

GROUND WATER QUALITY DISCHARGE PERMIT UGW270012

STATEMENT OF BASIS

Crystal Peak Minerals Inc.
Sevier Playa Potash Project
Millard County, UT

September 2019

Introduction

The Division of Water Quality (DWQ) under the authority of the Utah Ground Water Quality Protection Rules ¹(Ground Water Rules) issues ground water discharge permits to facilities which have a potential to discharge contaminants to ground water². As defined by the Ground Water Rules, such facilities include mining operations. ³The Ground Water Rules are based on an anti-degradation strategy for ground water protection as opposed to non-degradation; therefore, discharge of contaminants to ground water may be allowed provided that current and future beneficial uses of the ground water are not impaired and the other requirements of Rule 317-6-6.4.A are met.⁴ Following this strategy, ground water is divided into classes based on its quality⁵; and higher-quality ground water is given greater protection⁶ due to the greater potential for beneficial uses.

DWQ has developed permit conditions consistent with R317-6 and appropriate to the nature of the mined materials, facility operations, maintenance, best available technology⁷ (BAT) and the hydrogeologic and climatic conditions of the site, to ensure that the operation would not contaminate ground water.

Basis for Permit Issuance

Under Rule 317-6-6.4A, DWQ may issue a ground water discharge permit if:

- 1) The applicant demonstrates that the applicable class TDS limits, ground water quality standards protection levels and permit limits established under R317-6-6.4E will be met;
- 2) The monitoring plan, sampling and reporting requirements are adequate to determine compliance with applicable requirements;
- 3) The applicant is using best available technology to minimize the discharge of any pollutant; and

¹ Utah Admin. Code Rule 317-6

² https://deq.utah.gov/ProgramsServices/programs/water/groundwater/docs/2008/08Aug/GWQP_PermitInfo.pdf

³ Utah Admin Code Rule 317-6-6.1A

⁴ Preamble to the Ground Water Quality Protection Regulations of the State of Utah, sec. 2.1, August, 1989

⁵ Utah Admin. Code Rule 317-6-3

⁶ Utah Admin. Code Rule 317-6-4

⁷ Utah Admin. Code Rule 317-6-1(1.3)

- 4) There is no impairment of present and future beneficial uses of ground water.

Purpose

Crystal Peak Minerals Inc. (CPM) is proposing to construct potash (potassium sulfate) mining operations and facilities on the Sevier Playa located in Millard County, Utah approximately 30 miles southwest of Delta (Figure 1). The potash mining area will be the entire Sevier Playa surface (approximately 26 miles long and up to 8 miles wide), with production ponds and facilities located at the south end of the playa. The Project will be designed to produce approximately 328,500 tons of sulfate of potash, as well as other associated minerals, per year. The operations will be located on Bureau of Land Management (BLM), Utah School and Institutional Trust Lands Administration (SITLA), and private land.

In general, the mine design consists of three major components: 1) a brine extraction system consisting of canals, trenches, and wells; 2) a recharge system consisting of canals and trenches; and 3) a series of solar evaporation ponds. The production facilities will include a crystallization (processing) plant, potable water treatment facility, preconcentration ponds, production ponds, purge brine storage pond, and a tailings (waste) storage facility (Figure 2).

Ground Water Discharge Permit UGW270012 is issued to authorize the ground water discharge, or probable discharge, related to the potash mining operations. Construction Permits will be required in the future to authorize the construction of individual facilities, such as the Preconcentration Ponds, Production Ponds, Purge Brine Storage Pond, and the Tailings Storage Area. CPM will be the operator of the potash mining facility.

New Facilities

The following new facilities will be regulated under this Permit including the associated Best Available Technology (BAT) and Protection Levels:

- Preconcentration Ponds
- Production Ponds
- Purge Brine Storage Pond
- Tailings Storage Facilities
- Processing Facilities.

The project footprint area is approximately 124,400 acres. The Preconcentration Ponds will occupy 17,563 acres, the Production Ponds will be 2,539 acres. The Purge Brine Storage Pond will be 746 acres. The Tailing Storage Facility will occupy 543 acres. The playa surface will be mined and reclaimed in successive stages. At no point in time will the entire playa surface be actively mined. The process facilities will be located within one mile of the edge of the playa at south end of the playa. The anticipated lifespan of the mining operation is 30 years.

BAT Performance Monitoring

Best available technology monitoring will include minimum vertical freeboard and maximum Liner Hydraulic Conductivity. These performance standards are based on the precedence of previous ground water discharge permits.

Minimum Vertical Freeboard. A minimum of 24 inches of vertical freeboard in containment ponds shall be maintained to ensure containment of mining liquids.

Maximum Liner Hydraulic Conductivity. The Purge Brine Storage and the Tailings Storage Pond will be lined with a minimum of a 24 inches of native clay with a maximum hydraulic conductivity of 1×10^{-7} centimeters per second (cm/sec).

Potential Impacts to Ground Water

Potential impacts to ground water will be minimized by employing best available technology for storage ponds and in the inherent operations of the facility. The majority of the surface area of the brine mining operations will collect (extract) groundwater through trenches, canals, and wells and transport the water to evaporation ponds. Any groundwater leakage from these ponds will generally be re-collected by the extraction system and sent back to the evaporation ponds. Groundwater in the project area will also be intrinsically protected by the geological and hydrogeologic characteristics of the project area, as discussed in the *Geologic Description* section below.

Storage ponds, such as the Purge Brine Storage Pond and the Tailings Storage Area, located where the extraction system is less likely to intercept any groundwater leakage will have groundwater monitoring wells installed around their perimeters. Quarterly ground water monitoring will be implemented to assess and mitigate any discharge from these storage ponds.

A series of groundwater monitoring wells exist throughout the project area (Stantec 2019). The wells range in depth and will be used to assess any impacts to shallow, intermediate, and deeper aquifers from the potash mining operations. Crystal Peak Minerals initiated quarterly baseline sampling of these 17 existing wells in 2018.

Groundwater in the project area will also be inherently protected by the geological and hydrogeologic characteristics of the project area, as discussed in the *Geologic Description* below.

The Division of Water Quality will provide periodic onsite inspections during construction and operation of the facilities described above. Crystal Peak Minerals will ensure that the facility is operated in accordance with design specifications and will also ensure that any early indications of facility problems will be detected early and resolved. In addition to BAT performance monitoring, ground water quality monitoring of various aquifers in the project area will be conducted in monitoring wells to determine if ground water quality has been impacted by the potash mining operations.

Geologic Description

Regional. The Sevier Playa Project is situated within the Basin and Range physiographic province of Utah, and within the Great Basin carbonate and alluvial aquifer system (GBCAAS) as described by Heilweil and Brooks (2011). The GBCAAS is found through western Utah and eastern Nevada covering an area of approximately 110,000 square miles. The regional aquifer system is generally comprised of aquifers and confining units in unconsolidated basin fill and volcanic deposits in the basins, and carbonate and other bedrock in the mountain ranges. Most groundwater flow occurs at local and intermediate scales, but some interbasin flow may occur under certain conditions (Heilweil and Brooks, 2011). The Sevier Playa system is the terminus of the Sevier River and is considered a closed/terminal sedimentary basin.

The Sevier Playa system (Figure 3) is bounded on the east by the Cricket, Beaver Lake, and San Francisco Mountains and primarily comprised of Prospect Mountain Quartzite along the east playa margins (though other formation outcrops are observed). The playa is bounded to the west by the Black Hills and House Range and constrained primarily by the Notch Peak Limestone. Some volcanic flows are draped over these formations at the southern end of the playa. Prospect Mountain Quartzite and Mutual Formation outcrops (quartzite and shale) are also present south of the playa.

Sediments around the margin of the playa are described as alluvium/colluvium. This sediment has accumulated at the playa margin primarily by ephemeral stream deposition and mountain erosion (mass wasting). These coarser gravel and sand sediments also create discontinuous higher permeability beds within the fine-grained playa sediment system where infrequent high energy storms during historical wet periods resulted in sediments being washed out onto the playa surface.

The shallow Sevier Playa sediments are described as very fine-grained clay interbedded with silts and fine sands that grade to coarser grained material at the edge of the playa and at depth. The fine-grained playa sediments (with possible volcanics) are estimated to reach a thickness of 4,000 feet at the east edge of the playa (Case and Cook, 1979) and 560 feet on the west edge of the playa (Wilberg 1991).

Based on drilling logs, CPM describes the typical first 100 feet (in depth) of playa system as follows (Figure 4):

- 0-12 feet: Fat Clay Zone (FCZ), confining layer, no production,
- 12-35 feet: Marl Clay Zone (MCZ), upper production zone
- 35-75 feet: Siliceous Clay Zone (SCZ), lower production zone
- 75-80+ feet: hard dry clay, undefined thickness, no production

Similar playa sediment lithology was recorded by others (Gwynn 2006).

The USDA Natural Resource Conservation Service Web Soil Survey (websoilsurvey.sc.egov.usda.gov) describes the Sevier Playa soil type simply as “Playas” with a general elevation range between 4,300 to 5,800 feet, mean annual precipitation between 5 to 8 inches, mean annual air temperature between 48 to 51 degrees F, frost-free period between 115 to 145 days, and a farmland classification of “not prime.”

Hydrogeology

Groundwater flow systems, such as the basins within the GBCAAS, are described to occur at local, intermediate and regional scales (Toth 1963, Wilber 1991). Local flow is described as recharge and discharge generally constrained by surface (topographic) features, and is generally relatively shallow. Intermediate flow may cross drainage divides and is generally deeper than local flow. Regional flow is characterized by recharge at the water divide (highest topography) and discharge at the bottom of the basin. Regional flow systems are also characterized by long, inter-basin flow paths (Figure 5).

Based on potentiometric groundwater elevations, the Sevier Playa system has also been characterized as containing three interrelated systems (Whetstone 2017). The systems include the local-scale groundwater flow system, the “playa brine” groundwater flow system, and the regional groundwater flow system. This characterization of the playa system considers the evaporative surface of the playa as a discharge point for both the “playa brine” and regional groundwater systems.

Local groundwater flow in the Sevier Playa basin has been understood to be primarily driven by recharge from precipitation (snow) in mountains at higher altitudes, and infiltration of the surface water (such as the Sevier River and Amasa Creek). However, surface water use and storage by upstream users currently limits or eliminates significant recharge from the Sevier River. The only terminus discharge mechanism in the Sevier Playa basin for the Sevier River, as well as other local creeks and ephemeral stream, is evaporation (Heilweil and Brooks, 2011) very similar to the Great Salt Lake system. Therefore, while the playa surface may sporadically be considered a recharge system, it is overwhelming a net discharge zone.

The local groundwater flow system at the surface and around the margins of the playa is believed to be shallow and constrained by the clay confining layers observed in the CPM borings (described above) and an upward gradient observed in the wells deeper than 40 feet that is driven by evaporation. The evaporative discharge is understood to be driven by solar energy at the playa surface, capillary rise, and the upward hydraulic gradient. The closed nature of the shallow, local groundwater system has resulted in brine-saturated lacustrine deposits that represent a substantial saline resource for chloride and sulfate-based salts that are the target of the CPM mining operation (Gwynn 2006).

The intermediate flow system is primarily driven by recharge from mountain precipitation and is interpreted to include, at least partially, the “playa brine” system described by Whetstone and ENValue (2018) and the alluvial/colluvial system at the playa margins. Brine conditions (salt crystals, gypsum crystals, “salty” taste) have also been observed in the deeper basin sediments (Gwynn 2006). Some mixing of higher quality, deep regional groundwater and lower quality local/surface and intermediate water is predicted to occur (Garcia et al. 2015). The margins of these mixing zones, as well as the various flow systems, are likely to vary spatially based on depth, hydraulic conductivity of the sediment/bedrock, hydraulic gradients, fluid densities, and temperature.

Discharges from the Sevier Playa intermediate flow system are interpreted to be primarily evaporation at the playa surface and, for deeper sediments, comingling with and discharge to the regional groundwater system.

The regional, inter-basin flow system is principally driven by recharge to bedrock from precipitation (primarily snow) in the adjacent mountain ranges. Limestone bedrock in the adjacent Black Hills and House Range generally has a higher hydraulic conductivity than the quartzite typically found in the mountains to the east of the Sevier Basin. Based on groundwater age dating, it is estimated to take 15,000 years for deep, regional groundwater to flow from the east margin of the Sevier Playa to the western margin (Norwest 2018a).

Whetstone and ENValue and others (Wilberg 1991) assert, based on potentiometric groundwater elevations (measured to be at or above the playa surface) that regional groundwater flow may discharge, in part, at the Sevier Playa surface due to evaporation. CPM disagrees with this proposed connection of the regional aquifer to the playa surface based on borings that encountered multiple dense clay sequences observed well below the SCZ, suggesting the deep regional aquifer is semi-confined or confined. In either case, it is agreed that the Sevier Playa surface is primarily a *discharge* (evaporation) zone under all flow system scenarios. Based on these models, any near-surface activity on the playa surface is considered unlikely to negatively impact water quality in underlying aquifers.

Regional groundwater flow travels beyond the Sevier Basin towards the west-northwest to the carbonate bedrock system of the House Range (and possibly the Tule Valley) and towards Fish Springs Flat. There is broad consensus that the eventual discharge point of this regional aquifer system is Fish Springs located approximately 60 miles north of the Sevier Playa (Hurlow 2014). Several other hydrographic basins within the GBCAAS regional aquifer system also discharge at Fish Springs (Hurlow 2014, Masbruch et al. 2014).

Water discharging at Fish Springs National Wildlife Refuge (North and Middle Springs) has been dated using various methods to be between 7,700 and 16,600 years old (Hurlow 2014). Water discharging from Table Knoll Springs located in Fish Springs Flat (south of Fish Springs NWR) has been dated to be between 14,300 and 27,500 years old. Total dissolved solids (TDS) concentrations measured at these springs in this area range from approximately 1,800 to 20,000 milligrams per liter (Hurlow 2014).

Based on the distance, low hydraulic conductivity and gradient, vertical isolation from the deep regional aquifer, timeframe of the project, groundwater velocity, average age of the spring water, comingling of spring water with other source flows, and relatively poor existing water quality measured at the springs, DWQ believes it is implausible that impacts from surface activities on the Sevier Playa surface will ever be observed at Fish Springs.

Ground Water Quality

Ground Water Classification. Based on groundwater quality data submitted in the permit application and groundwater classification terms established in Utah Administrative Code (UAC) R317-6-3, groundwater at the Sevier Playa site is defined as “Class IV Saline Ground Water”. Groundwater from existing wells located away from the playa surface is classified (depending on depth and distance from the playa surface) as “Class IA – Pristine Ground Water”, “Class II – Drinking Water Quality Ground Water”, or “Class III - Limited Use Ground Water”.

As required in Part I.B.2.e of the Permit, a background monitoring program is being completed by the Permittee to collect additional data for calculating well-specific background ground water quality statistics and Protection Levels. After securing Director approval of the Background Monitoring Report(s), Ground Water Protection Levels will be calculated and established in accordance with the reopener provision in Part IV.N of the permit.

Until sufficient data are available to calculate Ground Water Protection Levels for analytes at each ground water monitoring well, facility compliance will be assessed using Interim Protection Levels. Interim groundwater protection limits have been calculated for seven representative groundwater monitoring wells and a subset of analytes using initial water quality data (Crystal Peak Minerals 2019a, 2019b, 2019c). The Interim Protection Levels are presented in Appendix B of the permit. Existing and proposed monitoring well location are presented in Figure 6.

Protection Levels. In accordance with UAC R317-6-4, the various classes of groundwater identified in the project area will be protected for use as established under rule. Groundwater found at the Sevier Playa is defined as “Class IV Saline Ground Water”. Protection levels for the playa groundwater are established in accordance with the criteria in UAC R317-6-4.7 (“established to protect human health and the environment”):

- a. Total dissolved solids may not exceed 1.5 times the background concentration level.
- b. In no case will the concentration of a pollutant be allowed to exceed the ground water quality standard due to discharge. If the background concentration of a pollutant exceeds the ground water quality standard, no statistically significant increase will be allowed.

COMPLIANCE SCHEDULE

- Ground Water Compliance Sampling

Compliance Monitoring wells shall be installed and sampled in accordance with R317-6-6.4.C.2 and R317-6-6.9A. The purposes of the Compliance Monitoring Wells include (i) obtaining additional baseline data regarding the aquifers, hydrogeological conditions, and background water quality; and (ii) establishing suitable points of compliance for the Permit.

Quarterly groundwater sampling will be conducted as described in the Fresh Water Baseline Study plan (Stantec 2019).

- Non-Compliance

The Permit defines the processes and schedule required in the event that a “Probable Out-of-Compliance” status is observed at a monitoring well (immediate resample) and “Out-of-Compliance” status is observed (Director notification and accelerated sampling). A contaminant assessment and corrective action process and schedule is also described.

- Final Closure Plan. In the event that the permittee decides to discontinue its operations at the facility the permittee shall notify the Director of such a decision and submit a Final Closure Plan within 180 days prior to the closure of the facility.

FIGURES

Figure 1 – Site Location Map

Figure 2 – Site Features Map

Figure 3 – Site Geology Map

Figure 4 – Sevier Playa Cross-Section

Figure 5 – Conceptualized Groundwater Flow in Great Basin System

Figure 6 – Existing and Proposed Monitoring Well Locations

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