% of the TDS. The TDS restoration value is set at the average plus one standard deviation.

Restoration values, secondary goal, for Mine Units 1 through 5 are given in Table 6.1-1. NDEQ Permit Number NE0122611 requires that Mine Unit be returned to a wellfield average of these restoration values. These concentrations were approved by the NDEQ with the Notice of Intent to Operate submittals. Post mining water quality for Mine Unit 1 can be found in Table 6.1-2.

Crow Butte Resources operated a R&D Pilot Facility starting in July 1986 and initiated restoration activities of its Wellfield No. 2 in February 1987. Wellfield No. 1 was incorporated into Mine Unit 1, thus no restoration took place in that area. The techniques used during that program are the basis for the commercial restoration program outlined in this section. Crow Butte Resources will utilize ion exchange columns, a reverse osmosis unit and reductant addition equipment similar to those used in the R&D restoration during commercial restoration operations.

The commercial groundwater restoration program consists of two stages, the restoration stage and the stabilization stage. The restoration stage consist of four activities:

- Groundwater transfer;
- Groundwater sweep;
- Groundwater treatment; and
- Wellfield recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

The stabilization stage consists of monitoring the restoration wells for six months following successful completion of the restoration stage. Stabilization will begin once restoration activities have returned the average concentration of restoration parameters to acceptable levels. Following the stabilization phase, Crow Butte Resources will make a request to the appropriate regulatory agencies that the wellfield is restored.

6.1.4 RESTORATION STAGE

Restoration activities include four steps that are designed to optimize restoration equipment used in treating groundwater and to minimize the number of pore volumes circulated during the restoration stage. Crow Butte Resources will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional techniques are necessary.

Table 6.1-1: Baseline and Restoration Values By Mine Unit

Parameter	Groundwater Standard	MU-1 Baseline	MU-1 Restoration Value	MU-2 Baseline	MU-2 Restoration Value	MU-3 Baseline	MU-3 Restoration Value	MU-4 Baseline	MU-4 Restoration Value	MU-5 Baseline	MU-5 Restoration Value
Ammonium (mg/l)	10.0	≤ 0.372	10.0	≤ 0.37	10.0	≤ 0.329	10.0	0.288	10.0	0.28	10.0
Arsenic (mg/l)	0.05	≤ 0.00214	0.05	≤ 0.001	0.05	≤ 0.001	0.05	≤ 0.00209	0.05	≤ 0.001	0.05
Barium (mg/l)	1.0	≤ 0.996	1.0	≤0.01	1.0	≤ 0.1	1.0	< 0.1	1.0	≤ 0.10	1.0
Cadmium (mg/l)	0.01	≤ 0.00644	0.01	≤0.01	0.01	≤ 0.01	0.01	< 0.01	0.01	≤ 0.01	0.01
Chloride (mg/l)	250.0	203.9	250.0	208.6	250.0	197.6	250.0	217.5	250.0	191.9	250.0
Copper (mg/l)	1.0	≤ 0.0249	1.0	≤0.013	1.0	≤ 0.0108	1.0	≤ 0.0114	1.0	≤ 0.01	1.0
Fluoride (mg/l)	4.0	0.686	4.0	0.67	4.0	0.719	4.0	0.745	4.0	0.64	4.0
Iron (mg/l)	0.3	≤ 0.0441	0.3	≤ 0.05	0.3	< 0.05	0.3	≤ 0.0504	0.3	≤ 0.05	0.3
Mercury (mg/l)	0.002	≤ 0.00067	0.002	≤ 0.001	0.002	< 0.001	0.002	< 0.001	0.002	< 0.001	0.002
Manganese (mg/l)	0.05	≤ 0.00122	0.05	≤0.01	0.05	≤ 0.01	0.05	≤ 0.01	0.05	≤ 0.01	0.05
Molybdenum (mg/l)	1.0	≤ 0.0689	1.0	≤ 0.073	1.0	< 0.1	1.0	< 0.1	1.0	≤ 0.10	1.0
Nickel (mg/l)	0.15	≤ 0.0340	0.15	≤0.05	0.15	< 0.05	0.15	< 0.05	0.15	≤ 0.05	0.15
Nitrate (mg/l)	10.0	≤ 0.050	10.0	≤0.039	10.0	≤0.0728	10.0	≤ 0.114	10.0	≤ 0.10	10.0
Lead (mg/l)	0.05	≤ 0.0315	0.05	≤ 0.05	0.05	< 0.05	0.05	< 0.05	0.05	< 0.05	0.05
Radium (pCi/L)	5.0	229.7	584.0	234.5	1058.0	165.0	611.0	154.0	496.0	166.0	535.00
Selenium (mg/l)	0.01	≤ 0.00323	0.01	≤0.001	0.01	≤ 0.00115	0.01	≤ 0.00244	0.01	≤ 0.002	0.01
Sodium (mg/l)	N/A	412		411		428		416.6	416.6	397.6	397.6
Sulfate (mg/l)	250.0	356.2	375.0	348.2	369.0	377.0	404.0	337.0	375.0	364.5	385.0
Uranium (mg/l)	5.0	0.0922	5.0	0.046	5.0	0.115	5.0	0.118	5.0	0.072	5.0

Table 6.1-1: Baseline and Restoration Values By Mine Unit

Parameter	Groundwater Standard	MU-1 Baseline	MU-1 Restoration Value	MU-2 Baseline	MU-2 Restoration Value	MU-3 Baseline	MU-3 Restoration Value	MU-4 Baseline	MU-4 Restoration Value	MU-5 Baseline	MU-5 Restoration Value
Vanadium (mg/l)	0.2	≤ 0.0663	0.2	≤ 0.1	0.2	< 0.1	0.2	≤ 0.0984	0.2	≤ 0.10	0.2
Zinc (mg/l)	5.0	≤ 0.0384	5.0	≤ 0.025	5.0	≤ 0.0131	5.0	≤ 0.0143	5.00	≤ 0.02	5.0
pH (Std. Units)	6.5-8.5	8.46	6.5-8.5	8.32	6.5-8.5	8.37	6.5-8.5	8.68	9.28	8.5	6.5-8.5
Calcium (mg/l)	N/A	12.5	125.0	13.4	134.0	13.3	133.0	11.2	112.0	12.6	126.0
Total Carbonate (mg/l)	N/A	351.2	585.0	362.0	585.0	377.0	592.0	374.0	610.0	373.0	590.0
Potassium (mg/l)	N/A	12.5	125.0	12.6	126.0	13.9	139.0	16.7	167.0	11.5	115.0
Magnesium (mg/l)	N/A	3.2	32.0	3.5	35.0	3.5	35.0	2.8	28.0	3.4	34.0
TDS (mg/l)	N/A	1170.2	1170.0	1170.4	1170.4	1183.0	1183.0	1221.0	1221.0	1179.0	1202.0