5.3 Waste Rock-Portal Pad Area and Landfill

5.3.1 Drainage Paths

Numerous seeps have been identified since 2021, that drain south from the base of the waste rock-portal pad area and then down to East Lake (Figure 3-3; SRK 2024a). These include contact water seeps directly from the base of the pad, seeps that surface within the tundra, and sub-surface seepage that is audible beneath boulders. In addition, ULU-15 was established by Blue Star in 2020 as a compliance monitoring site at the downstream end of the culvert at the base of the landfill (landfill built in 2021). Flow from ULU-15 disappears into the tundra and is thought to re-surface down-gradient at Seep-02, which subsequently flows to East Lake.

There has been uncertainty; however, of the source of flow into ULU-15, and also if water may flow from the mine sump area and from stockpiled mineralized rock and waste rock around the portal, into the waste rock-portal pad. Some of the stockpiled rock is acid generating (SRK 2024a and see next section) and therefore could be a source of loadings to seepage downstream of the waste rock-portal pad.

Freshet conditions were directly observed by SRK and Blue Star in 2024. These observations were combined with review of photographs taken by Blue Star during the 2022 freshet. The observations are important due to zinc concentrations at ULU-15 being close to the Water License criteria in 2023, and also to help determine management priorities for rock in the mine sump and portal area.

The observations indicated the following during freshet at the waste rock-portal pad and landfill area:

- Snowmelt in the portal and mine sump area collects in the portal pond (ULU-4a), the mine sump (ULU-4b), and a third temporary pool (Pool-4c), illustrated in photographs in Figure 5-27 to Figure 5-26 and on an aerial drone image of the area in Figure 5-27.
  - The portal pond was predominantly frozen at freshet, but some water was present, and the water level was high extending out of the pond southeast towards the adjacent road and mine sump berm. No flow from the portal pond was observed.
  - The mine sump pond was partially filled with snow at freshet. Seepage from the base of the mine sump berm was observed to flow along the north side of the adjacent road and then south across the road and into the roadbed (up-gradient of Seep-02). It is unclear if the seepage from the mine sump berm had flowed through the berm from the mine sump, or along the berm from water extending out of the portal pond.
  - Temporary Pool-4c had not previously been recognized but had high water level on May 22, and the water level had dropped to almost empty by May 28, with audible flow to the south/southeast beneath the adjacent road (up-gradient of Seep-02). Pool-4c was in contact with adjacent stockpiled mineralized rock when the water level was highest, and with strongly oxidized fill in the berm along the edge of the road.
- As snow cover on waste rock and mineralized rock in this area melts, the contact water is expected to drain into all three of these ponds. Conditions at freshet are, however, expected to be dilute.

- There is potentially a flow path from Pool-4c to ULU-15 as the road in between was saturated, and the ditch at the base of the landfill contained visible flow to the ULU-15 culvert (Figure 5-27). This ditch also contains waste rock. Run off and seepage through the sand-covered landfill is also expected to be a source of drainage into ULU-15, although much of the snow on the landfill had already melted when observations at ULU-15 were made.
- Other much smaller pools and flowing water were observed at a few locations on the waste rock-portal pad, as shown on Figure 5-27. Also, meltwater from west of the portal pond area flows south across the road and into the waste rock-portal pad. Strongly oxidized waste rock is stockpiled on the west side of the portal pond, that was still snow-covered when observations were made.

To summarize, it is apparent that contact water from waste rock (in stockpiles and berms) and stockpiled mineralized rock, in the portal area has the potential to flow through/across the adjacent road and/or the waste rock-portal pad, or into Pool-4c, and then into down-gradient seepage. Pool-4c has some potential to drain to ULU-15, but the majority of water was audibly draining south through the road and tundra, down towards Seep-02. Seep-02 mostly upwells from the tundra (Figure 5-28), approximately 100 m south and down-gradient of ULU-15. The portal pond (ULU-4a) appears unlikely to have been a source of water to downstream seepage in 2024. The mine sump (ULU-4b) could be a source of seepage as seepage from the berm was observed, but visible flow was just a trickle.

Figure 5-24. Frozen Portal Pond (ULU-4a, May 19, 2024) Looking NW, and Pooled Water Extending South to the Adjacent Road in the Foreground.

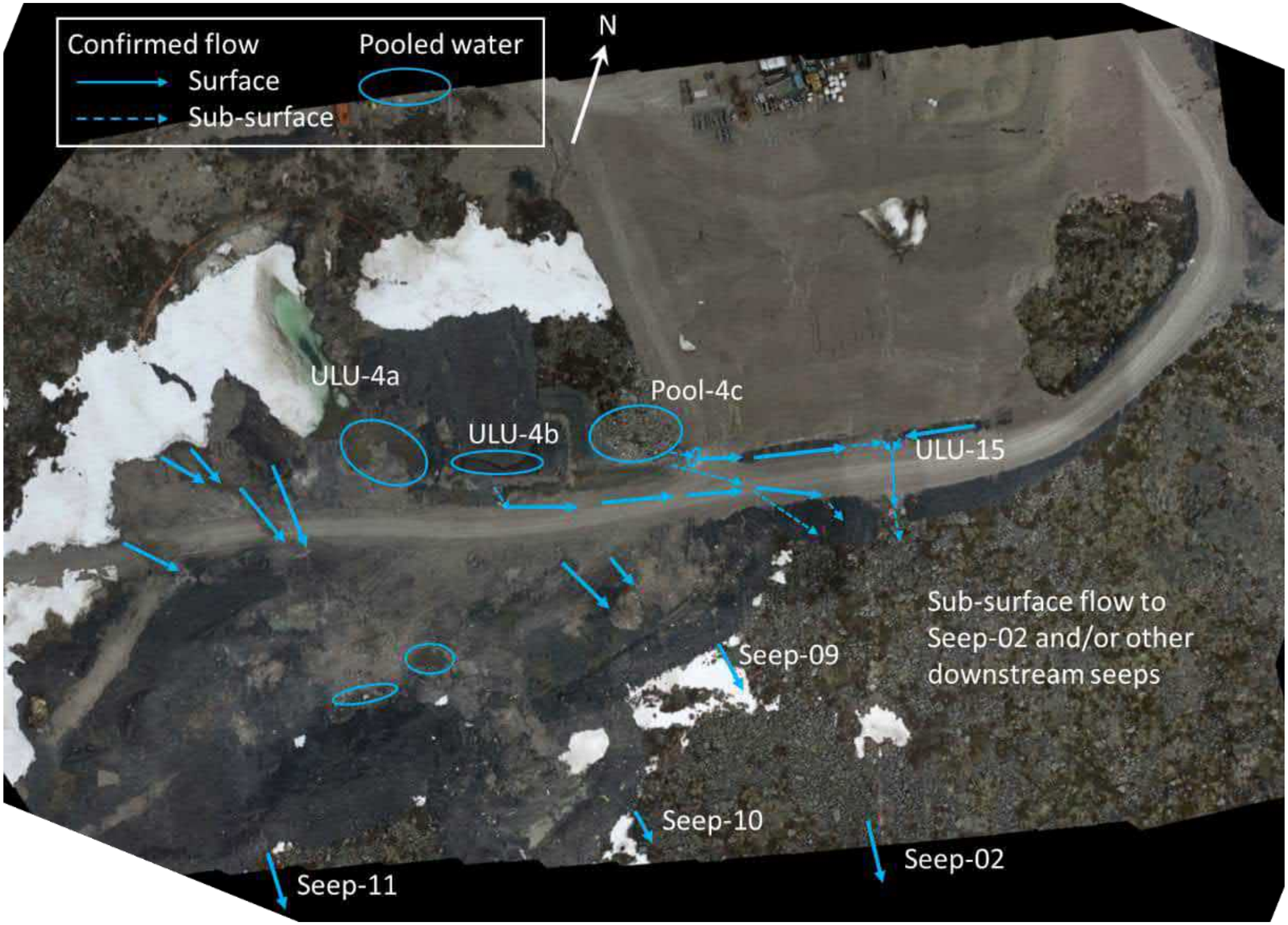
Figure 5-25. Snow Filled Mine Sump Looking NE (May 22, 2024).

Notes: Mine sump berm in the foreground. Stockpiled mineralized rock to the left and far centre. Sand covered landfill in the background.

Figure 5-26. Temporary Pool-4c (May 26, 2024), Looking ENE from the Mine Sump Berm Towards the Landfill.

Notes: Pool is approximately 15 m long. Water level was almost at the top of the highest boulder four days prior to this.

Figure 5-27. Freshet Flow in the Waste Rock-Portal Pad Area.



Source: https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-07 Data Interpretation/ Portal area freshet water flow_kk.pptx

Notes: Drone image from Blue Star June 2, 2024. View is approximately 350m across the longest axis.

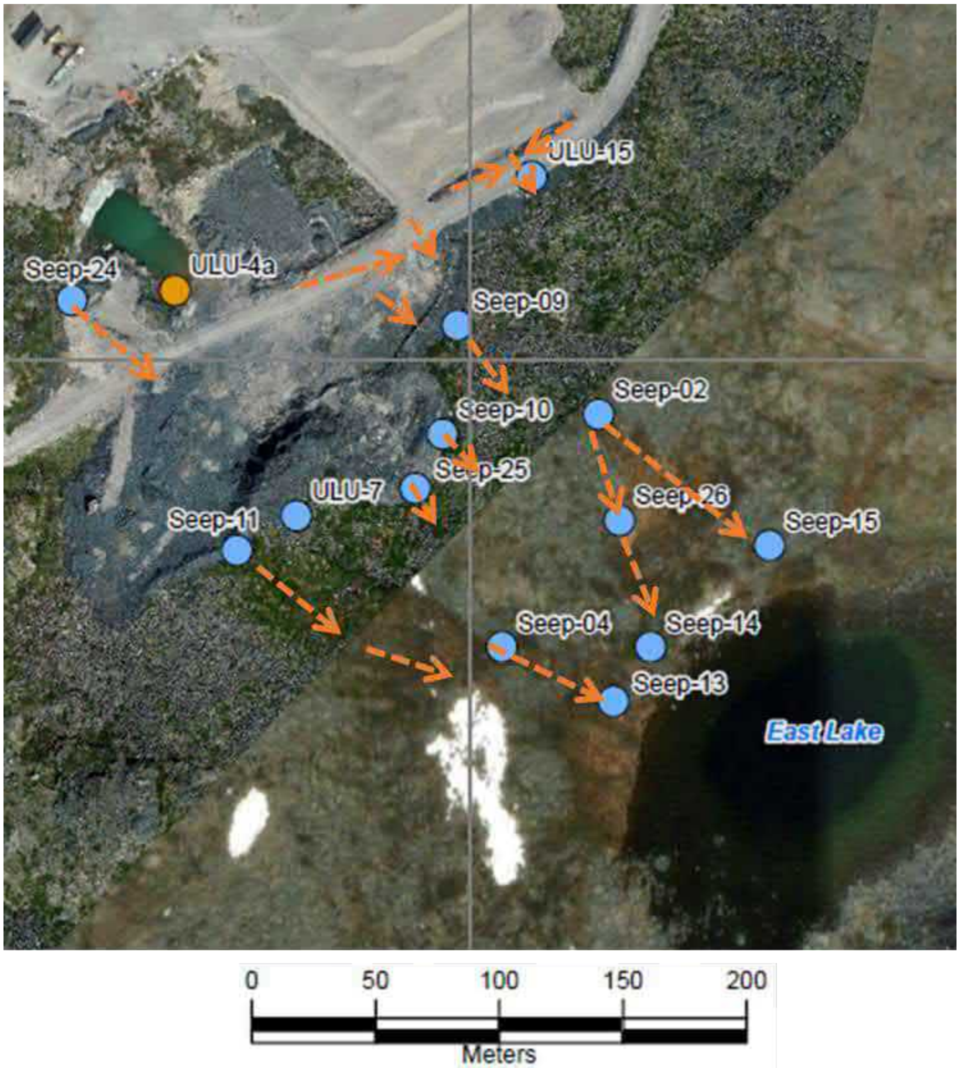
Figure 5-28. Seep-02 at Freshet, Looking NW/Up-Gradient Towards the Waste Rock-Portal Pad Area.

Notes: Arrow tip shows location of flow out from the tundra

In addition to Seep-02, the other on-going monitoring site down-gradient from the waste rock-portal pad is Seep-13 (Figure 5-29). Both Seep-02 and Seep-13 have had observed flow much more frequently than ULU-7 during the 2021 to 2024 monitoring seasons (Figure 5-30).

Figure 5-29. Seep-13 Looking Up-Gradient Towards the Waste Rock Stockpile.

Figure 5-30. Generalized Flow Paths from the Waste Rock-Portal Pad Area to East Lake.



Source: https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400--08_Reporting/Camp Pad and waste rock pad flow paths.pptx

Notes: Based on observed or audible flow between 2021 and 2024.

5.3.2 Rinse pH in the Waste Rock-Portal Pad Area

Rock present in the catchment includes:

- Small stockpiles of waste rock west of the portal pond and contained within the mine sump berm.
- Mineralized rock stockpiled above (east of) the portal pond and partially pushed into the mine sump.
- The waste rock-portal pad and waste rock stockpile.
- Rock fill along the road south of the landfill.
- Rock fill along the top (north) edge of landfill, now covered in sand (e.g., in TP-01 from 2020).

Previous rinse pH results indicated that:

- Stockpiles between 25 m and 40 m west of the portal pond, and rock in the mine sump berm were strongly oxidized/orange and acid generating (rinse pH 3.2-3.6, SRK 2024a).
- The waste rock-portal pad had variable rinse pH between 3.6 and 8.4, with orange acid generating rock encountered in one test pit from surface down to 1.4 m, whereas other test pits contained thin (up to 20 cm thick) layers of orange acid generating rock underlain by grey rock with circum-neutral rinse pH (SRK 2024a).
- Rinse pH of stockpiled mineralized rock had apparently declined from pH 6.2 to 7.7 in 2021 (n=3), to pH 4.2 in 2023 (n=2), although this was based on a small sample population (SRK 2024a).
- The waste rock stockpile on the waste-rock-portal pad has not been excavated to determine weathering condition or rinse pH.

2024 Rinse pH Results

The 2024 samples and photographs are provided in Appendix B. The rinse test results for the portal area collected in May and June 2024 are presented in Table 5-2, and rinse pH versus rinse conductivity are plotted in Figure 5-31 with samples collected from 2020 to 2024.

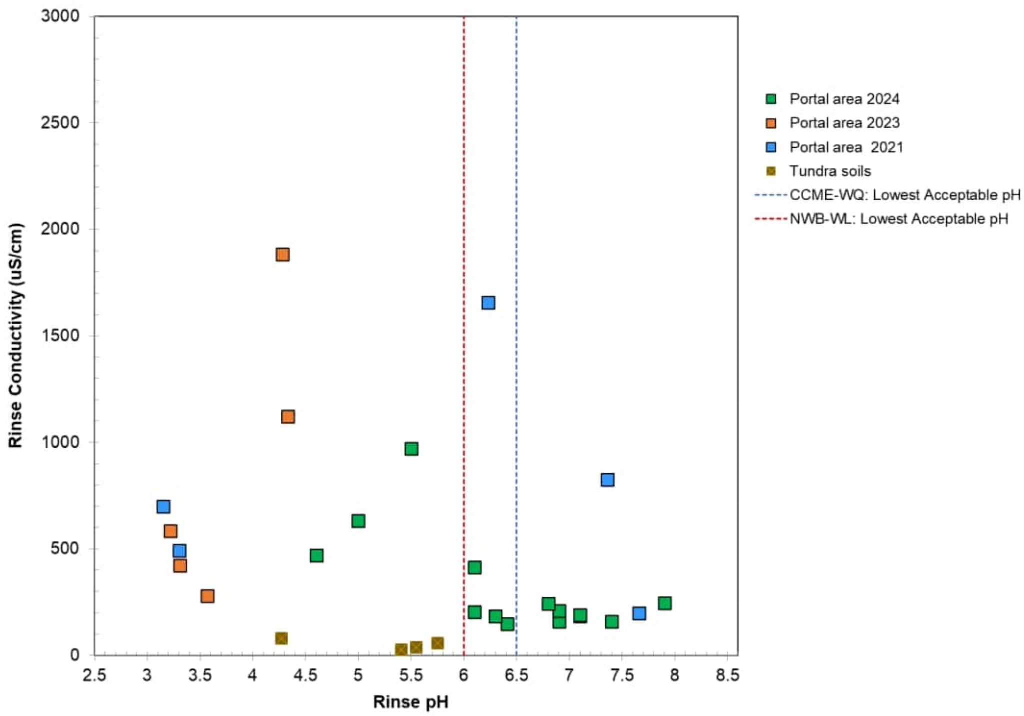
Samples collected from the east side of the portal area in 2024 (n=13) had rinse pH values ranging from 4.6 to 7.9 (average = 6.4). Samples at TP24-01 had acidic rinse pH values (<5.0), and samples from TP24-02 and TP24-07 were mildly acidic (rinse pH between 5.0 and 6.5), all other samples were circum-neutral (n=7). The rinse conductivities that corresponded to the circum-neutral rinse pH samples ranged from 160 to 250 µS/cm, whereas the samples that were slightly acidic to acidic (pH < 6.5) had rinse conductivities that ranged from 180 to 970 µS/cm. The 2024 results contrast the rinse pH results from 2023 (TP23-12, TP23-18), which had much lower rinse pH (~4.3). TP24-01 rinse pH was comparable to TP23-12 (Figure 3-2). This indicates that there is a large degree of variability in the rinse pH of mineralized rock from the portal pond area and the stockpiled mineralized rock has not all shown a pH decline between 2021 and 2023/2024.

Table 5-2. 2024 Rinse Test Results for Portal Area.

Area	Test Pit	Sample	Sample Depth (cm)	Colour of <2mm Sieved Rock Fraction	Rinse pH	Rinse Conductivity (µS/cm)
Portal area (East of Portal Pond)	TP24-01	1A	20-25	Brown	4.6	470
Portal area (East of Portal Pond)	TP24-01	1B	35-40	Brown	5.0	630
Portal area (East of Portal Pond)	TP24-02	2A	20-25	Brown	6.1	410
Portal area (East of Portal Pond)	TP24-02	2B	30-35	Brown	5.5	970
Portal area (East of Portal Pond)	TP24-03	3A	25-30	Grey	7.4	160
Portal area (East of Portal Pond)	TP24-04	4A	20-26	Brown/Grey	6.9	160
Portal area (East of Portal Pond)	TP24-04	4B	30-35	Brown/Grey	7.9	250
Portal area (East of Portal Pond)	TP24-06	6A	30-35	Grey	6.9	210
Portal area (East of Portal Pond)	TP24-06	6B	40-45	Grey	7.1	180
Portal area (East of Portal Pond)	TP24-07	7A	30-35	Brown/Grey	6.3	180
Portal area (East of Portal Pond)	TP24-07	7B	40-45	Brown	6.1	200
Portal area (East of Portal Pond)	TP24-08	8A	30-35	Grey	7.1	190
Portal area (East of Portal Pond)	TP24-08	8B	40-45	Brown/Grey	6.8	240

Source: SRK Consulting\NA CAPR002649 Ulu Reclamation SOW 2023 - Internal\Task100_ML-ARD\160_Data management\Rinse test results compiled_UluCamp_KYK_Rev01.xlsx

Figure 5-31. Rinse pH vs Rinse Conductivity for 2024 Portal Area Samples.



https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Rinse test results compiled_UluCamp_CAPR003217_KYK_Rev01.xlsx]

5.3.3 Waste Rock-Portal Pad Area and Landfill Seepage Results

In 2024, seepage sampling occurred at ULU-15, Seep-02, and Seep-13 at the waste rock-portal pad and landfill areas (Figure 5-32 to Figure 5-43). Water samples were also collected at the Portal Pond (ULU-4a; June, July), Mine Sump (ULU-4b; May, June), and the seasonal pool Pool-4c (May). All waste rock-portal pad and landfill seepage charts including the water quality limits are provided in Appendix C (Figures C39–C76).

pH and Conductivity Trends in 2024

Measured pH at ULU-15, Seep-02, and Seep-13 ranged from 6.3 to 7.5 and the pH trends were generally consistent with previous monitoring years (Figure 5-32, Figure 5-36, Figure 5-40). The exception to this was pH measured in May at Seep-13, with a pH of 6.3 being recorded (predominantly reflecting snowmelt); however, pH increased in June to 7.3 and remained above pH 7.0 for the rest of summer season. The pH at ULU-4a,b, and Pool-4c ranged from 6.7 to 7.5. The lower pH values downstream are consistent with the pH conditions observed in the tundra reference stations (pH 6.4 to 6.9) reflecting the influence of water flowing across the tundra. pH results currently indicate a lack of ARD from the waste rock-portal pad and landfill area.

Conductivity measurements increased through the summer months in 2024 at the monitored seeps. Electrical conductivity at Seep-02 and Seep-13 were similar to each other and ranged from 66 to 621 µS/cm. Whereas electrical conductivity at ULU-15 was typically higher compared to the other two seeps and increased from 472 µS/cm in May to 753 µS/cm in June. Electrical conductivity measured at ULU-4a,b,and Pool-4c ranged from 190 to 340 µS/cm and was consistent with measurements from previous years at ULU-4a (ranging from 180–230 µS/cm).

Major Ions

During 2024, the major anions present in seepage were sulphate, alkalinity, and chloride. In terms of molar equivalent proportions sulphate and alkalinity were the dominant anions at ULU-15 (Figure 5-32, Figure 5-33), Seep-02 (Figure 5-36, Figure 5-37) and Seep-13 (Figure 5-40, Figure 5-41). Sulphate comprised 51% to 80% of the total anions, followed by alkalinity (9–47%) and then chloride (2–13%). At all three locations the proportion of alkalinity decreased throughout the summer months, while the molar proportion of sulphate increased. However, the concentrations of sulphate and alkalinity increased through the season. Sulphate concentration at all three seeps have been generally similar between 2024 and the previous years of monitoring with the greatest variation occurring within a season (reflecting dilution at freshet) and increasing concentrations through the season as up-gradient rock thawed and sulphate derived from sulphide oxidation was being leached.

Chloride concentrations were below the CCME water quality guideline in 2024, and only one sample exceeded the BC water quality guideline for sulphate (218 mg/L) in 2024 (240 mg/L SO_4 in ULU-15 in June).

Calcium was the predominant major cation present at ULU-15, Seep-02, and Seep-13 followed by magnesium, sodium, and potassium. Calcium and magnesium together proportionally made up 73 to 92% of the total cations. Sodium was proportionally lower at these monitoring locations typically ranging from 4 to 13%, except for one sample at Seep-13 (August) where the molar proportion of sodium was 21%. Cation concentrations at all three monitoring locations gradually increased through the summer months.

Sulphate and chloride concentrations at the portal pond (ULU-4a), mine sump pond (ULU-4b) and seasonal pond (Pool-4c) were below the CCME water quality guidelines for chloride and BC water quality guidelines for sulphate. Anion concentrations and molar proportions at ULU-4a in 2024 were similar to previous years, where sulphate was the dominant anion (44–51%) followed by nearly equimolar proportions of alkalinity (22–25%) and chloride (26–31%). Similarly, cation concentrations and molar proportions in 2024 followed historic water quality trends at ULU-4a. Cation molar proportions followed the order: calcium (55%), sodium (23–25%), magnesium (18–19%), and potassium (3%). As described in Section 5.2.3, the presence of chloride in some of the seepage appears to be related to use of sodium chloride during portal development and ore extraction (Klohn-Krippen 1998). Saline water was present in the portal pond when samples were analyzed in 2020 and 2021, and similarly chloride was present in Seep-24 close to the portal in 2023.

ULU-4b and Pool-4c were only sampled in May and early June in 2024. Unlike ULU-4a, anion molar proportions at ULU-4b and Pool-4c were dominated by sulphate (66–78%) with alkalinity (18–32%), with chloride (2–4%) being present at lower proportions. Calcium and magnesium composed 91 to 92% of the cation molar proportions at ULU-4b and Pool-4c. Cation and anion concentrations at ULU-4b increased between May and June, and had similar concentration and molar proportions as observed at Seep-02. This is consistent with observations of flow during freshet (Section 5.3.1) and suggests that a portion of ULU-4b drains towards Seep-02.

Trace Ions

Seasonal trends for trace element concentrations are shown for ULU-15 (Figure 5-34, Figure 5-35), Seep-02 (Figure 5-38, Figure 5-39), and Seep-13 (Figure 5-42, Figure 5-43). None of these seeps exceeded the NWB water licence limits. The following were above the CCME water quality guidelines in 2024 samples:

- Aluminum at Seep-13 (May).
- Arsenic at ULU-4b (May).
- Cadmium at ULU-15 (June) and Seep-13 (August).
- Copper at ULU-15 (May, June), Seep-13 (June, August), ULU-4a (June), and Pool-4c (May).
- Fluoride at ULU-15 (May, June) and Seep-02 (June, July).
- Zinc at ULU-15 and ULU-4a.

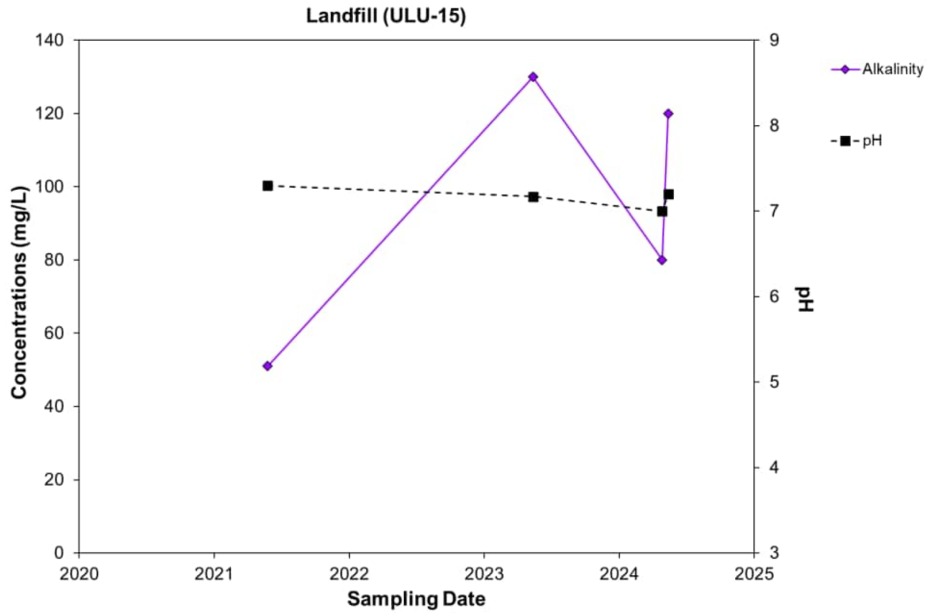
Background levels of aluminum, copper, and fluoride are naturally elevated in the Ulu area based on concentrations in the reference stations in 2022 and 2023.

Trace element concentrations at ULU-15 and Seep-02 tended to remain relatively constant through the season, except for a large decrease in zinc at ULU-15. Whereas trace element concentrations at Seep-13 increased through the summer months, except for aluminum and iron. Of note, zinc concentrations at ULU-15 were an order of magnitude lower in 2024 (0.014 mg/L in August) compared to 2023 (0.29 mg/L in August). The lower concentrations of zinc could be related to sampling ULU-15 upstream of the zinc galvanized culvert in 2024, compared to downstream of the culvert previously, or perhaps there was previously zinc release from the scrap metal that was placed in the landfill in 2021 and 2022; however, further monitoring is required to assess the trend in zinc at this location.

Scatter plots are presented in Figure 5-44 to Figure 5-46 to assess the source of the seepage at ULU-15 and the potential for the ponds in the portal area to influence seepage water quality (Figure 5-27). The portal pond (ULU-4a) is characterized by relatively high dissolved zinc concentrations and relatively low arsenic and sulphate concentrations. Comparatively, the mine sump pond (ULU-4b) has higher dissolved arsenic and sulphate concentrations, which is similar to previously measured water chemistry from Seep-16 (seepage flow through stockpiled mineralized rock, into the portal pond). This suggests that the mine sump pond is influenced by sulphide oxidation and arsenic leaching sourced from the nearby stockpiled mineralized rock and waste rock. It would be expected that the portal pond would behave similarly; however, dissolved constituents are generally lower reflecting more significant dilution in this much larger pond. The exception to this in the portal pond is zinc (0.13 to 0.21 mg/L), which may be sourced from leaching of submerged sources.

Seepage from the landfill measured at ULU-15 maintains higher sulphate concentrations compared to the portal pond and mine sump ponds, and overall has water chemistry reflecting sulphide oxidation of waste rock. It is unlikely that the mine sump pond (ULU-4b), or nearby temporary pond (Pool-4c) is a significant source of seepage to ULU-15 based on the measured water chemistry and the geometry of the landfill area, with drainage from these ponds instead expected to flow predominantly sub-surface to Seep-02. Waste rock is present along the northern edge of the constructed landfill (e.g., TP-01 in SRK 2021) buried below esker sand (~0.5 m) which may be a source of water with elevated sulphate, flowing sub-surface to ULU-15. Waste rock also occurs along the ditch at the base of the landfill, with flow observed at freshet to ULU-15. It is expected that waste rock oxidation at the northern and southern edges of the landfill will continue until further mitigation actions are taken.

Figure 5-32. ULU-15 Ore Pad Seepage pH and Alkalinity.



https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rfc_kyk_rev00.xlsx]

Figure 5-33. ULU-15 Ore Pad Seepage Major Cations and Anions.

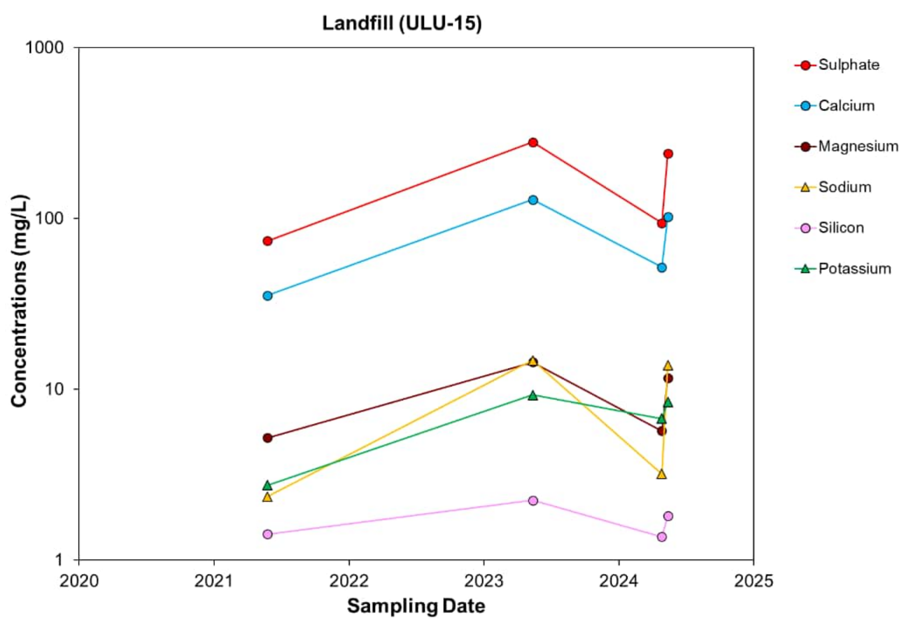


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Figure 5-34. ULU-15 Ore Pad Seepage Oxyhydroxide Forming Elements.

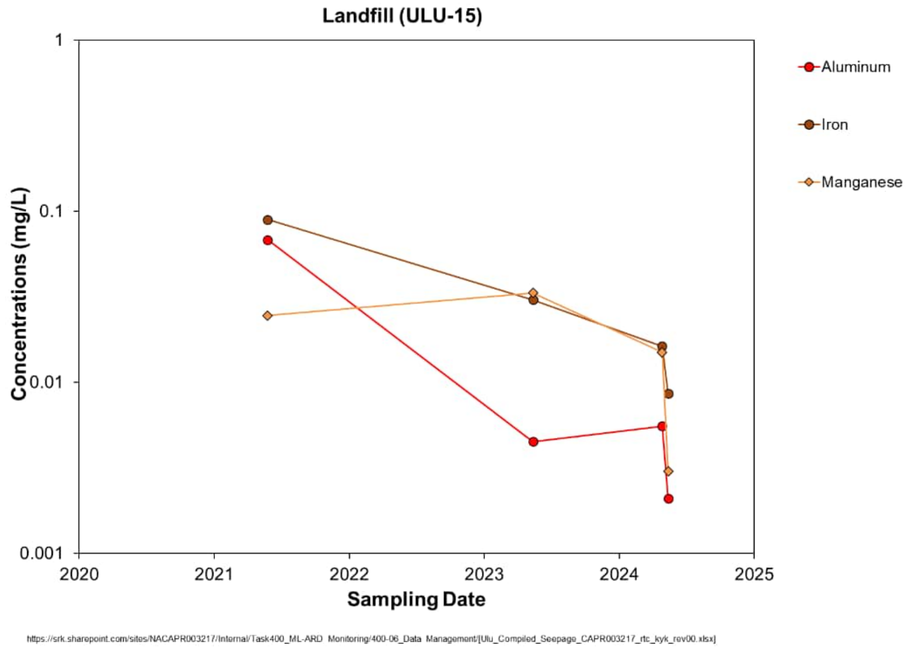


Figure 5-35. ULU-15 Ore Pad Seepage Trace Elements.

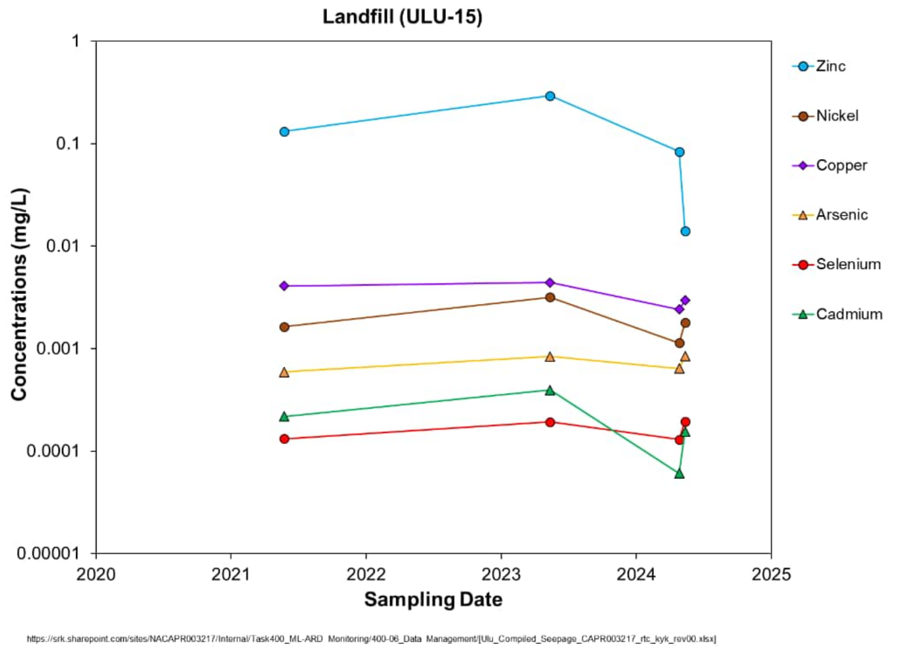


Figure 5-36. Seep-02 Ore Pad Seepage pH and Alkalinity.

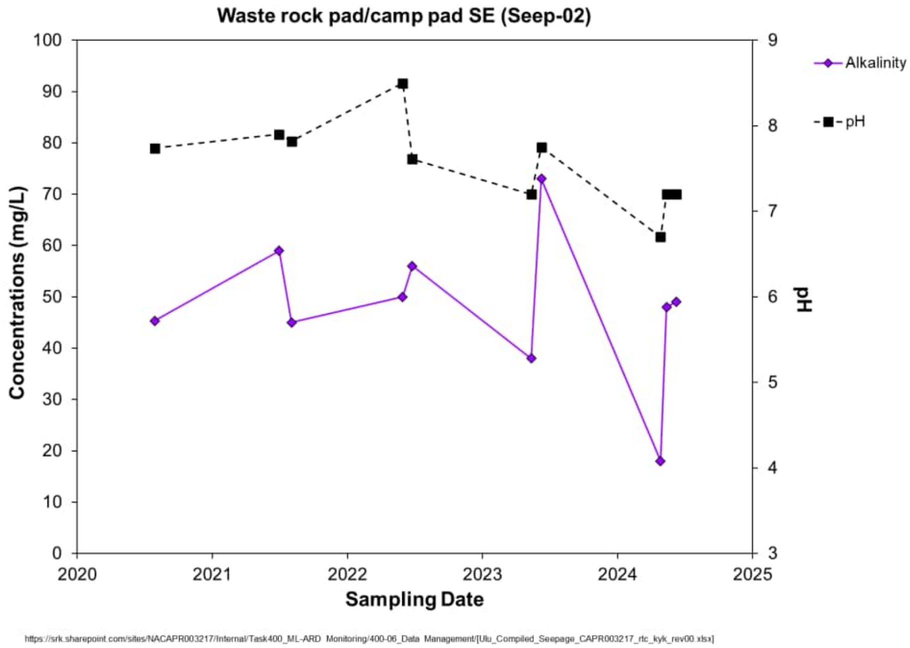


Figure 5-37. Seep-02 Ore Pad Seepage Major Cations and Anions.

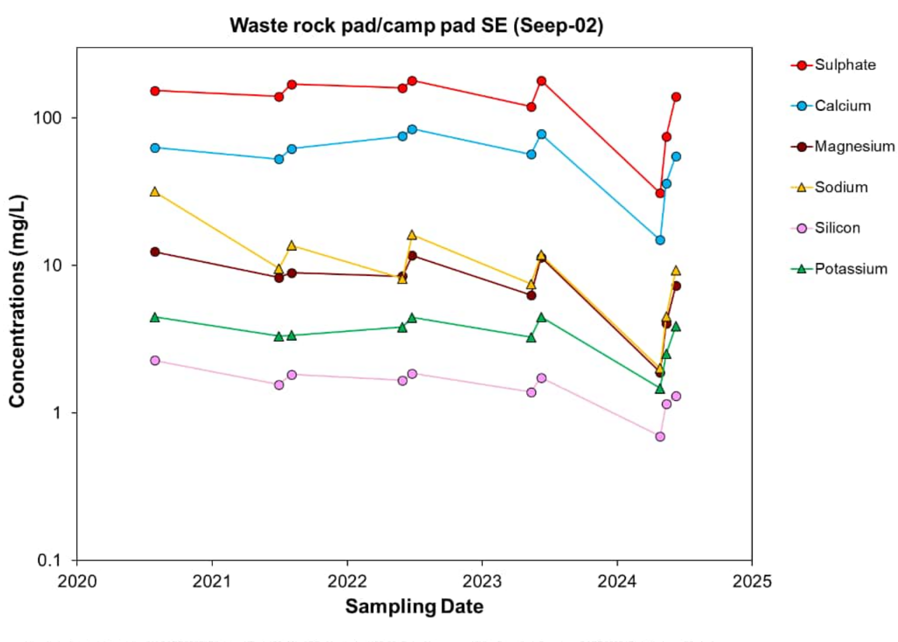
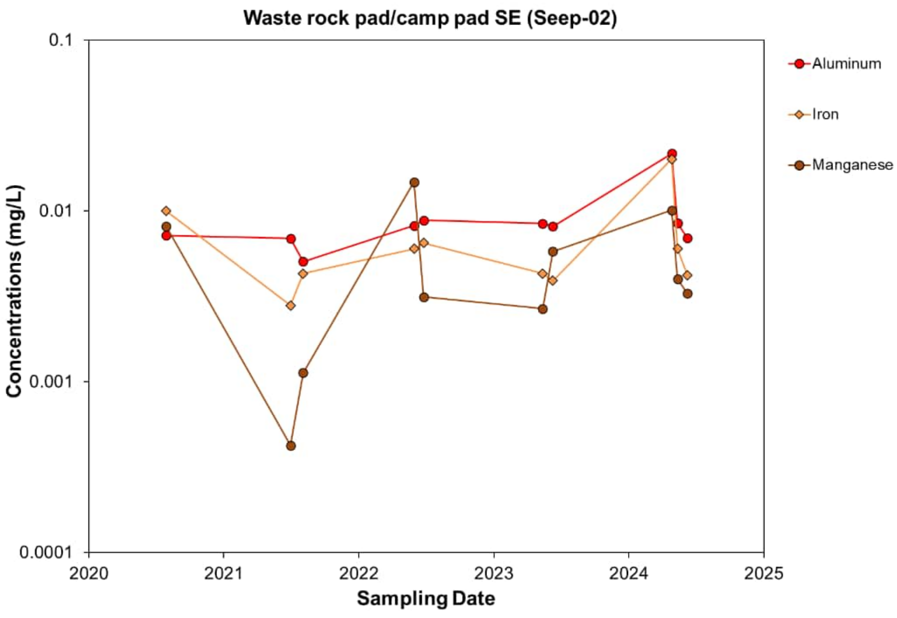
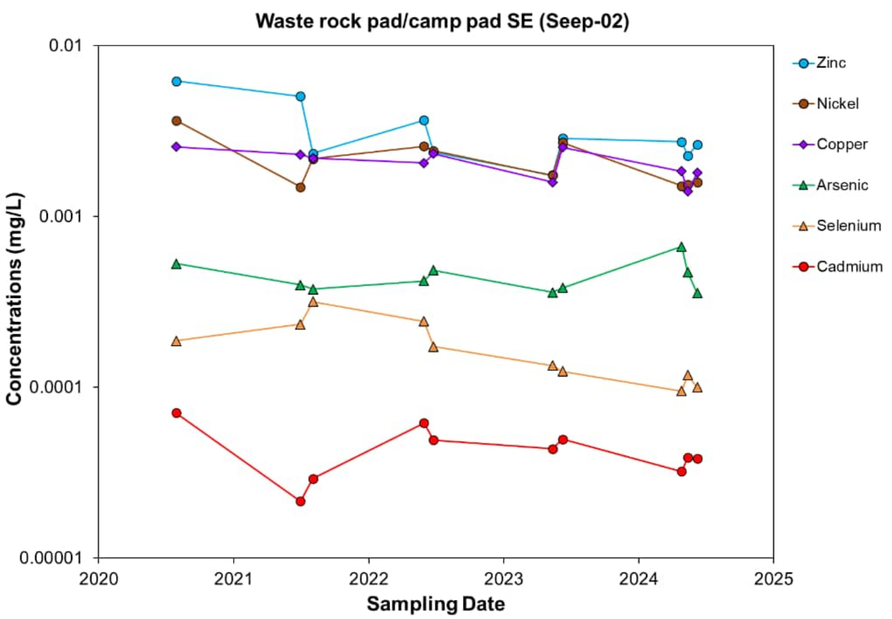


Figure 5-38. Seep-02 Ore Pad Seepage Oxyhydroxide Forming Elements.



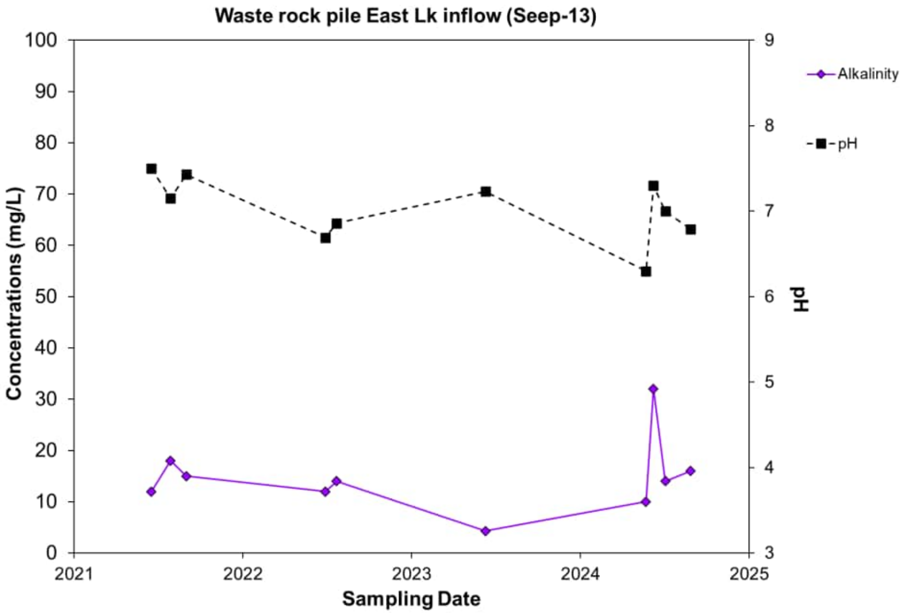
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rtc_kyk_rev00.xlsx]

Figure 5-39. Seep-02 Ore Pad Seepage Trace Elements.



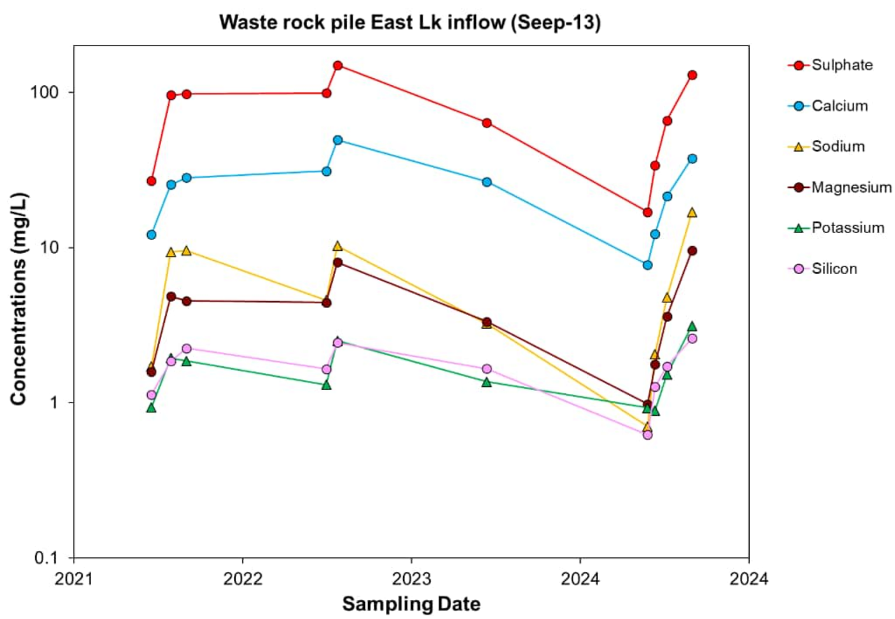
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rtc_kyk_rev00.xlsx]

Figure 5-40. Seep-13 Ore Pad Seepage pH and Alkalinity.



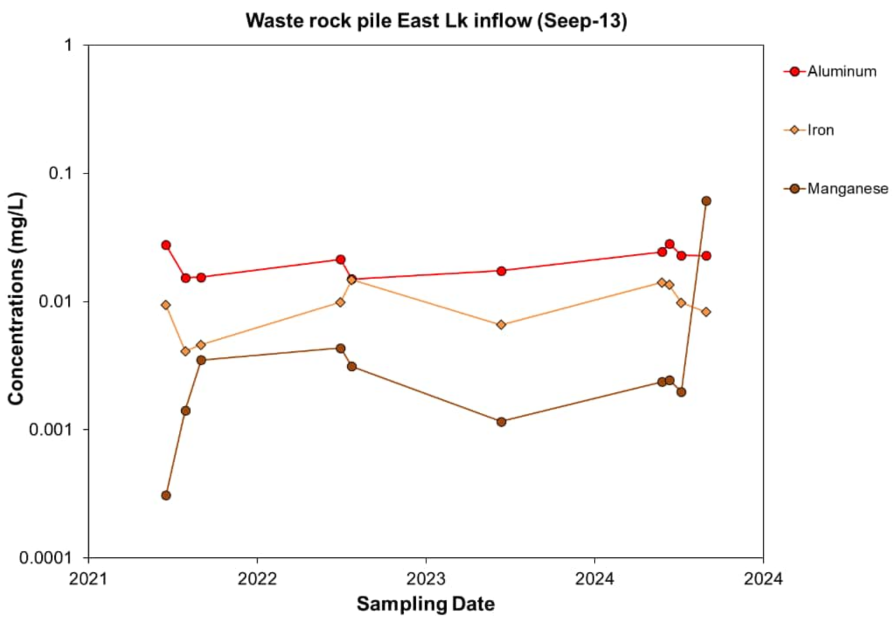
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rfc_kyk_rev00.xlsx]

Figure 5-41. Seep-13 Ore Pad Seepage Major Cations and Anions.



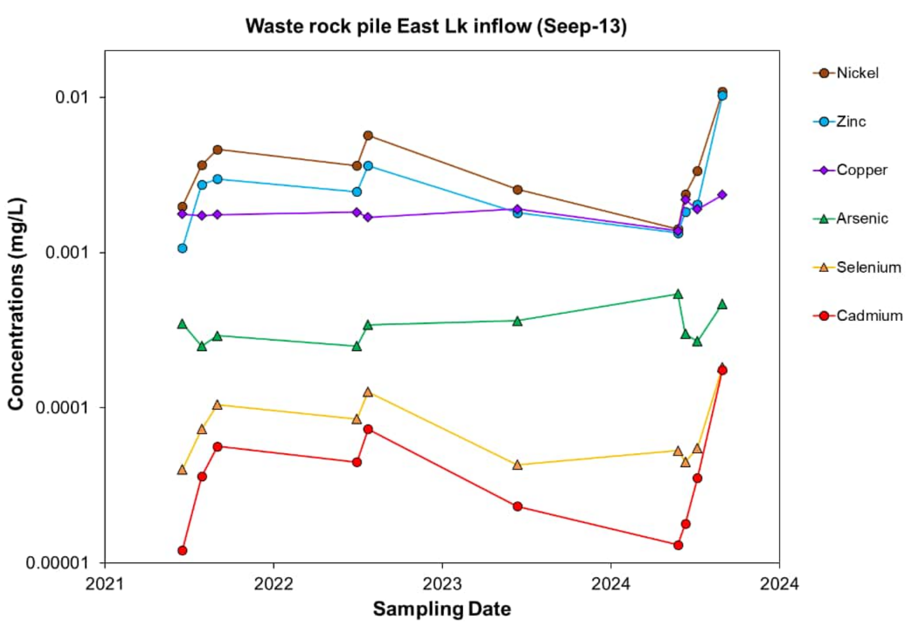
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rfc_kyk_rev00.xlsx]

Figure 5-42. Seep-13 Ore Pad Seepage Oxyhydroxide Forming Elements.



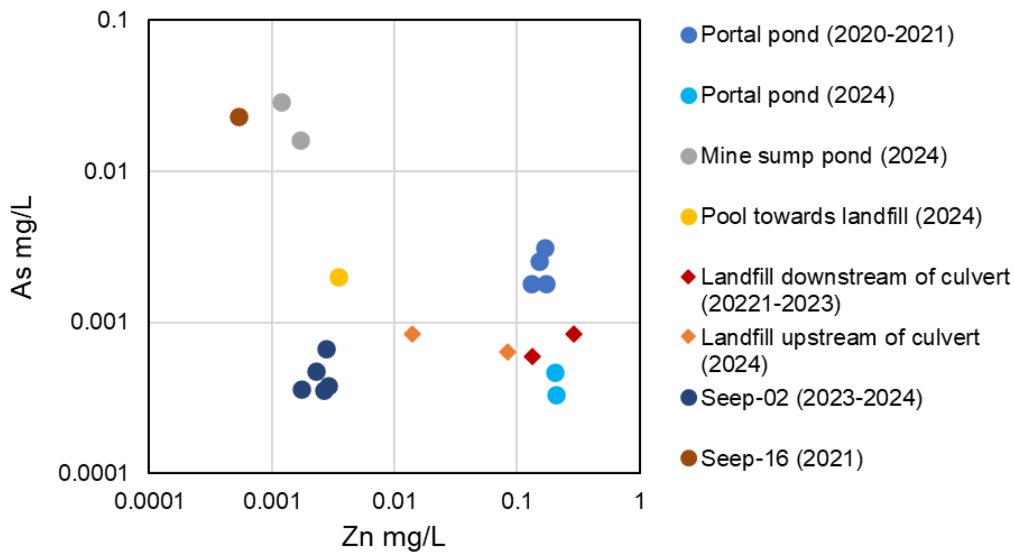
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rtc_kyk_rev00.xlsx]

Figure 5-43. Seep-13 Ore Pad Seepage Trace Elements.



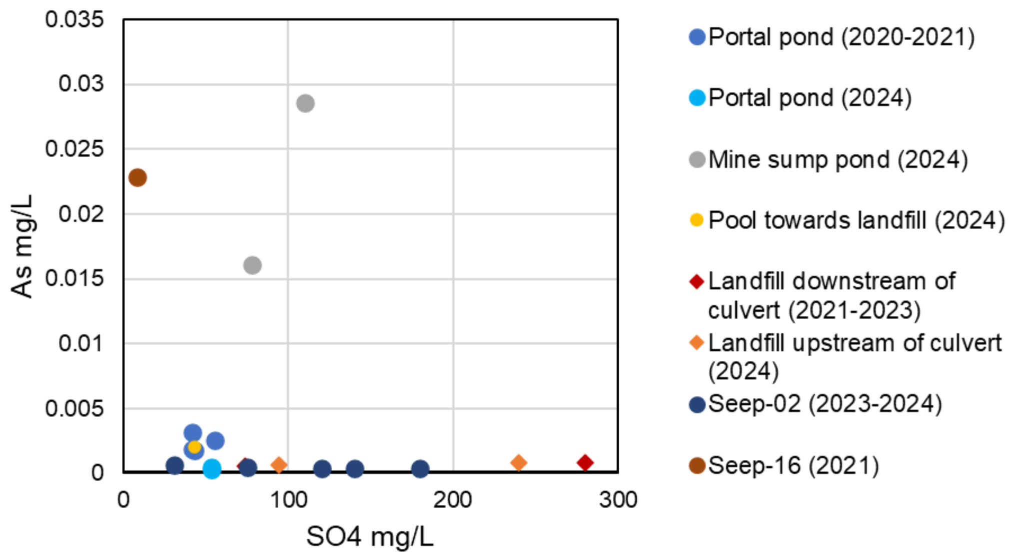
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-06_Data Management/[Ulu_Compiled_Seepage_CAPR003217_rtc_kyk_rev00.xlsx]

Figure 5-44. Arsenic Versus Zinc Concentrations for Portal Pond and Landfill Areas.



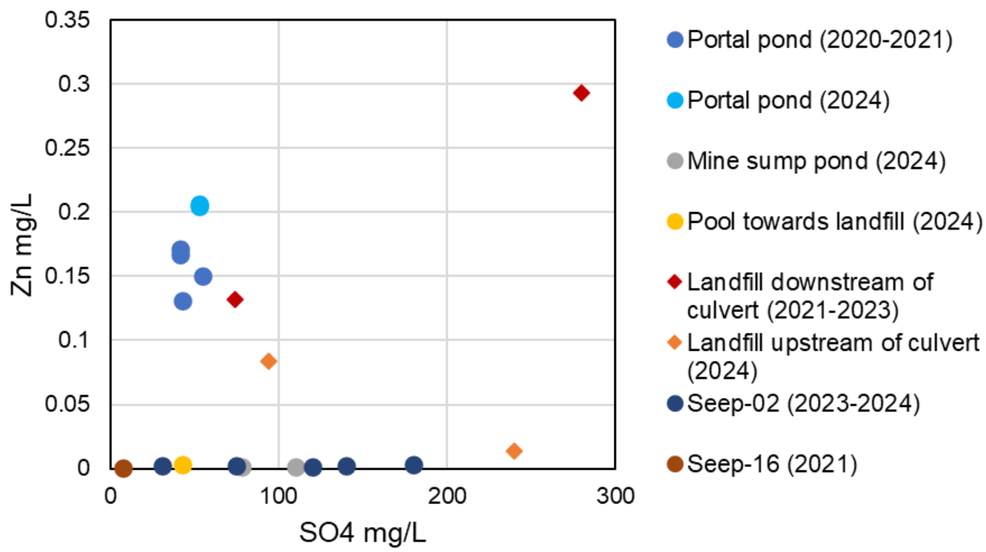
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-07 Data Interpretation/[Ulu portal area-landfill SO4-As-Zn_kyk_Rev00.xlsx]

Figure 5-45. Arsenic Versus Sulphate Concentrations for Portal Pond and Landfill Areas.



https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-07 Data Interpretation/[Ulu portal area-landfill SO4-As-Zn_kyk_Rev00.xlsx]

Figure 5-46. Zinc Versus Sulphate Concentrations for Portal Pond and Landfill Areas.



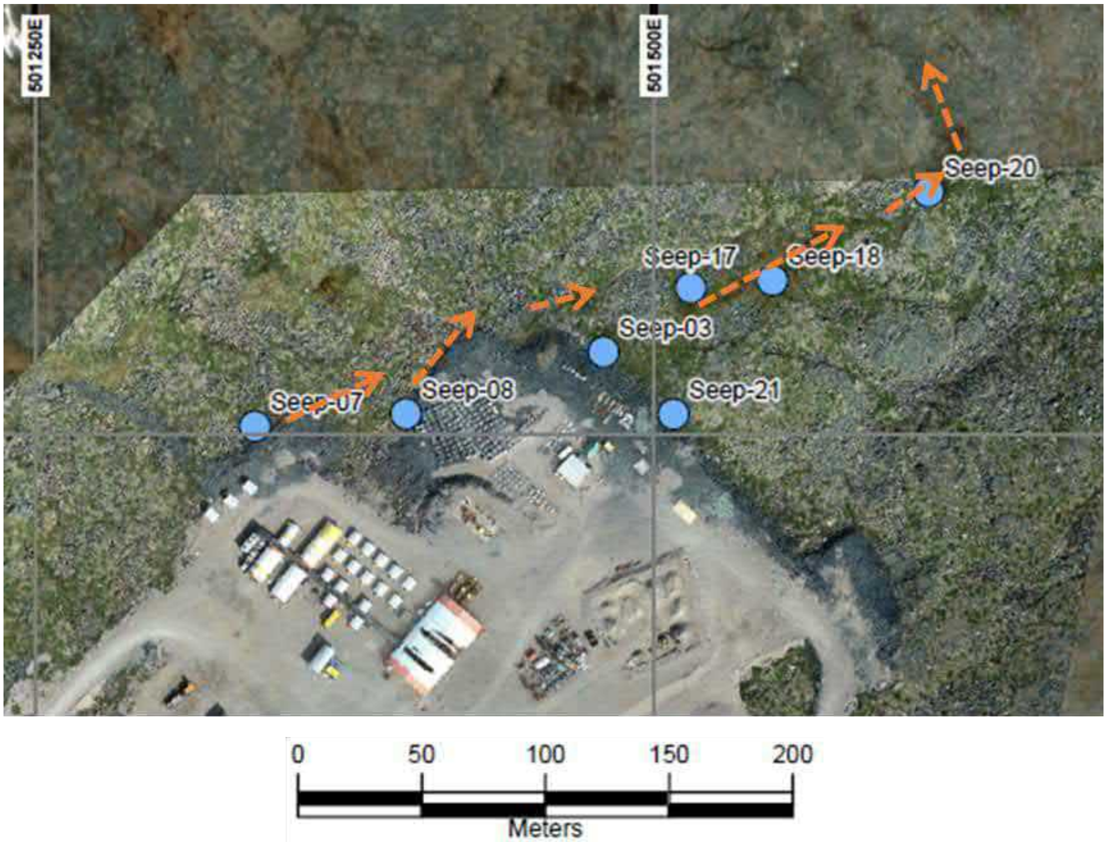
https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400-07 Data Interpretation/[Ulu portal area-landfill SO4-As-Zn_kyk_Rev00.xlsx]

5.4 Camp Pad North

5.4.1 Drainage Paths

Seepage from the north side of the camp pad drains to the northeast (Figure 5-47). Flow from Seep-07 and Seep-08 typically occurs at freshet, parallel to the edge of the pad, and is partially inaccessible beneath boulders. Flow surfaces at Seep-17, 35 m northeast of the pad where water upwells from a pool where a large boulder compresses the tundra. Surface flow occurs along the small valley which is also expected to capture drainage from Seep-03 and Seep-21 at the edge of the pad. Flow along this valley disappears into the tundra just beyond Seep-20 (approximately 200 m NE from the edge of the camp pad). Seep-17 and Seep-20 flow for much of the season. Only small standing water pools (<0.5 m across) amongst boulders have been observed at Seep-03 and Seep-21 since the monitoring program was formalized in 2021. On-going monitoring in this drainage is at Seep-17 shown in Figure 5-48.

Figure 5-47. Generalized Flow Paths from the North Side of the Camp Pad.



Source: https://srk.sharepoint.com/sites/NACAPR003217/Internal/Task400_ML-ARD Monitoring/400--08_Reporting/Camp Pad and waste rock pad flow paths.pptx

Notes: Based on observed or audible flow between 2021 and 2024.

Figure 5-48. Seep-17 Looking Up-Gradient Towards the Drill Core Storage Area of the Camp Pad.

5.4.2 Rinse pH in the Camp Pad

The camp pad is predominantly made from sand, and based on previous test pitting programs, rock present in this catchment just occurs along the north edge of the pad and in the drill core storage area. 2021 and 2023 rinse pH's from strongly oxidized orange to brown rock in three test pits in the drill core storage area were acidic at pH 3.1 to 3.7, with the thickness of this layer varying from 60 cm to 2 m. The acid generating layer was underlain by grey rock with higher rinse pH (pH 4.7, pH 5.7 or pH 7.8-7.9 depending on the test pit; SRK 2024a). A surface grab sample in 2021 had rinse pH of 2.9. Beneath 2 m this pad was still frozen in late July 2023, and it is unknown if it thaws to the base by the end of each season.

Elsewhere, rock within this catchment along the edge of the camp pad, had circum-neutral rinse pH except at the northwest edge of the camp pad (by the tents) where a 20cm thick intermittent near-surface orange oxidized layer had rinse pH of 3.4 in 2023 (SRK 2024a). No rinse pH testing was conducted in this area in 2024.

5.4.3 Camp Pad Seepage Results

In 2024, seepage sampling occurred at Seep-17 northeast of the camp pad area (Figure 5-49 to Figure 5-52). All camp pad seepage charts, including comparison to water quality limits, are provided in Appendix C (Figures C77–C114).

pH and Conductivity Trends in 2024

Measured pH at Seep-17 ranged from 6.6 to 7.1, with the lowest pH being measured in early August (Figure 5-49). Conductivity measurements increased over the summer months from 112 µS/cm to 634 µS/cm, which is consistent with previous seasonal monitoring data at this location. The lower pH values are consistent with the pH measured in the tundra reference stations (pH 6.4 to 6.9) reflecting the influence of water interacting with the tundra, however, conductivity is significantly higher than background (Figure 5-49). pH results currently indicate a lack of ARD from the camp pad.

Major Ions

Similar to previous monitoring years, major anions and cations (Figure 5-50) were lowest at freshet and increased through the summer months at Seep-17. In terms of molar proportions, sulphate comprised 59% to 71% of the total anions, followed by alkalinity (23–35%) and then chloride (4–10%). Chloride and sulphate concentrations were below water quality guidelines in 2024. Sulphate increased from 25 to 210 mg/L and alkalinity increased from 9 to 80 mg/L, both suggesting that as more waste rock thawed through the season, buffering capacity increased in tandem with sulphide oxidation.

Calcium was the predominant major cation present at Seep-17 followed by magnesium, sodium, and potassium. Calcium and magnesium together proportionally made up 87 to 92% of the total cations.

Trace Ions

Seasonal trends for trace element concentrations are shown for Seep-17 in Figure 5-51 and Figure 5-52. None of the regulated parameters exceeded the NWB water license limits at Seep-17. Copper and fluoride exceeded the CCME water quality guidelines in 2024 samples; however, background levels of copper, and fluoride are naturally elevated in the Ulu area based on concentrations in the reference stations in 2022 and 2023. All other trace elements were below the CCME water quality guidelines in 2024 samples. Trace element concentrations at Seep-17 tended to decrease between May and June before increasing in concentration again between July and August. This trend was not observed in previous monitoring years likely due to limited data towards the end of the season and no data in May. The drop in concentrations between May and June may reflect that snow takes longer to melt on the north side of the camp pad, so greatest dilution occurs in June rather than May.

Figure 5-49. Seep-17 Camp Pad Seepage pH and Alkalinity.

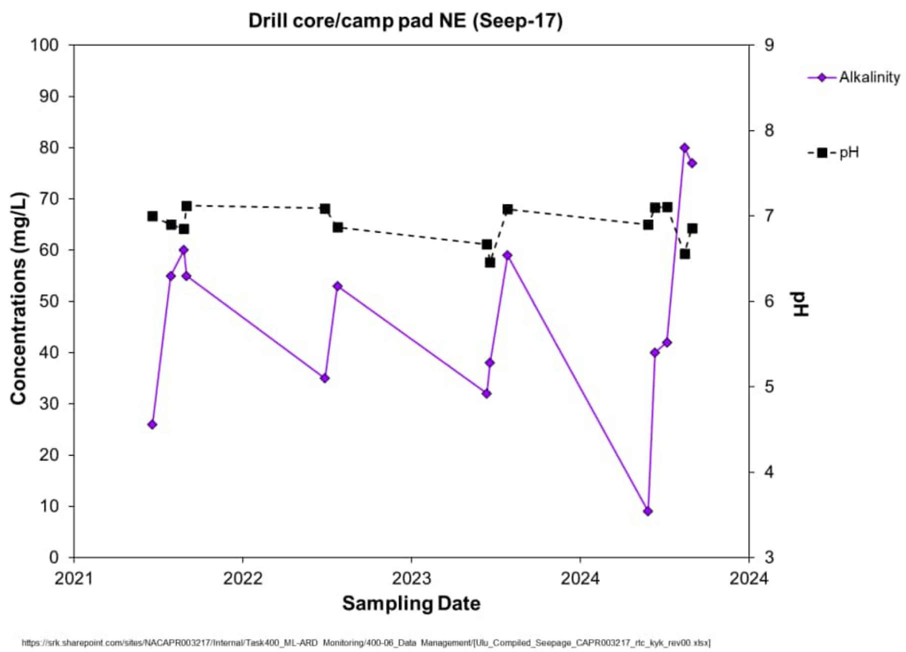


Figure 5-50. Seep-17 Camp Pad Seepage Major Cations and Anions.

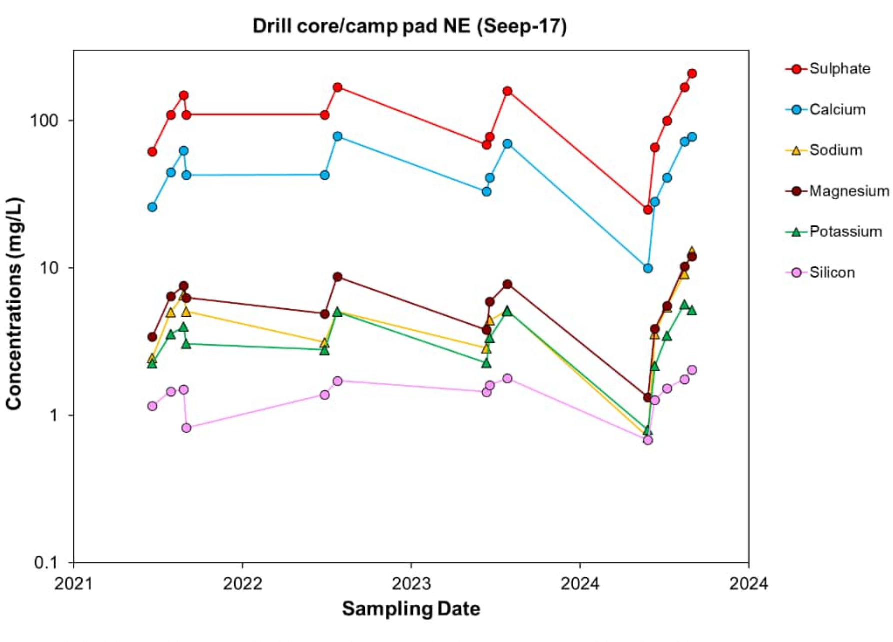


Figure 5-51. Seep-17 Camp Pad Seepage Oxyhydroxide Forming Elements.

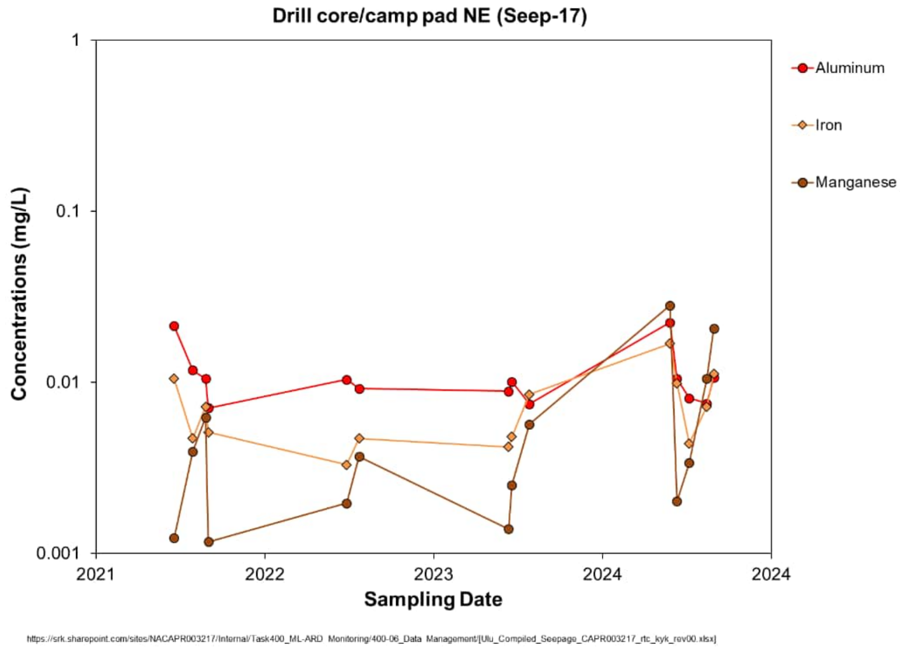
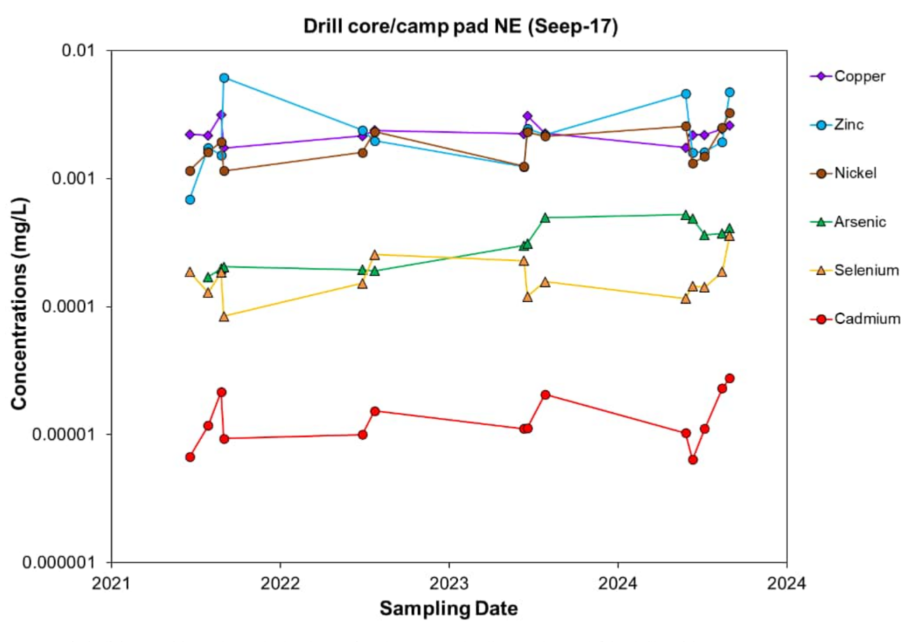


Figure 5-52. Seep-17 Camp Pad Seepage Trace Elements.



6 Summary and Conclusions

The 2024 monitoring program indicates the following regarding ARD:

- The south side of the ore pad, the waste rock-portal area and the camp pad are not at present generating ARD. Drainage from the camp pad, waste rock-portal pad area and the south side of the ore pad is currently (in 2024) being neutralized before it exits the pads. However, as carbonates continue to be depleted, the capacity for neutralization declines and ARD is expected to become more widespread without management of the rock.
- ARD is present seasonally (July/August) at the northwest edge of the ore pad and impacting the tundra through sub-surface drainage. Water quality has declined there since 2020; however, acid generating rock in this catchment was removed in August and September 2024.
- Rinse pH testing of grab samples from the northwest edge of the ore pad, as the rock was being excavated for relocation, indicated the rock (pH 2.9-6.4) and underlying tundra soil (pH 3.2-4.5) were dominantly acidic.
- Rinse pH tests on mineralized rock stockpiled above the portal pond had pH 4.6 to 7.9 (average 6.4, n=13). Combined with two results in 2023 of pH 4.3, this indicates that pH weathering conditions in the mineralized rock are highly variable (acidic and circum-neutral).

The 2024 monitoring program indicates the following regarding element leaching:

- Dissolved arsenic, copper, lead, nickel, and zinc were all below the maximum average and maximum grab sample effluent quality limits in the NWB water license in all the seepage monitored from the ore pad, camp pad, waste rock-portal pad area and landfill.
- Dissolved zinc was close to the NWB-WL effluent quality limit in ore pad seepage from the north edge of the ore pad. Zinc leaching has increased there since 2020. Zinc leaching in seepage at the south edge of the ore pad was lower than in 2023 but still the same order of magnitude as the effluent quality limit and is expected to get worse unless rock in the ore pad is managed.
- Aluminum, cadmium, copper, fluoride, iron, manganese, nickel, selenium, sulphate, and zinc were present in ore pad seepage at concentrations above background and above the water quality guidelines. Concentrations of most of these parameters would be expected to get worse if conditions became more acidic.
- Aluminum, arsenic, cadmium, copper, fluoride, sulphate, and zinc concentrations were above background and above the water quality guidelines at the waste rock-portal area.
- Zinc leaching in the landfill area (ULU-15) was an order of magnitude lower in June 2024 than the June 2023 high that was close to the NWB limit. This may be a result of switching to monitoring it upstream of the culvert (rather than downstream).
- Only copper and fluoride were above the water quality guidelines at the camp pad area, and were consistent with background concentrations for these parameters.

7 Recommendations

7.1 ML/ARD Management

SRK (2021) showed that 90% of the waste rock in the infrastructure pads was classified as potentially acid generating, therefore areas of the pads that currently contain circum-neutral pH rock will need managing to prevent ARD.

To reiterate estimates of timing of ARD onset for PAG rock, provided in SRK (2022b); based on calculations of site weathering rates, and measured ARD potential of the rock in the pads, delay to onset of ARD estimates for rock not covered in esker sand ranged from less than a year to six years (from 2020) for “worst case” material, depending on the depth, and six to 16 years (from 2020) for material with average ARD potential, again depending on the depth. Given that significant areas of rock are already generating acid, and these predictions are being realized, there is only a short window of opportunity to manage the PAG rock not covered in esker sand (and not already acidic) before widespread ARD is likely.

Therefore, SRK recommends the acid generating and potentially acid generating rock at Ulu be managed to prevent further development of ARD and acceleration of leaching of regulated parameters. Limiting pH decline in the infrastructure pads is necessary to avoid deterioration of water quality and remain compliant with the water license. As SRK (2024a) previously recommended, an ML/ARD management plan needs to be developed and implemented. The apparent trajectory of acidification indicates that acidification needs to be arrested this year to avoid impact to the surrounding environment from ARD.

Highest priority areas that need management are currently:

- Acid generating rock that was relocated from the north edge of the ore pad to the centre of the ore pad during 2024 Although this rock is no longer sitting directly on the tundra, it is currently at risk of developing more severely acidic conditions which could accelerate metal leaching and rapidly deplete carbonate from underlying rock in the ore pad.
- The southeast part of the ore pad where mineralized rock was previously stockpiled (this part of the ore pad is currently at high risk of exceeding the NWB effluent quality limit for zinc).
- The southern edge of the ore pad where there is limited sand cover (also at risk of generating ARD and more severe metal leaching).
- Mineralized rock (that is partially acid generating) stockpiled above the portal. Seepage drains into the mine sump pond (where the integrity of the liner is questionable), the portal pond, or a third adjacent temporary pond directly to the west which is thought to drain (sub-surface) to Seep-02 and then into East Lake.

Additional acidic rock that has the capacity to locally generate severe contact water chemistry, but water drains into the portal pond or into the waste rock-portal pad before it may exit the site, include:

- Waste rock just west of the portal pond and in the mine sump berm (seepage drains across the road into the waste rock-portal pad). Managing this rock may limit localized release of acidity and metals into water that drains into the waste rock-portal pad where it can contribute to depleting the neutralization capacity in that pad.

The drill core storage area has a significant volume of rock around pH 3 but due to the pads greater thickness (more than 3 m on the northeast side), it may remain frozen at the base providing some mitigation. Managing acid generating rock in this area is needed, but drainage chemistry is currently less problematic than ore pad drainage chemistry.

7.2 ML/ARD Monitoring

Table 7-1 shows the recommended seeps and frequency for on-going monitoring of ML/ARD conditions at Ulu (as recommended in SRK 2024a). It is recommended that ULU-15 be sampled upstream of the culvert (as in 2024) and not downstream (as in 2021 and 2023). Monitoring of the reference stations was also no longer considered necessary (SRK 2024a), as the reference station water chemistry is not expected to vary substantially and therefore the results from 2022 and 2023 are considered sufficient to represent background tundra water chemistry.

Table 7-1. Summary of On-going Seepage Monitoring Recommendations.

Area	Monitoring Location	Sampling Frequency	Additional Comments
Ore pad, southwest	Seep-01	At freshet, then after significant rainfall (as defined in the protocol), or monthly if there is no significant rainfall.	
Ore pad, northwest	Seep-05		
Ore pad, southeast	ULU-8A if flowing, otherwise ULU-8		Weekly checks of ULU-8A during July are recommended to identify if flow is present, associated with thawing of the pad at depth.
Camp pad, north	Seep-17	At freshet, then after significant rainfall (as defined in the protocol), or monthly if there is no significant rainfall.	Weekly checks of the edge of the camp pad upstream of Seep-17 during July/August are recommended to identify if direct flow out of the pad is present, associated with thawing of the pad at depth. If present, then sample this upstream flowing seepage too (monthly frequency).
Waste rock portal area, east	Seep-02	At freshet, then after significant rainfall (as defined in the protocol), or monthly if there is no significant rainfall.	
Waste rock portal area, west	Seep-13		

In addition to on-going seepage monitoring, the following are recommended to inform ML/ARD conditions for 2025:

- Regular rinse pH monitoring of the waste rock in the infrastructure pads, as per the rinse pH monitoring protocol (SRK 2022d), is no longer considered necessary for the following reasons:
  - The spatial distribution of acid generating rock in the pads and stockpiled mineralized rock has been well constrained between 2020 and 2024 and further test pits would be unlikely to add to this understanding or change the requirements for ML/ARD management that have been determined.
  - Excavating material on a regular basis could advance oxidation reactions by allowing increased oxygen ingress at test pit locations, given the limited size and depth of the infrastructure pads.
  - The excavation process can result in mixing of acidic layers near the surface of waste rock with pH neutral material at depth, which means the progression of acidic weathering conditions can no longer be established.
  - It is recommended; however, that rinse pH testing be performed on rock that is being relocated, on a few samples that represent the range of weathering/oxidation conditions present in the rock. Grab samples from the excavator bucket are sufficient.
- Conduct an EM-31 geophysical survey at the north and south side of the ore pad to identify the extent of the shallow sub-surface flow paths receiving loadings from mine rock. This is necessary because most of the flow out of the ore pad is sub-surface, and hence the extent of its impacts, or whether attenuation occurs close to the ore pad, is unknown.

Closure

This report, 2024 Monitoring of Metal Leaching and Acid Rock Drainage Potential at the Ulu Camp, was prepared by

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendix A Seepage and Rinse Test Sampling Coordinates

WGS84 UTM Zone 12N			Notes
Seep	Easting	Northing	
Seep-01	501162	7420747	
Seep-02	501551	7420979	
Seep-03	501480	7421283	Removed from monitoring
Seep-04	501512	7420885	Removed from monitoring
Seep-05	501071	7420847	
Seep-06	501540	7420721	Removed from monitoring
Seep-07	501338	7421254	Removed from monitoring
Seep-08	501399	7421259	Removed from monitoring
Seep-09	501494	7421015	Removed from monitoring
Seep-10	501488	7420971	Removed from monitoring
Seep-11	501405	7420924	Removed from monitoring
Seep-12	500934	7420797	Removed from monitoring
Seep-13	501557	7420863	
Seep-14	501572	7420885	Removed from monitoring
Seep-15	501620	7420926	Removed from monitoring
Seep-16	501387	7421054	Removed from monitoring
Seep-17	501514	7421310	
Seep-18	501547	7421313	Removed from monitoring as too close to Seep-17
Seep-19	499918	7415390	Camp 3, monitoring not required
Seep-20	501611	7421348	Removed from monitoring
Seep-21	501508	7421258	Removed from monitoring
Seep-22	501097	7420786	Removed from monitoring
Seep-23	501227	7420775	Removed from monitoring
Seep-24	501339	7421024	Removed from monitoring
Seep-25	501478	7420948	Removed from monitoring
Seep-26	501560	7420935	Removed from monitoring
ULU-4a	501381	7421028	
ULU-4b	501427	7421040	
Pool-4c	501453	7421052	
ULU-7	501429	7420938	
ULU-8	501252	7420805	
ULU-15	501524	7421075	
Loc-01	501467	7421309	Intermediate flow point from Seep-08 to Seep-18

Test Pit	Easting	Northing
TP24-01	501408	7421060
TP24-02	501418	7421064
TP24-03	501425	7421057
TP24-04	501418	7421049
TP24-06	501415	7421083
TP24-07	501402	7421074
TP24-08	501395	7421063
TP24-09	501123	7420848
TP24-10	501122	7420858
TP24-11	501102	7420849
TP24-12	501133	7420860
TP24-13	501133	7420849
TP24-14	501158	7420873

Appendix B Rinse Test Sampling Log

Location	Portal area (Above Portal East side)
Samples Collected	Depth (m)
TP24-01	0.40

Interval/sample	From (m)	To (m)	Description
	0	0.20	Brown rock
1A	0.20	0.25	Brown rock
1B	0.35	0.40	Brown rock

Photo 1: TP24-01

Photo 2: Sample before 2mm sieving

Location	Portal area (Above Portal East side)
Samples Collected	Depth (m)
TP24-02	0.35

Interval/sample	From (m)	To (m)	Description
	0	0.20	Brown rock
2A	0.20	0.25	Brown rock
2B	0.30	0.35	Brown rock

Photo 1: TP24-02

Photo 2: Sample after 2mm sieving

Location	Portal area (Above Portal East side)
Samples Collected	Depth (m)
TP24-03	0.30

Interval/sample	From (m)	To (m)	Description
	0	0.25	Grey rock
3A	0.25	0.30	Grey rock

Photo 1: TP24-03

Photo 2: Sample after 2mm sieving

srk consulting	Ulu ML/ARD Monitoring	Test Pits (May 2024) Photo Log
		Test Pit TP24-03
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / **Appendix A**

Location	Portal area (Above Portal East side)
Samples Collected	Depth (m)
TP24-04	0.35

Interval/sample	From (m)	To (m)	Description
	0	0.25	Grey rock
4A	0.20	0.26	Brown/Grey rock
4B	0.30	0.35	Brown/Grey rock

Photo 1: TP24-04

Photo 2: Sample after 2mm sieving

srk consulting	**Ulu ML/ARD Monitoring**	Test Pits (May 2024) Photo Log
		Test Pit TP24-04
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 — **Appendix A**

Location	Portal area (East of Portal Pond)
Samples Collected	Depth (m)
TP24-06	0.45

Interval/sample	From (m)	To (m)	Description
	0	0.30	Grey rock
6A	0.30	0.35	Grey rock
6B	0.40	0.45	Grey rock

Photo 1: TP24-06

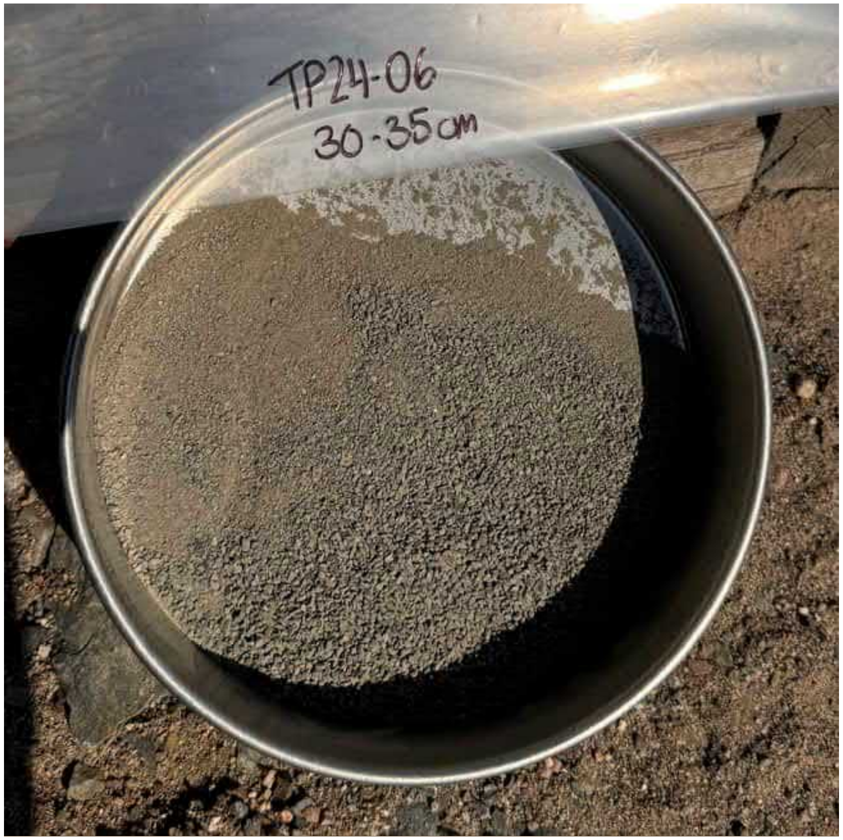

Photo 2: Sample after 2mm sieving

Location	Portal area (East of Portal Pond)
Samples Collected	Depth (m)
TP24-07	0.45

Interval/sample	From (m)	To (m)	Description
	0	0.30	Grey rock
7A	0.30	0.35	Brown/Grey rock
7B	0.40	0.45	Brown rock

Photo 1: TP24-07

Photo 2: Sample after 2mm sieving

srk consulting	Ulu ML/ARD Monitoring	Test Pits (June 2024) Photo Log
		Test Pit TP24-07
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 — Appendix A

Location	Portal area (East of Portal Pond)
Samples Collected	Depth (m)
TP24-08	0.45

Interval/sample	From (m)	To (m)	Description
	0	0.30	Grey rock
8A	0.30	0.35	Grey rock
8B	0.40	0.45	Grey rock

Photo 1: TP24-08

Photo 2: Sample after 2mm sieving

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-09	0.45

Interval/sample	From (m)	To (m)	Description
9A	0	0.10	Brown tundra soil
9B	0.40	0.45	Orange tundra soil

Photo 1: TP24-09

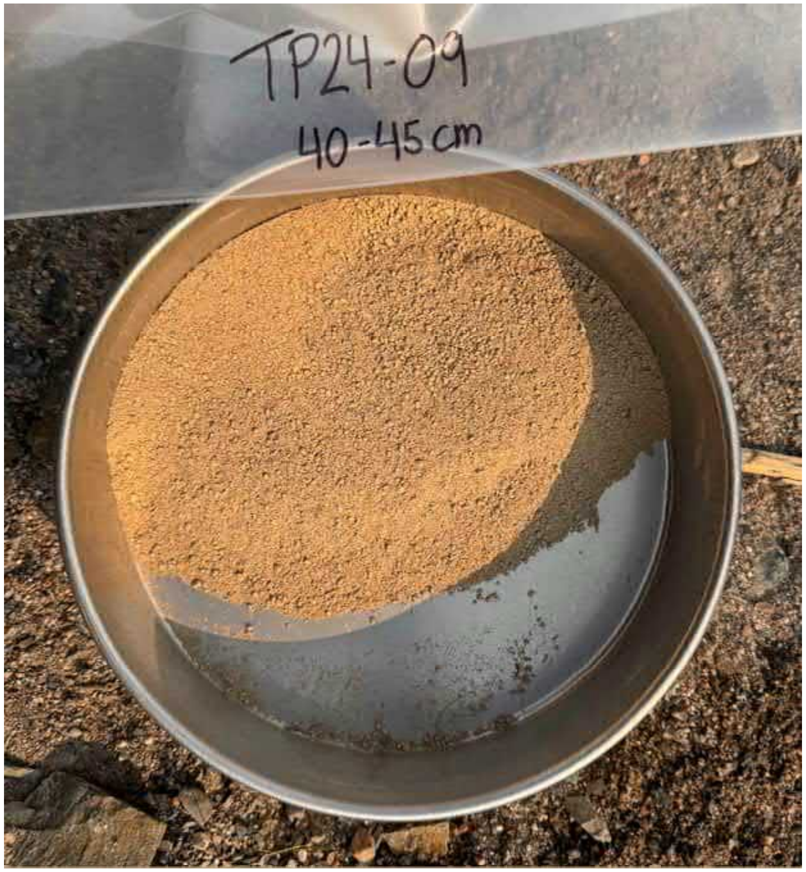

Photo 2: Sample after 2mm sieving

srk consulting	**Ulu ML/ARD Monitoring**	Test Pits (August 2024) Photo Log
		Test Pit TP24-09
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / **Appendix A**

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-10	0.30

Interval/sample	From (m)	To (m)	Description
10A	0	0.10	Orange rock
10B	0.25	0.30	Brown tundra soil

Photo 1: TP24-10

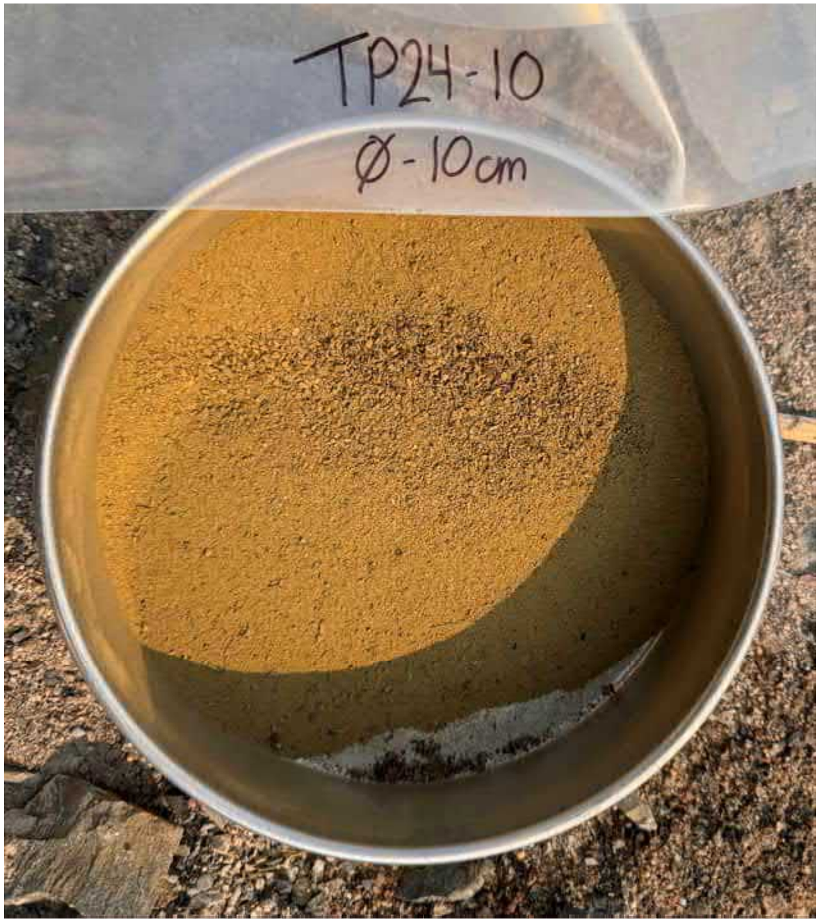

Photo 2: Sample after 2mm sieving

srk consulting	Ulu ML/ARD Monitoring	Test Pits (August 2024) Photo Log
		Test Pit TP24-10
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / Appendix A

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-11	0.25

Interval/sample	From (m)	To (m)	Description
11A	0.20	0.25	Grey rock

Photo 1: TP24-11

Photo 2: Sample after 2mm sieving

srk consulting	**Ulu ML/ARD Monitoring**	Test Pits (August 2024) Photo Log
		Test Pit TP24-11
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / **Appendix A**

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-12	0.20

Interval/sample	**From (m)**	**To (m)**	**Description**
12A	0.15	0.20	Orang/Brown tundra soil

Photo 1: TP24-12

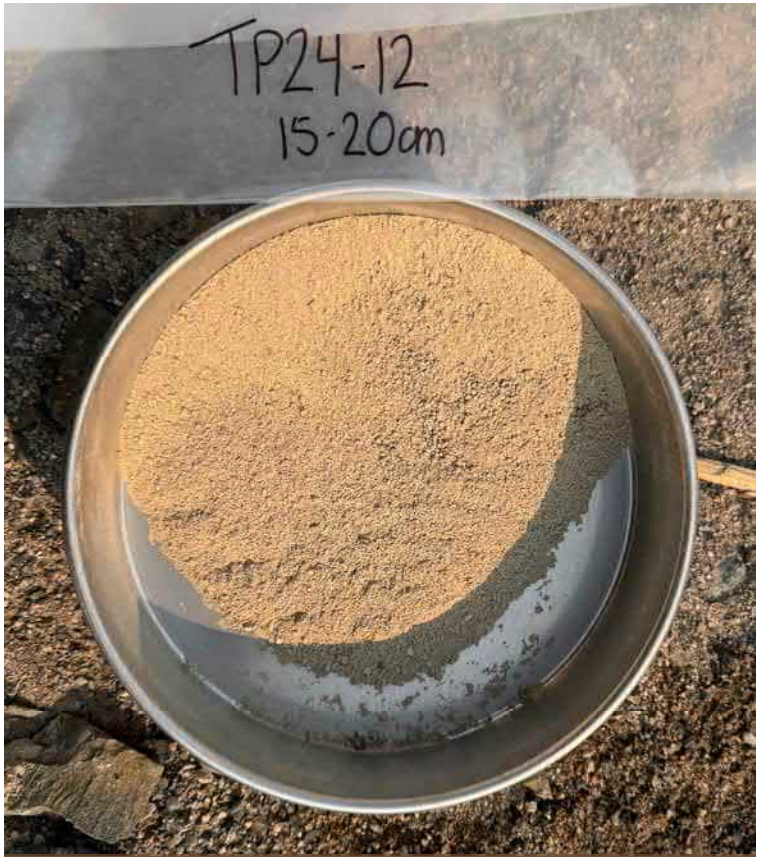

Photo 2: Sample after 2mm sieving

srk consulting	**Ulu ML/ARD Monitoring**	Test Pits (August 2024) Photo Log
		Test Pit TP24-12
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / **Appendix A**

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-13	0.10

Interval/sample	From (m)	To (m)	Description
13A	0	0.10	Orange rock

Photo 1: TP24-13

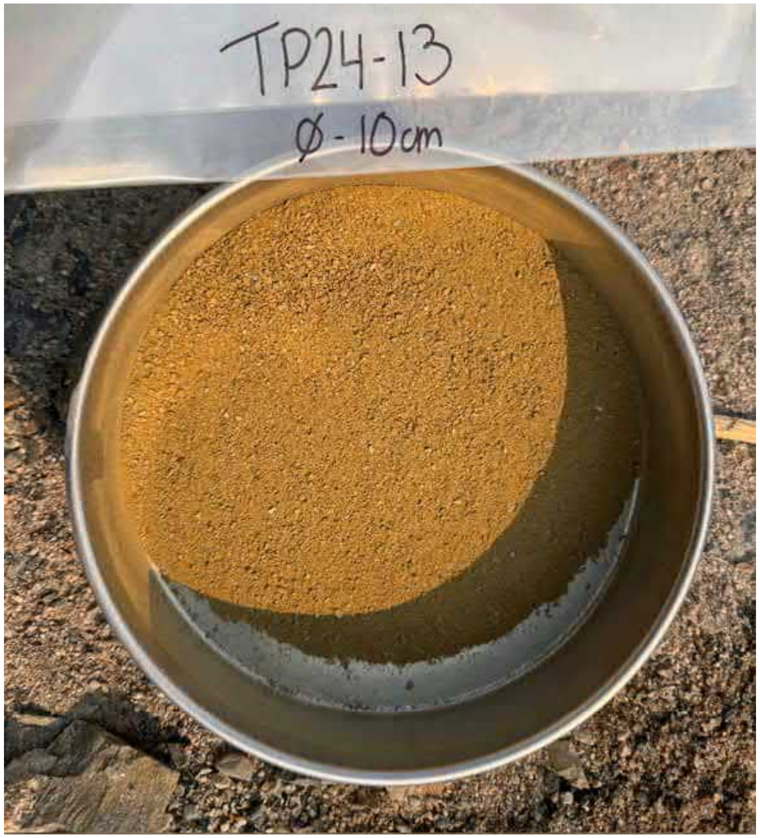

Photo 2: Sample after 2mm sieving

srk consulting	**Ulu ML/ARD Monitoring**	Test Pits (August 2024) Photo Log
		Test Pit TP24-13
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / **Appendix A**

Location	Ore Pad (North)
Samples Collected	Depth (m)
TP24-14	0.05

Interval/sample	From (m)	To (m)	Description
14A	0	0.05	Orange/brown rock/tundra soil

Photo 1: Sample before 2mm sieving

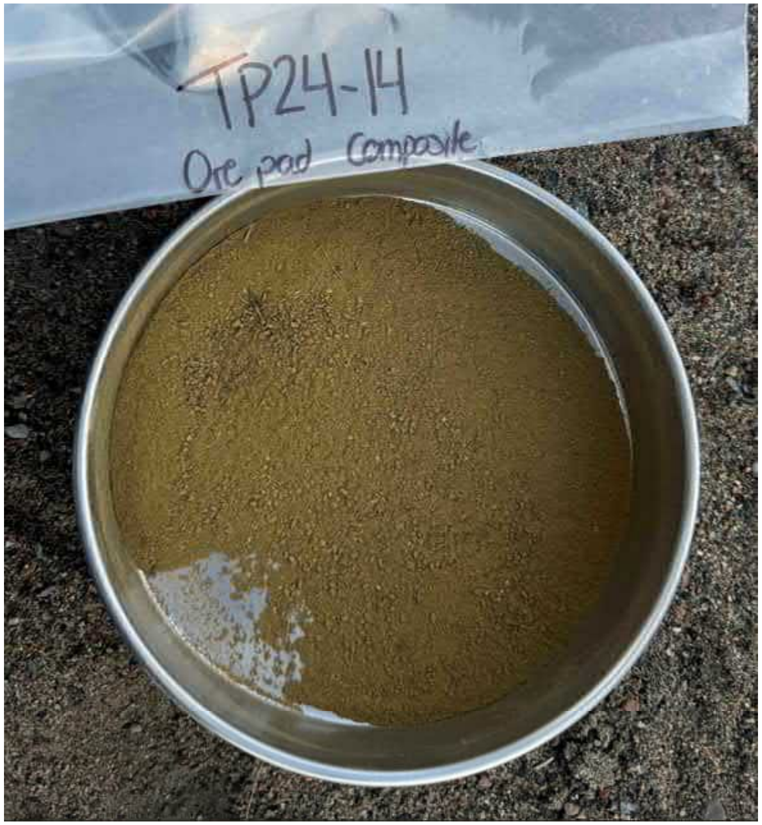

Photo 2: Sample after 2mm sieving

srk consulting	Ulu ML/ARD Monitoring	Test Pits (August 2024) Photo Log
		Test Pit TP24-14
AppA_Ulu Test_Pit_Photo_Log_CAPR003217_Rev00.pptx		Date: March 2025 / Appendix A