

GROUND WATER QUALITY DISCHARGE PERMIT UGW350011

STATEMENT OF BASIS

Kennecott Utah Copper LLC (Kennecott)
Tailings Impoundment
Magna, Utah

March 2016

Purpose

This Statement of Basis describes the facility, hydrogeology, ground water quality, and basis of permit issuance for Ground Water Discharge Permit UGW350011 for the Kennecott Utah Copper LLC (Kennecott) Tailings Impoundment. UGW350011 was initially issued to Kennecott Utah Copper in 1996. Subsequent renewals of the permit were issued in 2001, 2006, and 2011. This is the fourth renewal of the UGW350011. No new construction or enlargement of the facility footprint is authorized in this renewed permit.

The 2016 renewal incorporates the following changes from the previous permit:

- 1) The Diving Board Area, located south of State Road 201, has been removed from the Permitted Facilities list.
- 2) Table 1 Protection Levels for Total Dissolved Solids and Sulfate have been adjusted for several compliance monitoring wells based on historical trends observed during the previous 5-year permit term.

Description of Facility

The current Tailings Impoundment complex is located in portions of Sections 1, 2, 3, 10, 11, 12, 13, 14, 15, 23 and 24 of Township 1 South, Range 3 West; Sections 4, 5, 6, 7, 8, 9, 17, 18, 19, and 20 of Township 1 South, Range 2 West; Sections 31, 32 and 33 of Township 1 North, Range 2 West; and Sections 35 and 36 of Township 1 North, Range 3 West.

The Tailings Impoundment has operated since 1906 for the storage of tailings from concentrators processing ore from the Bingham Canyon mine. The Tailings Impoundment has undergone numerous changes and expansions to accommodate the volume of materials. The original 1,350-acre impoundment was located in the western portion of the Magna impoundment area. Around 1914, the original impoundment was enlarged to the east by approximately 1,466 acres. By the early 1990's, the footprint of the South Impoundment had reached approximately 5,700 acres with a height of over 220 feet, storing 1.5 billion tons of tailings. The South Impoundment currently does not receive tailings materials but could receive tailing in an upset or management-designated situation.

In 1995, Kennecott added approximately 3,300 acres adjacent to and north of the existing impoundment to enable continuity of Bingham Canyon Mine operations. This expansion also allowed for a seismic upgrade of the impoundment. Beginning in 1999, tailings deposition began transitioning from the South Impoundment to the North Impoundment. The current discharge into the North Impoundment could approach approximately 200,000 tons per day of tailings from the Copperton Concentrator.

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South Impoundment - Draindown water from the South Impoundment is collected in the clarification canal, the West C7 and from drainage north into the North Impoundment. When necessary, the water in the clarification canal can be discharged through UPDES permitted discharge points. Some seepage from the South Impoundment enters the Shallow Aquifer system. The seepage rate may gradually decrease over time due to the establishment of a vegetative evapotranspiration cover. The South Impoundment is underlain by the Bonneville Clay, a thick, laterally extensive, low-permeability lacustrine deposit.

A sedimentation pond is located east of the northeast corner of the South Impoundment. The Sedimentation Pond is also underlain by the low permeability Bonneville Clay.

“Diving Board” Area - The “Diving Board” area is located immediately south of State Road 201 and west of 9180 West. It is currently designated as the emergency capture area for tailings, the Magna Reservoir solutions, or other vicinity process waters. Dissolved arsenic levels in the shallow groundwater have exceeded the Utah Ground Water Quality Standard, likely due to historical operations in this area. The upward hydraulic gradient has protected the intermediate aquifer from arsenic degradation.

North Impoundment - The North Impoundment is underlain by the Bonneville Clay, a thick laterally extensive low-permeability lacustrine deposit. This contiguous stratum represents the top layer of a several hundred foot thick sequence of fine-grained lacustrine sediments.

Tailings can be deposited into the North Impoundment in slurry form, from a discharge system that deposits tailings into the interior as well as through a peripheral system fed by two cyclones. Cyclones direct overflow (fine-grained material) to the interior and the underflow (coarse material) to the embankment. An underdrain consisting of a blanket drain and finger drains composed of crushed slag were constructed in the base of the embankment to promote horizontal seepage of tailings water under the embankment and into the perimeter toe drain collection ditch. Water is also removed from a decant pond and recycled back to the Copperton Concentrator. When necessary, the water can be discharged through a UPDES permitted discharge point. Some seepage from the North Impoundment enters the Shallow Aquifer system.

Bevill-Excluded Wastes - Congress granted an exclusion from the requirements of the hazardous waste program for certain mining wastes. This exclusion, known as the Bevill Amendment, identifies solid wastes from the extraction, beneficiation, and processing of ores and minerals and excludes them from the requirements of the EPA Hazardous Waste Program. The basis of this exclusion was that these wastes are characterized by high volume, low hazard, and that management as hazardous waste may be inappropriate. On June 23, 1990, EPA issued a final rule that listed 20 mineral processing wastes that are excluded. Several inflows to the Tailings Impoundment are included under this Bevill exclusion and therefore are not subject to the requirements of the Hazardous Waste Program.

Waste Stream Inflows - Waste stream inflows authorized under this permit for placement in the Tailings Impoundment are:

1. Copper tailings from the Copperton Concentrator;
2. Slag tailings from the slag concentrator at the Smelter;
3. Power plant ash slurry;
4. Smelter process waters;
5. Wastewater effluent slurry from the Hydrometallurgical Plant at the Smelter;
6. Mine leach water and meteoric contact water that have been treated in the tailings

- pipeline;
7. Wastewater effluent from the Reverse Osmosis treatment of sulfate-contaminated waters;
 8. Neutralization of acid-mine contaminated waters;
 9. Barneys Canyon mine pit dewatering and heap leach pad and other draindown waters;
 10. Construction, maintenance and non-hazardous waste (Salt Lake Valley Health Department Permit: 35-0011805 covering footprint of Tailings Impoundment);
 11. Treated effluent from the sewage treatment plant; and
 12. Other inflows that are approved by the Director for this permit or UPDES permit UT0000051.

The first three waste streams listed above are included under the regulatory exclusion from RCRA as Bevill waste. The majority of materials placed in the Tailings Impoundment are copper tailings. Following settlement of a Natural Resources Damage Claim, the State of Utah has approved a plan to clean up contaminated ground water in the Southwest Jordan Valley area of Salt Lake County. Over the next 40 years, extraction and treatment of ground water from contaminated zones will remove contaminants and provide municipal-quality drinking water to the public. By removing contaminated water from the underlying aquifer, the project will also improve ground water quality and prevent further migration of the contamination in the valley. In the absence of a better disposal option for contaminants removed from the treated water, the treatment concentrates will be introduced into the tailings pipeline for disposal in the Tailings Impoundment.

These sources enter the Tailings Impoundment at the following discharge points:

- 1) West Cyclone Station
- 2) East Cyclone station
- 3) North Impoundment Single Points Discharge
- 4) North Impoundment Peripheral Discharge

Site Hydrogeology

Three aquifer systems exist in the vicinity of the Tailings Impoundment: the Bedrock Aquifer system associated with the Oquirrh Mountains, the confined Principal Aquifer, and the unconfined Shallow Aquifer. The bedrock aquifer is comprised of highly fractured Paleozoic carbonate rocks. Recharge to this system is principally from precipitation from the Oquirrh Mountains to the south. The flowpath through this aquifer travels from the fractured bedrock into the Principal and Shallow Aquifers or is discharged as spring water along bedrock contacts at the base of the mountains. Water quality of the bedrock aquifer is generally Class II ground water (TDS less than 3,000 mg/l).

The Principal Aquifer is a confined system which includes a gravel zone and lacustrine deposits. The gravel zone was most likely derived from the local mountains during an extensive low lake cycle. Many high-yield water supply wells near the Oquirrh Mountains are completed in the gravel zone of the Principal Aquifer. The lacustrine zone consists of clay, silt and interbedded fine sand. Ground water flow direction for the Principal Aquifer is north toward the Great Salt Lake. Measured water levels in the Principal Aquifer wells located around the perimeter of the tailings impoundment are above the water levels in adjacent nested Shallow Aquifer wells, indicating an upward hydraulic gradient throughout the vicinity of both impoundments. The majority of Principal Aquifer wells located along the perimeter of the North and South Impoundments are under flowing artesian conditions. Ground water quality in the Principal Aquifer is generally better than the Shallow Aquifer, with TDS values ranging from

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approximately 700 to 30,000 mg/l (from 2006 through 2014). The higher TDS values correlate with proximity to the Great Salt Lake. Background Concentrations of arsenic in excess of Utah Ground Water Quality Standards have been observed in the Principal Aquifer in the Tailing Impoundment area.

The Shallow Aquifer system consists of interbedded lacustrine Bonneville Clay, silt, and fine sand. The exact depth of this system varies but is approximately the upper 35 to 50 feet of saturated sediments. The potentiometric surface for the Shallow Aquifer system depicts lateral flow in a northerly direction toward the Great Salt Lake. An upward hydraulic gradient from the underlying Principal Aquifer exists for the majority of well nests completed in both the Shallow and Principal Aquifers. Localized confining conditions exist in the Shallow Aquifer within the Tailings Impoundment area. The majority of the Shallow Aquifer wells located along the northern perimeter of the North Impoundment are under flowing artesian conditions. The hydraulic head in the Tailings Impoundment is higher than the hydraulic head in the Shallow Aquifer, resulting in downward vertical gradients with a potential for discharge of tailings water into the shallow aquifer system. Ground water quality in the shallow lacustrine unit is Class III Limited Use and Class IV Saline Ground Water, with TDS values up to approximately 70,000 mg/l in the vicinity of the Great Salt Lake (from 2006 through 2014). Background Concentrations of arsenic in excess of Utah Ground Water Quality Standards have been observed in the Principal and Shallow Aquifer in the Tailing Impoundment area.

Background Ground Water Quality

Assessing background ground water quality is a complicated task for the area around the Tailings Impoundment because several complicating factors impede measurement or estimation of true background. There are two previously existing facilities that may have impacted ground water quality. The abandoned Morton Salt operation and the Chevron Phosphate operation are within the footprint of the North Impoundment. These operations have likely complicated the ability to observe any impacts from tailings. In addition, given the nearly century-long history of operations, impacts from the Tailings Impoundment have probably already occurred.

In light of the aforementioned complicating factors, Ground Water Protection Levels for this permit are established using existing ground water quality on a well-by-well basis. This approach ensures that the existing ground water quality will be protected by not allowing significant degradation from existing concentrations. Several compliance monitoring wells are relatively close to the bedrock contact and indicate Class II ground water quality. These wells are assigned protection levels consistent with Class II ground water. Ground water in the majority of the compliance monitoring wells is classified Class III ground water and are assigned protection levels consistent with this classification. Additionally, the method given in R317-6-4.6(A)(3) allows for a no net increase standard for Class III waters when the background concentration already exceeds the ground water quality standard. Compliance wells completed in Class IV ground water are assigned protection levels equal to the greater of the Utah Ground Water Quality Standards or the background value plus two standard deviations, with the exception that TDS limits are not imposed for Class IV Saline ground water. Due to influences of the Great Salt Lake, TDS values in the Class IV wells range from 9,000 to over 70,000 mg/l (2006 through 2014). The basis for assigning protection levels (except TDS) to Class IV waters that are in close proximity to the Great Salt Lake is to protect wetland systems that exist in proximity to the lake and serve as habitat for shore birds and other aquatic species.

In most of the Class III wells, the background value for arsenic exceeds the Ground Water Quality Standard of 0.05 mg/l. Sample results from these wells routinely exceed the background

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value due to normal variation around the mean; probable out of compliance is defined by concentrations which exceed the ground water protection levels listed in Permit UGW350011 Table 1.

Kennecott conducts Toxic Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) analyses of tailings material to describe the toxicity of the tailings even though this material is not subject to RCRA requirements. Both TCLP and SPLP analysis have not revealed any toxicity concerns. The interstitial waters in the tailings have been characterized and do not appear problematic to water quality of aquifers underlying the impoundment. To assure that the waste streams deposited into the Tailings Impoundment do not contain materials that differ markedly from those waste streams that have been characterized, the permit clarifies at Part I.D (Permitted Inflow Waste Streams). There is a provision that allows Kennecott to request a variance from this standard for incidental situations that would not impact overall water quality of aquifers underlying the impoundment.

Compliance Monitoring Program

As a basis for issuance, modification, and renewal of the ground water discharge permit as required under UAC R317-6-6.4(C), and to assure adequate groundwater quality protection, the facility has been designed to employ discharge minimization and control technology with groundwater monitoring to prevent any impairment of present and future beneficial uses of the groundwater. Ground water monitoring is the primary compliance monitoring method for the Tailings Impoundment. General monitoring of the Kennecott well network is performed to develop a data base and identify ground water quality trends. Compliance monitoring is performed at selected wells located outside the impoundment footprint. Most sites are situated to characterize the influence of the tailings disposal on groundwater. Compliance monitoring wells are listed in Table 1 of the Permit.

A semiannual compliance monitoring program is required by the permit. Protection Levels have been established following the specific rule of R317-6-4. The following parameters were selected for compliance monitoring based on their high concentrations in the process water compared to concentrations in shallow ground water:

- Alkalinity
- Calcium
- Chloride
- Dissolved Metals
- Magnesium
- Potassium
- Sodium
- Sulfate
- TDS

The compliance monitoring well network is currently comprised of multiple well locations. Most locations contain nested or paired wells: one screen interval in the upper shallow aquifer and one screen interval completed in the lower confined aquifer. The perimeter of the South and North Impoundment is approximately 14 miles long. The multiple locations comprise a well frequency of about one well location per mile of embankment.

Kennecott utilizes a discharge minimization approach with ground water monitoring to assess if any impacts occur. Discharge minimization is achieved by utilizing a natural clay liner beneath

the impoundment to impede downward flow of tailings waters. The clay liner consists of the upper portion of the Bonneville Clay, which has been mapped at an average thickness of 8 feet and is continuous throughout the approximate 10,000 acre area of the South Impoundment and North Impoundment. Measured vertical hydraulic conductivities for this segment of the Bonneville Clay range from 3×10^{-7} cm/sec to 4×10^{-8} cm/sec, which meets the liner requirements of R317-6-6.4.A3 and C3. Best Available Technology is defined in R317-6-1.3 as "... the application of design, equipment, work practice, operation standard or combination thereof at a facility to effect the maximum reduction of a pollutant achievable by available processes and methods taking into account energy, public health, environmental and economic impacts and other costs."

Potential Impacts to Water Quality

With the height of Tailings Impoundment reaching over 200 feet, it is likely that downward hydraulic gradients will develop and allow some movement of tailings waters through the Bonneville Clay and into the underlying aquifer systems. The average concentrations of common constituents in the key waters associated with the tailings when compared to the concentrations in the shallow and principal aquifers are summarized in Table S-1 of this Statement of Basis.

While the concentrations in Table S-1 are average values and some individual values may vary significantly, it is anticipated that the overall water quality of the Shallow and Principal Aquifers will not be degraded by water from the impoundment. Water from the impoundment will continue to be sampled semi-annually throughout the term of this permit to provide a check on the quality of the water.

One of the most important technical issues associated with the Tailings Impoundment is the long term potential for acidification of the tailings materials. The chemical reactions associated with oxidation of sulfides results in production of acid, which if not neutralized could, over time, acidify the tailings materials. Should this happen, leaching of metals and other constituents that are not mobile in neutral pH conditions may occur.

Kennecott conducts static and kinetic testing of tailings materials to predict the potential for the tailings to acidify over time. Results to date indicate a low potential for the fine fraction tailings (overflow) to become acidic. The coarse fraction (underflow) can acidify under conditions mentioned above. To assure that signs of acidification are not occurring through the life of the impoundment, Kennecott is required to monitor the interstitial water within the tailings and to perform analysis of the copper tails inflow to the impoundment on a semi-annual basis. Surface sites on the impoundment exterior are also sampled and analyzed for acidification potential.

The North Impoundment covers a phosphogypsum tailings pile (gypstack) in the northwestern corner of the expanded impoundment. This tailings pile was part of a phosphate fertilizer production facility that was not affiliated with Kennecott. Downward hydraulic gradients could move gypstack pore fluids into the Shallow Aquifer and toward the toe drain. Hydraulic conductivity modeling has estimated a very slow rate of travel in the mine tailings and aquifer. Two monitoring well pairs were installed to detect effects, if any, from burial of the phosphogypsum tailings. These wells have many years of background monitoring to establish background levels of radionuclides. Monitoring frequency has been changed to once every five years, until such time that detections of radionuclides and uranium may exceed Utah Ground Water Quality Standards.

Basis for Permit Issuance

As a basis for issuance, modification, and renewal of the ground water discharge permit as required under UAC R317-6-6.4, and to assure adequate ground water quality protection, the facility has been designed to employ discharge minimization and control technology with ground water monitoring to prevent any impairment of present and future beneficial uses of the ground water. For this renewal, the authorized waste stream inflow materials has not changed.

Ground water monitoring is the primary compliance monitoring method for the Tailings Impoundment. General monitoring of the Kennecott well network is performed to develop a data base and identify ground water quality trends. Compliance monitoring is performed at selected wells located outside the impoundment footprint. Most sites are situated to characterize the influence of the tailings disposal on ground water. Compliance monitoring wells are listed in Table 1 of the Permit. The compliance monitoring parameters are listed in Permit Part I, Section E.

Basis for Specific Permit Conditions

1. Corrective Action - The Utah Administrative Rules for Ground Water Quality Protection (UAC R317-6) require applicants to submit a Corrective Action Plan or other response measures to remedy any violation of ground water quality standards resulting from discharges. The permit has a compliance condition that allows the Director to call for a Contamination Investigation and Corrective Action Plan to be submitted and made a part of this permit should future data indicate that clean-up of contamination at the Tailings Impoundment site is needed.
2. Assessment of Acidification Potential - Ongoing analysis and testing is being required to assess the potential for the tailings material to acidify using Net Acid Generation (NAG) testing. Kennecott is required to provide an annual report that compiles the results of each years sampling and analysis.
3. Operational Monitoring Plan - A water quality summary and analysis is required to assess long term changes to water quality over the life of this structure. The water quality of interstitial waters within the tailings, waters that are decanted from the top of the impoundment and other outflows such as seeps, and characterization of inflows will provide information that will assist in predicting potential impacts from the impoundment as well as track changes over time. This condition requires Kennecott to provide an annual report that compiles the results of each years sampling and analysis.
4. Permit Renewal Application Items - This condition requires three items to be included in the application for permit renewal to be submitted 180 days prior to permit expiration in the year 2021. Maps of the potentiometric surface for both the shallow and principal aquifer systems will be required in order to observe temporal changes to these aquifer systems near the impoundment, and monitoring results for radionuclides and uranium in wells NET1386A&B and NET1393A&B.
5. Closure Plan - Final closure of the South Impoundment is complete. Any proposed changes to the current closure plan based on ongoing characterization of tailings mineralogy, impoundment surface oxidation, internal pore water chemistry, or other data, shall be submitted to the Director for review and approval.

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Permit Reference Documents

- 1) Assessment of Acidification Potential v.2015
- 2) Compliance and Operational Monitoring Plan v.2016
- 3) Pipeline Inspection Plan v.2016

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Table S-1

Water Quality Summary of Aquifers and Potential Sources

Constituent	Mean Concentrations in Shallow Aquifer¹	Mean Concentrations in Principal Aquifer²	Mean Concentrations in Tailings Pore Waters³	Mean Concentrations in Clarification Canal⁴
pH	7.5	7.6	6.90	7.32
TDS	22,373	6,573	5,653	8,270
Sulfate	1,900	360	1,631	3,036
Arsenic	0.043	0.071	0.110	0.027
Barium	0.137	0.127	0.015	0.102
Cadmium	0.002	0.001	0.004	0.006
Chromium	0.004	0.004	<0.01	<0.01
Copper	0.118	0.032	0.789	0.030
Lead	0.001	0.001	0.005	0.007
Selenium	0.005	0.006	0.026 ⁵	0.015 ⁶
Silver	0.002	0.001	<0.005	<0.005
Zinc	0.022	0.022	0.246	0.039

All concentrations in mg/l

^{1, 2} Arithmetic mean concentrations are based on available analyses from permit origination 1995. The mean incorporates non-detections, assuming that the reporting limit is the concentration.

³ Tailings pore water is represented by 5 Kennecott South Tailings operational, wells (NET2596, TLT887, TLT2452, TLT2575A, TLT2575B) inception through 2015.

⁴ The clarification canal is represented by Kennecott sample location CLC452 average 2006-2015.

⁵ Selenium (Dissolved); As Selenium DRC-D (mg/L) = 0.002

⁶ Selenium (Dissolved); As Selenium DRC-D (mg/L) = 0.022