# 2023 Monitoring of Metal Leaching and Acid Rock Drainage Potential at the Ulu Camp, Ulu Gold Project, Nunavut

**Prepared for**

Blue Star Gold Corp

**Prepared by**

srk consulting

SRK Consulting (Canada) Inc.
CAPR002649
March 2024

# 2023 Monitoring of Metal Leaching and Acid Rock Drainage Potential at the Ulu Camp, Ulu Gold Project, Nunavut

March 2024


**Prepared for**

Blue Star Gold Corp
700 West Pender Street, Suite 507
Vancouver, BC  V6C 1GB

Tel.: 1-778-379-1433
Web: www.bluestargold.ca

**Prepared by**

SRK Consulting (Canada) Inc.
320 Granville Street, Suite 2600
Vancouver, BC  V6C 1S9
Canada

Tel.: +1 604 681 4196
Web: www.srk.com



Project No.: CAPR002649

File Name: Ulu 2023 MLARD Monitoring Report_CAPR002649_FINAL_20240327.docx




srk consulting

# Executive Summary

The Ulu project was historically an advanced gold exploration project with underground development occurring in 1996 and 1997. Waste rock from underground was placed in infrastructure pads which remain on the surface of the site. Studies in 2020 and 2021 have shown that around 90% of the waste rock in the infrastructure pads was classified as potentially acid generating, and the rock is currently acidifying in the pads. Monitoring of the rock and seepage from the pads has been used to understand the current metal leaching and acid rock drainage (ML/ARD) conditions to inform management of the rock as part of site reclamation.

The 2023 ML/ARD program included:

- Monitoring rinse pH of rock in the infrastructure pads (with sample collection from test pits), to assess the development of acidic weathering conditions.
- A one-off pH-conductivity survey in pooled water in the tundra adjacent to the north edge of the ore pad (and the downgradient swamp), with targeted water sampling, to help determine the impact acidic rock at the edge of the ore pad is having on the downgradient environment.
- Monitoring of seepage from the infrastructure pads at freshet and through the open water season to improve understanding of ML/ARD and identify changing conditions.
- Monitoring of pH, conductivity, and redox conditions in the pools in the tundra around the ore pad (every two weeks), to improve the understanding of factors that cause pH decline.
- Monitoring of the reference stations that were established in 2022 to determine natural background levels of parameters associated with metal leaching, in tundra run-off.

Blue Star conducted most of the field program, with SRK providing training in the field and off-site support.

Results from the 2023 monitoring program combined with the previous datasets from 2020 onwards indicate the following regarding ARD:

- The waste rock-portal area and the camp pad are not generating ARD.
- The south side of the ore pad is not generating ARD.
- 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 and is expected to continue to get worse unless acid generating rock in this catchment is managed.
- In July 2023, acidic conditions in the tundra extended for at least 15 m, but less than 25 m from the north edge of the ore pad.
- Rinse pH testing of samples from test pits in the pads showed that acid generating rock has been identified in each of the pads at multiple locations, and in ore and waste rock stored on the east and west side of the portal. Drainage from the camp pad, waste rock-portal area and the south side of the ore pad is currently (in 2023) 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.

- Lowest rinse pH results were pH 2.9, and lowest pH measured in drainage in the tundra was pH 4.2 therefore this site has the potential to develop more severe pH drainage conditions.
- To reiterate estimates of timing of ARD onset 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. There is therefore a short window of opportunity to manage the rock not covered in esker sand before widespread ARD is likely.

The 2023 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 licence.
- Dissolved zinc was close to the NWB-WL effluent quality limit in ore pad seepage, from both the north and south edges of the ore pad. Zinc leaching has increased since 2020 and is expected to get worse unless rock in the ore pad is managed.
- Aluminum, cadmium, copper, fluoride, iron, manganese, nickel, selenium, and zinc were present in ore pad seepage at concentrations above background and above the CCME PAL-FW water quality guidelines. Concentrations of most of these parameters would be expected to get worse if conditions became more acidic.
- Leaching of sulphate, cadmium, copper, iron, nickel, manganese, selenium, and zinc is associated with sulphide oxidation, and is consistent with the presence of iron sulphides, and trace chalcopyrite, sphalerite, arsenopyrite, and millerite in the waste rock in the infrastructure pads.

The rock at Ulu needs to be managed to prevent further development of ARD and avoid deterioration of water quality. Developing and implementing an ML/ARD management plan should therefore be a priority. Several highest priority areas need management within a short time frame (in 2024).

Continued monitoring of seepage and rinse pH testing of the waste rock in the pads is recommended.

# Table of Contents

# List of Figures

# List of Tables



# Appendices

# List of Abbreviations

| | |
|---|---|
| ARD | Acid rock drainage |
| BV | Bureau Veritas Labs |
| CCME | Canadian Council for Ministers of the Environment |
| CCME PAL-FW | water quality guidelines for the protection of aquatic life freshwater |
| DI | de-ionized |
| DL | detection limit |
| DO | dissolved oxygen |
| EC | electrical conductivity |
| FCSAP | Federal Contaminated Sites Action Plan |
| ICP-MS | ICP metal scan |
| ML/ARD | metal leaching and acid rock drainage |
| NWB-WL | Nunavut Water Board Water Licence |
| ORP | oxidation reduction potential |
| PAG | potentially acid generating |
| QA/QC | Quality assurance/quality control |
| STF | soil treatment facility |
| TDS | total dissolved solids |
| TSS | total suspended solids |

# 1 Introduction

## 1.1 Scope of Work

SRK Consulting (Canada) Inc. is providing support to Blue Star Gold Corp. (Blue Star) for monitoring of current metal leaching and acid rock drainage (ML/ARD) conditions at the Ulu reclamation project in Nunavut.

Objectives of the ML/ARD program for the 2023 season were to:

- Monitor seepage from infrastructure pads at the Ulu camp to inform understanding of current ML/ARD conditions from rock brought to surface during historical mining activities.
- Monitor rinse pH of rock in the infrastructure pads to assess the development of acidic weathering conditions.
- Improve the understand of pH and metal leaching conditions in the tundra down-gradient of the north side of the ore pad.
- Report on the results and interpretations related to the development of ML/ARD.
- Provide input for management of problematic rock as part of on-going reclamation activities.

This report summarizes the methods used, results, interpretations, and findings from the 2023 program and is the deliverable for Task 100 of SRK's scope of work dated May 10, 2023. It is intended for use by Blue Star.

## 1.2 Background Information

### 1.2.1 Site History and Description

The Ulu project was historically an advanced gold exploration project with underground development occurring in 1996 and 1997. An estimated 126,900 tonnes of waste rock were produced during the underground exploration program (Wolfden 2005). Development waste rock brought to surface was used to construct the camp pad, sections of the road network and to build the ore pad and waste rock-portal pad (Figure 1.1). Estimated volumes in each of the pads from BGC (2003) are 15,000 $m^3$ in the camp pad, 20,000 $m^3$ in the ore pad, and 8,000 $m^3$ in the waste rock-portal pad including approximately half of which is in a waste rock stockpile on the waste rock-portal pad (4,300 $m^3$). The pads are estimated to be around 1 to 3 m thick.

Approximately 2,200 tonnes of mineralized bulk sample were brought to surface and temporarily stored on the ore pad prior to removal off-site (Cowley et al 2015). An estimated 750 $m^3$ of this remained on the ore pad in a stockpile when the project was abandoned, until 2018 when the mineralized rock was subsequently relocated to the portal-mine sump area (Figure 1.1).

Sand and gravel from an esker approximately 6 km south of the Ulu camp was also used as a construction material at the site and overlies waste rock on much of the ore pad and parts of the camp pad. Based on test pit programs, the earliest (central) part of the camp pad is built from esker material with waste rock additions around the margins, as development rock from underground became available.

As part of Blue Star's reclamation activities in 2020, much of the esker sand on the ore pad surface was stockpiled along the centre of the pad to expose the underlying rock. The esker sand had reportedly been up to a meter thick in places (A. Stearman, personal communication, 2020). Waste rock from an area of approximately 6 m by 50 m along the northwest edge of the ore pad (that had not historically been covered in esker sand) was removed by excavator and stockpiled in preparation for building a new soil treatment facility (STF) on the ore pad. Some of the waste rock was used to fill in low points on the ore pad STF site and was then covered with the stockpiled esker sand (A. Stearman, personal communication, 2021). Some of this waste rock is still stockpiled on the ore pad (Figure 1.1). Both the stockpiled waste rock and residual waste rock on the tundra along the northwest edge of the ore pad are currently acid generating based on rinse test results (SRK 2021). The stockpiled waste rock was covered with tarps in July 2022 to limit precipitation ingress. The STF has not yet been built pending decisions on management of the rock in and on the ore pad.

During August and September 2021, acid generating waste rock removed from camp 3 (200 $m^3$) and culvert 6 (68 $m^3$) during remediation works was temporarily relocated to the ore pad (SRK 2022a). The waste rock was subsequently covered with tarps, to limit precipitation ingress, pending development of a long-term management plan for the larger volumes of acid generating and potentially acid generating (PAG) rock at the Ulu site.

The broader Ulu property is undergoing exploration by Blue Star, however, infrastructure at the Ulu camp site that is not required for the exploration program is being reclaimed. A landfill facility was constructed to the south of the camp pad during the 2021 season, and stockpiled scrap materials from various locations around the camp pad and on the waste rock-portal pad were removed and relocated to the landfill and covered with esker sand. The landfill is contoured such that drainage at freshet should run-off the frozen esker sand cover. This may subsequently drain into the eastern part of the waste rock-portal pad and into down-gradient seeps towards East Lake or may drain to compliance monitoring site ULU-15 (Figure 3.3).


**LEGEND**

**NOTES**

1. Drone Imagery: Blue Star Gold Corp - 2023.
2. Basemap Imagery: ESRI, Maxar Earthstar Geographics.

**REFERENCES**

1. Coordinate System: NAD 1983 UTM Zone 12N

0 25 50 75 100
Meters

srk consulting

SRK JOB NO: CAPR002649

LAYOUT: CAPR002649_Ulu_Annual_reports

BLUE STAR GOLD CORP.

Ulu

2023 ML/ARD Characterization

Site Layout

| Date: | Approved: | Figure: |
|---|---|---|
| Mar 2024 | KYK | 1.1 |

PROJECT PATH: C:\Users\MSMITH\SRK Consulting\FS725 Ulu - !040_AutoCAD\GIS\Projects\CAPR002649_Ulu_Annual_reports\CAPR002649_Ulu_Annual_reports.aprx - L-Fig 1-1_Site Layout

### 1.2.2 Geology and Mineralization

The Ulu property lies towards the southern end of the Archean High Lake greenstone belt of the Slave Geological Province. Cowley et al (2015) indicated that the greenstone belt in the Ulu area is dominated by a basaltic sequence of pillow lavas, massive flows and contemporaneous gabbro sills, with lesser turbidites and younger granites. The greenstone belt has been regionally metamorphosed to upper greenschist to amphibolite grade and is intruded by McKenzie diabase dykes.

**Waste Rock**

SRK has observed that waste rock in the infrastructure pads (representing waste removed during portal and ramp development) is basaltic. Mineralogy on seven test pit samples (SRK 2022b) indicated the dominant minerals are amphibole (26-38%), plagioclase feldspar (21-28%) and quartz (17-22%), with minor pyroxene, chlorite, biotite, K-feldspar, and ilmenite (2-7%). In the samples tested, total sulphide minerals were present at 0.94 to 2.3%, with pyrrhotite (or sometimes pyrite) dominating. Chalcopyrite, sphalerite, arsenopyrite and millerite were present in all samples at less than 0.1% abundance, except for one sample that contained 0.39% sphalerite. Calcite was the dominant carbonate mineral (present at 0.02% to 0.69% in five samples, and 2.1% in one sample), with dolomite also present (0.01 to 0.21%).

The waste rock in the pads is variably oxidized, and ranges from predominantly grey, to predominantly orange/brown with particle surfaces coated in the weathering products of sulphide oxidation. Accordingly, goethite/limonite was present in all the mineralogy samples at 0.60 to 1.30%, jarosite was present in all samples at 0.001 to 0.004%, and gypsum was present in two samples at 0.00003 to 0.11% (SRK 2022b). Additionally, the surface of the infrastructure pads in areas of more strongly oxidized rock, may become coated in prominent secondary minerals as the rock dries out and porewater evaporates during dry periods.

In general, the most oxidized areas of waste rock are near the surface of the pads, where there has historically been no esker sand cover, including around the edges of the pads, although strongly oxidized rock has also been found at depth (down to 1.5 m; SRK 2023).

**Ore/Waste Above the Mine Sump**

Rock above (and partially in) the mine sump (Figure 1.1) was previously stockpiled on the ore pad from 2006 through 2018 representing the remnants of the bulk sample removed from underground for processing at Lupin Mine. The rock includes both waste rock and ore that has been somewhat mixed during relocation. The surface rock is predominantly grey metabasalt that appears to contain only rare fresh sulphides and is not strongly oxidized; however, there are common brown oxidized surface coatings comprising up to 30% of the visible surfaces, and grey-brown fines are present just below the surface. There is also material with more abundant fresh sulphides (around 10% abundance, that appears to be predominantly pyrrhotite, and likely also contains pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena, based on ore mineralogy reported in Cowley et al, 2015).

### 1.2.3 ML/ARD Potential at Ulu

Previous geochemical studies at Ulu have been documented by SRK (2021, 2022b, 2023). The main conclusions from the static characterization work conducted in 2020 and from rinse pH and seepage monitoring conducted in 2020, 2021 and 2022 were:

- Around 90% of the waste rock in the infrastructure pads was classified as potentially acid generating (PAG).
- Waste rock was undergoing acidification to some extent in all the pads, particularly in near-surface rock, and down the outer edges of the pads as shown by rinse pHs of 2.9 to 3.7.
- Most waste rock at depth had circum-neutral pH (6.5 to 8); however, acidic areas existed at depths of up to 1.5 m within the pads, associated with areas that were not covered in esker sand, and with higher than typical sulphide content.
- Seepage monitoring indicated that the waste rock in the camp pad and waste rock-portal pads was not generating ARD as contact water seeps and tundra seepage had pHs above 6.5 (from 2020 through 2022). Local acid generation within the waste rock was being neutralized by carbonates before drainage left the pads.
- Acidic pHs in tundra seepage down gradient of the ore pad (down to pH 4.6 in 2022) were thought to represent either ARD or be a result of extended interaction of water that was not flowing, with the naturally acidic tundra soils (measured with rinse pH down to pH 4.3).
- Based on calculations using all the available datasets, 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 for material with "typical" ARD potential, again depending on the depth. Where rock had historically been covered in esker sand, the estimated delay to ARD was longer at 11 to 25 years (from 2020).
- Where surface to near-surface rock is underlain by rock with longer delay to ARD onset, the underlying materials may temporarily help maintain circum-neutral pH from acidic surface rock; however, as calcite gradually becomes depleted, acidic conditions are expected to advance and lead to ARD.
- Seepage from the infrastructure pads is impacted by metal leaching at levels above CCME water quality guidelines, which is predominantly being driven by oxidation of pyrrhotite and pyrite (as the dominant sulphides) along with trace chalcopyrite, sphalerite, arsenopyrite and millerite; resulting in widespread leaching of sulphate and zinc, in addition to leaching of cadmium, iron, manganese, nickel, and selenium in ore pad seepage, and leaching of arsenic from ore.
- Metal leaching was at levels below the Nunavut Water Board effluent water quality criteria[1]; however, dissolved zinc was within an order of magnitude of the criteria.
- Trace element leaching is expected to increase if pH declines further or if local acidic conditions within the pads become more widespread.

[1] Parameters that have criteria are total arsenic, total copper, total lead, total nickel, and total zinc.

### 1.2.4 ML/ARD Monitoring Programs

Based on the findings and recommendations provided in SRK (2021, 2022b), a comprehensive seepage monitoring program was initiated by SRK and Blue Star in June 2021 so that changing pH conditions are identified. The program is conducted as part of Blue Star's reclamation research and was formalized in a seepage monitoring protocol (SRK 2022c). Seepage monitoring has been conducted at Ulu since 2021 during each open water season, as per the monitoring protocol. Seepage monitoring in 2020 was conducted for Blue Star by Peridotite 932 Consulting.

A rinse pH monitoring program on the waste rock in the infrastructure pads was also recommended in SRK (2022b) to provide an "early warning system" compared to seepage monitoring, providing information on the degree of acidic weathering conditions within the pads. The rinse pH monitoring protocol was formalized as SRK (2022d). Rinse pH monitoring has been conducted at Ulu in 2020, 2021 and 2023.

### 1.2.5 Climate Conditions and the Effect of Esker Sand Cover on the Infrastructure Pads

Based on climate normals for the nearby Lupin Mine (Environment and Climate Change Canada 2022), the Ulu site has a mean annual air temperature of around –11ºC, with a mean air temperature in July at around 12ºC. Mean annual snowfall recorded at the Lupin Mine is 138 mm. Mean annual rainfall is 160 mm, mostly occurring in July and August. Freshet occurs during May or June at Ulu, when the majority of flowing water is encountered at site.

The site is within continuous permafrost with an active layer that thaws seasonally. Thermal modelling work conducted by SRK (2022e) indicated that exposed (uncovered) waste rock in the infrastructure pads at Ulu that are approximately 2.0 m thick or less would be expected to completely thaw and freeze-back each year. Thaw duration is at least 4 months per year for rock down to depths of 1.3 m; however, average temperature of thawed rock declines substantially over this depth range (15ºC at surface vs 0.9ºC at 1.3 m depth). As temperature is a control on reaction rates, degree of sulphide oxidation is expected to decline with depth.

The modelling also showed that an esker sand cover on the pads would be expected to reduce the active layer depth and therefore limit the portion of seasonally unfrozen waste rock susceptible to oxidation of sulphides. The modelling also indicated that a sand cover is effective in reducing the seasonal thaw duration and temperature for the portion of waste rock that does become unfrozen, to an extent that would significantly limit geochemical reactions.

The modelling is consistent with observations from the site of the degree of oxidation being lowest in waste rock at depth where there was historically an esker sand cover (i.e., on the central part of the ore pad; Figure 1.1).

In 2022, Blue Star installed ground temperature monitoring instruments in the ore pad at two locations, one with and one without an esker sand cover, to ground truth the modelling work and improve the understanding of the thermal effects of an esker sand cover over the waste rock. Data collection has been on-going since August 2022 and will be used in the future as an input to determine cover thickness requirements in planning for final reclamation and closure of the site.

# 2 2023 ML/ARD Program

The following components were part of the 2023 ML/ARD program:

- Monitoring rinse pH of rock in the infrastructure pads (with sample collection from test pits), to assess the development of acidic weathering conditions.
- A one-off pH-conductivity survey in pooled water in the tundra adjacent to the north edge of the ore pad, and along the downgradient swampy drainage path towards Lake G43, with targeted water sampling, to help determine the impact acidic rock at the edge of the ore pad is having on the downgradient environment. This was recommended in SRK (2023).
- Monitoring of seepage from the infrastructure pads at freshet and through the open water season to improve understanding of ML/ARD and identify changing conditions.
- Monitoring of pH, conductivity, and redox conditions in the pools in the tundra around the ore pad (every two weeks), to improve the understanding of factors that cause pH decline.
- Monitoring of the reference stations that were established in 2022 to determine natural background levels of parameters associated with metal leaching, in tundra run-off.

# 3 Methods

SRK Principal Consultant Kirsty Ketchum (PGeo) was on site from June 8 through June 14 for the 2023 seepage monitoring program and from July 19 through July 22 for the rinse pH monitoring program and the survey of pooled water in the tundra downgradient of the north edge of the ore pad.

## 3.1 Rinse pH Monitoring

Blue Star environment staff were trained in rinse pH monitoring (sampling and testing) by SRK on July 19 to 21, 2023 and sampling was completed by Blue Star on July 23, 2023.

Rinse pH monitoring was conducted using the methods in the Rinse pH monitoring protocol (SRK 2022d). Sample locations were pre-selected based on a 50 m grid. The grid was modified to improve coverage of locations falling just off the grid. An additional location was added for residual waste rock sitting on the tundra where rock in the north edge of ore pad was previously removed.

Most samples were collected from excavated test pits as per the protocol. A few pits were dug by shovel or hand-shovel where excavator access was not possible, or the waste rock was not thick enough to require an excavator. Sample locations are shown in Figure 3.1 and co-ordinates are provided in Appendix D.

Sample depths are provided with the results. Rinse testing included measurement of rinse pH and rinse conductivity. Results are provided in Section 5.1.


**LEGEND**

- 2023 Test Pit Locations
- Not Excavated / Not Sampled

**NOTES**

1. Drone Imagery: Blue Star Gold Corp - 2023.
2. Basemap Imagery: ESRI, Maxar Earthstar Geographics.

**REFERENCES**

1. Coordinate System: NAD 1983 UTM Zone 12N

0 25 50 75 100
Meters

srk consulting

BLUE STAR GOLD CORP.

SRK JOB NO: CAPR002649

LAYOUT: CAPR002649_Ulu_Annual_reports

Ulu

2023 ML/ARD Characterization

2023 Test Pit Locations for Rinse pH Monitoring

| Date: | Approved: | Figure: |
|---|---|---|
| Mar 2024 | KYK | 3.1 |

## 3.2 In Situ pH-Conductivity Survey

To help determine the extent that acidic rock along the north edge of the ore pad is affecting the downgradient tundra, a one-off pH-conductivity survey was conducted, with in situ testing of pooled water in the tundra adjacent to the ore pad, and along the swampy drainage path towards Lake G43 (Figure 3.2). The survey was conducted by SRK and Blue Star on July 21, 2023, with follow up targeted water sampling on July 22, 2023.

The entire survey distance from the road to Lake G43 is approximately 325 m. The intention was to test water for pH and conductivity approximately every 30 m, to give 10 test locations; however fewer sites than this were found. Four sites northeast of Seep-05 and three sites west/southwest of Seep-05 were found, which in addition to Seep-05, gave eight survey sites (Figure 3.2). For sites that were along the drainage path adjacent to the ore pad, the perpendicular distance from the edge of the ore pad ranged between approximately 10 m and 50 m. Seep-12 (at the end of the drainage path), that was flowing into Lake G43 in early July had dried up.

Pools that were tested in situ are shown on Figure 3.2. Location numbers refer to meters from Seep-05 (recorded by GPS), with negative numbers indicating up-gradient (to the northeast of Seep-05) and positive numbers indicating down-gradient (i.e., beyond Seep-05, to the west/southwest, towards Lake G43). The suffix -SW indicates standing water.

Of the eight sites tested for pH and conductivity, four were sampled the next day for the full suite of seepage parameters. These included three sites closest to the north edge of the ore pad, and one site further down-gradient of the northwest corner of the ore pad (Figure 3.2). A discussion on the limitations of sampling and interpreting data from stagnant waters is provided in Section 3.6.2. Results are provided in Section 5.2.

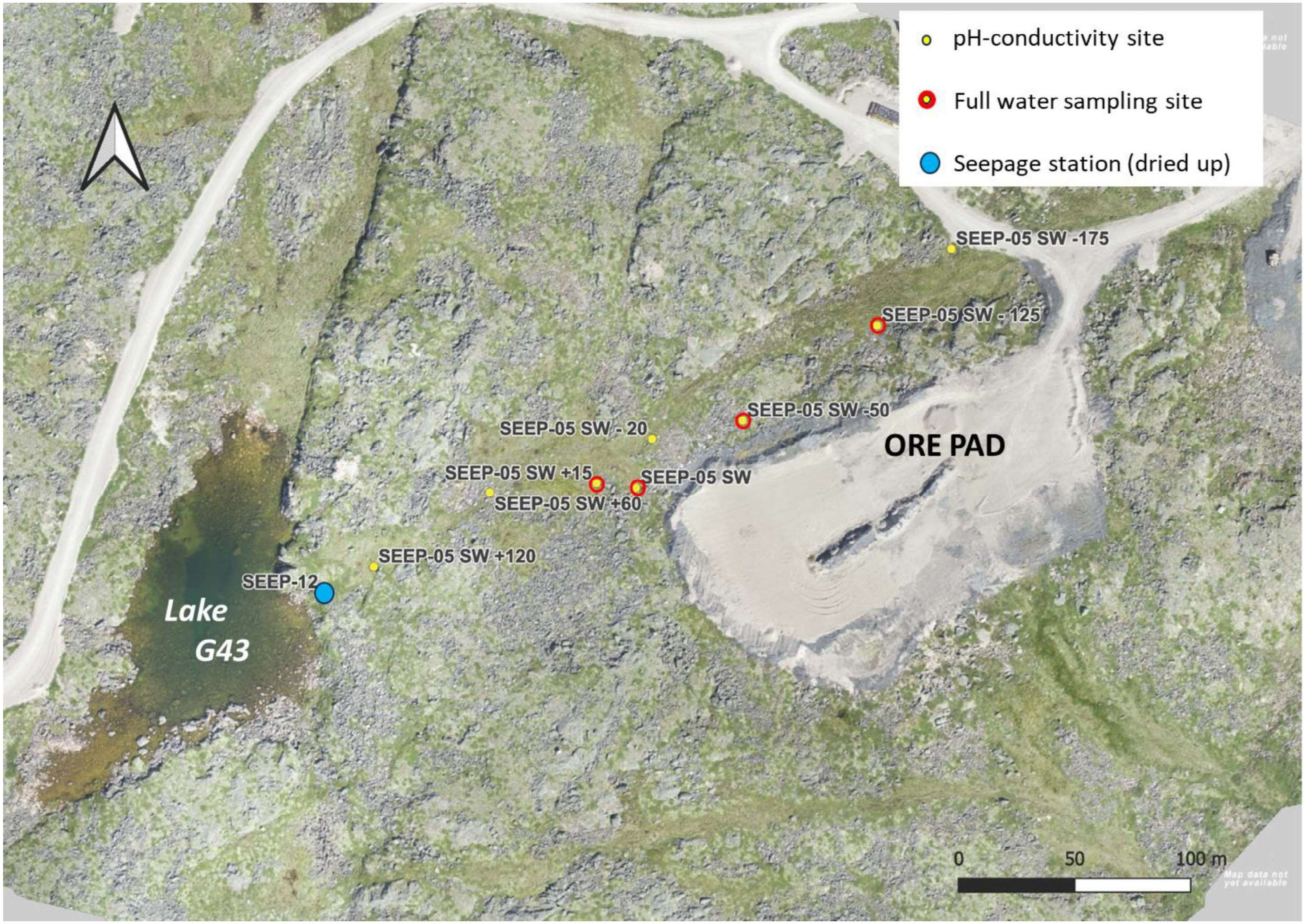



**Figure 3.2. North Ore Pad July 2023 pH-Conductivity Survey Locations (source Blue Star Gold)**

## 3.3 Seepage Monitoring

The Ulu seepage monitoring protocol (SRK 2022c) documents the methods to be used for seepage monitoring at Ulu including monitoring frequency, field data to be collected, sample collection procedures (including QC samples) and setting up new monitoring stations.

Based on the protocol, and more recent recommendations (SRK 2023) made due to acidic pH's in tundra seepage down gradient of the ore pad (down to pH 4.6 in 2022), and acid generating rock present at the edges of the ore pad and the drill core storage area of the camp pad, the monitoring included the following key components:

- Sampling all flowing seeps after freshet and after significant rain
- Sample standing water seeps at freshet (based on the assumption that water was recently flowing)
- Weekly checks for flow directly out of the ore pad and drill core area
- Bi-weekly field readings of pools surrounding the ore pad
- In addition, monthly compliance monitoring (during periods of flow, when the site is active) is required by the Nunavut Water Board for seeps that are identified in the water licence (ULU-7, ULU-8, and ULU-15).

Key information on the seepage monitoring stations is tabulated in Table 3-1 including year established, upstream and downstream locations and what the water is thought to represent. Locations are shown on Figure 3.3 and co-ordinates are provided in Appendix D.

Blue Star environment staff were trained in seepage sampling by SRK during freshet monitoring from June 9 through June 13, 2023. Freshet monitoring occurred later than peak freshet conditions as indicated by the advanced degree of snow melt when monitoring started. Although monitoring started as soon as Ulu Camp opened, conditions were unseasonably warm as was typical across the north in the spring/summer of 2023 and the snow had melted early. As a result, some of the seeps from previous years were not sampled as they had already dried up; however, 19 seeps were sampled during freshet monitoring including five new seeps that were set up as new monitoring stations (Seep-22 to Seep-26).

Subsequent monitoring was conducted by Blue Star environment staff, including sampling on June 19 to 20 after rainfall (over the three proceeding days), and field data collection with some sample collection was conducted on July 1 to 3, July 7 to 8, July 16, and July 27 to 29. The sampling/field data collection is summarized in Table 3-2. Significantly, direct flow out of the south edge of the ore pad was recognized during the weekly checks for flow. This was set up as a new seepage station, ULU-8A, which was interpreted to flow sub-surface to ULU-8 which is approximately five meters down-gradient from the edge of the ore pad. ULU-8A was sampled three times while flowing, between July 1 and July 16.

Field data were collected from several monitoring stations that had standing water, around the camp pad and waste rock-portal pad. This exceeded the requirements of the program (highlighted in green in Table 3-2). Field data collection around the ore pad on a bi-weekly frequency generally occurred, with exceptions noted in Table 3-2 (highlighted in yellow).

Several seeps were not checked for flow during the June 19 to 20 sampling that occurred following significant rain. Most of these were likely to have been flowing based on previous years experience (highlighted in pink in Table 3-2). Two other seeps were also observed to be flowing during this sampling event but were not sampled (highlighted in red in Table 3-2).

The last seepage monitoring event occurred July 27 to 29 as the camp was closed early for the season. A total of 28 seepage samples were collected between June 9 and July 27 (not including QC samples).

In addition to the seepage samples, the two reference stations (Ref-03 and Ref-06) were sampled on June 13 and July 3. These were dry when checked on July 29. Their locations are shown on Figure 3.4.

Seepage and reference station results are provided in Section 5.3.

Quality assurance/quality control (QA/QC) sampling included collection of five field method blanks, five duplicate samples and six trip blanks. The QA/QC results are discussed in Section 4.

**Table 3-1. Overview of Ulu Seepage Monitoring Stations**

| Seep | Area | Year established | Upstream location | Comments/represents | Downstream location | Monitoring recommendations for 2023 |
|---|---|---|---|---|---|---|
| Seep-01 | Ore pad (south) | 2019 | Ore pad/tundra | Ore pad tundra seep, sub-surface drainage. | Seep-06, then East Lake | Freshet monitoring. Check weekly for flow associated with thawing of pad at depth. Check after significant rain events. Sample if flow is present. Bi-weekly field readings. |
| Seep-02 | Within tundra between waste rock pad and East Lake | 2020 | Seep-09 | Waste rock pad seepage modified by tundra interaction | Seep-14 and seep-15 (flow splits into two), then East Lake | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Seep-03 | Camp pad (NE) | 2020 | Camp pad | Thought to be contact water. To be confirmed when flow is next observed. | Seep-20 then sub-surface to Ulu Lake | Freshet monitoring. Check weekly for flow associated with thawing of pad at depth. Check after significant rain events. Sample if flow is present. |
| Seep-04 | Within tundra between waste rock pad and East Lake | 2020 | Seep-11 and ULU-7 | Waste rock pad seepage modified by tundra interaction | Seep-13 then East Lake | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Seep-05 | Ore pad (NW) | 2020 | Ore pad/tundra | Ore pad tundra seep, likely sub-surface drainage. | Seep-12 then Lake G43 | Freshet monitoring. Check weekly for flow associated with thawing of pad at depth. Check after significant rain events. Sample if flow is present. Bi-weekly field readings. |
| Seep-06 | Inflow to East Lake (S) | 2020 | ULU-8 and Seep-01 | Flow into East Lake from south side of ore pad | East Lake | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Seep-07 | Camp pad (N) | 2021 | Camp pad | Camp pad contact water | Sub-surface to Seep-17/Seep-20 drainage | |
| Seep-08 | Camp pad (N) | 2021 | Camp pad | Camp pad contact water | Sub-surface to Seep-17/Seep-20 drainage | |
| Seep-09 | Waste rock pad (E) | 2021 | Waste rock pad | Waste rock pad contact water | Sub-surface to Seep-02, -26, -14, -15 then East Lake | |
| Seep-10 | Waste rock pad (C) | 2021 | Waste rock pad | Waste rock pad/stockpile contact water | Sub-surface to Seep-13 or Seep-14 | |
| Seep-11 | Waste rock pad (W) | 2021 | Waste rock pad | Waste rock pad/stockpile contact water | Seep-04, then Seep-13 to East Lake | |
| Seep-12 | Inflow to small lake (G43) west of ore pad | 2021 | Seep-05 and boggy drainage area becoming defined surface flow | Flow into small lake (G43), part of West Lake catchment, from northwest side of ore pad | Lake G43 | |
| Seep-13 | Inflow to East Lake (W) | 2021 | Seep-04 (and potentially sub-surface from Seep-10) | Flow into East Lake from waste rock pad and waste rock stockpile. | East Lake | |
| Seep-14 | Inflow to East Lake (W) | 2020 | Seep-02 (and sub-surface from Seep-09, -10) | Flow into East Lake from waste rock pad | East Lake | |
| Seep-15 | Inflow to East Lake (NW) | 2021 | Seep-02 and higher ground to the east | Flow into East Lake from waste rock pad, also receives drainage from higher ground to the east. | East Lake | |
| Seep-16 | Portal area | 2021 | Mineralized rock above mine sump | Flow from snow melt passing through a few meters of waste rock/ore above portal/mine sump. | Portal pond | |
| Seep-17 | Camp pad (NE) | 2021 | Camp pad/tundra | Tundra seep from camp pad area where drill core is stored. Location also receives drainage from higher ground to the NW. | Seep-20, then sub-surface towards Ulu Lake | |
| Seep-18 | Camp pad (NE) | 2021 | Seep-17 | Tundra seep from camp pad area, downstream of Seep-17. Location also receives drainage from higher ground to the NW. | Seep-20, then sub-surface towards Ulu Lake | Discontinued as too close to Seep-17. Seep-20 established further downstream instead. |
| Seep-20 | Camp pad (NE) | 2022 | Seep-17, Seep-03, Seep-21 | Tundra seepage from Camp pad area, multiple flow paths converge upstream. This is last point before flow becomes sub-surface. | Disappears into tundra, sub-surface towards Ulu Lake | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Seep-21 | Camp pad (NE) | 2022 | Camp pad | Camp pad contact water | Seep-20 | |
| Seep-22 | Ore pad (W) | 2023 | Ore pad | Ore pad tundra seep, likely sub-surface drainage. | Seep-06, then East Lake | Freshet monitoring. Check weekly for flow associated with thawing of pad at depth. Check after significant rain events. Sample if flow is present. Bi-weekly field readings. |
| Seep-23 | Ore pad (S) | 2023 | Ore pad | Ore pad tundra seep, sub-surface drainage. | Seep-06, then East Lake | |
| Seep-24 | Portal area | 2023 | Waste rock west of portal entrance | Waste rock contact water | Waste rock-portal pad | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Seep-25 | Waste rock pad (C) | 2023 | Waste rock pad | Waste rock pad/stockpile contact water | Sub-surface to Seep-13 or Seep-14 | |
| Seep-26 | Within tundra between waste rock pad and East Lake | 2023 | Seep-02, -09 | Waste rock pad seepage modified by tundra interaction | Sub-surface to Seep-14 then East Lake | |
| ULU-7 | Waste rock stockpile | Historical | Waste rock stockpile | Waste rock pad/stockpile contact water | Seep-04, then seep-13 to East Lake | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| ULU-8 | Ore pad (S) | Historical | Ore pad | Ore pad seepage, likely predominantly sub-surface. | Seep-06, then East Lake | Freshet monitoring. Check weekly for flow associated with thawing of pad at depth. Check after significant rain events. Sample if flow is present. Bi-weekly field readings. |
| ULU-8A | Ore pad (S) | 2023 | Ore pad | Direct surface flow out of ore pad | Sub-surface to ULU-8 | |
| ULU-15 | Camp pad (S) | 2021 | Camp pad/landfill | Seepage from south side of camp pad and drainage through/run-off from landfill. | Sub-surface, likely to Seep-02 | Freshet monitoring. Check after significant rain events, and sample if flow is present. |
| Ref-03 | North of Camp | 2022 | Tundra | Background conditions | Ulu Lake | Freshet and monthly monitoring. Also check after significant rain events, and sample if flow is present. |
| Ref-06 | North of Ulu Lake | 2022 | Tundra | Background conditions | Ulu Lake | |
| Seep-19 | Camp 3 | 2021 | Camp 3 road | Camp 3 road contact water, prior to removal of acidic waste rock. | Lake K29a | All waste rock removed, therefore no longer represents waste rock seepage. Monitoring discontinued. |

Source: SRK Consulting\NA CAPR002649 Ulu Reclamation SOW 2023 - Internal\Task100_ML-ARD\160_Data management\ Ulu_Compiled_Seepage_CAPR002649_rtc_kyk_rev00.xlsx

**Notes**: highlighting indicates: grey=waste rock contact water, green=flows or daylights within tundra, blue=downstream inflow to lake.


**LEGEND**

- Seepage Monitoring Locations
- Portal Pond

**NOTES**

1. Drone Imagery: Blue Star Gold Corp - 2023.
2. Basemap Imagery: ESRI, Maxar Earthstar Geographics.

**REFERENCES**

1. Coordinate System: NAD 1983 UTM Zone 12N

0 50 100 150 200
Meters

srk consulting

SRK JOB NO: CAPR002649

LAYOUT: CAPR002649_Ulu_Annual_reports

BLUE STAR GOLD CORP.

Ulu

2023 ML/ARD Characterization

Seepage Monitoring Locations

| Date: | Approved: | Figure: |
|---|---|---|
| Mar 2024 | KYK | 3.3 |

PROJECT PATH: C:\Users\MSMITH\SRK Consulting\FS725 Ulu - 1040_AutoCAD\GIS\Projects\CAPR002649_Ulu_Annual_reports\CAPR002649_Ulu_Annual_reports.aprx - L-Fig 3-3_Seepage Monitoring Locations


LEGEND

Seepage Reference Monitoring Locations

NOTES

1. Drone Imagery: Blue Star Gold Corp - 2023.
2. Basemap Imagery: ESRI, Maxar Earthstar Geographics.

REFERENCES

1. Coordinate System: NAD 1983 UTM Zone 12N

0 100 200 300 400

Meters

srk consulting

SRK JOB NO: CAPR002649

LAYOUT: CAPR002649_Ulu_Annual_reports

BLUE STAR GOLD CORP.

Ulu

2023 ML/ARD Characterization

Seepage Reference Monitoring Locations

Date: Mar 2024 | Approved: KYK | Figure: 3.4

PROJECT PATH: C:\Users\MSMITH\SRK Consulting\FS725 Ulu - !040_AutoCAD\GIS\Projects\CAPR002649_Ulu_Annual_reports\CAPR002649_Ulu_Annual_reports.aprx - L-Fig 3-4_Seepage Reference Locations

**Table 3-2. Summary of Seepage Monitoring Conducted During 2023**

| | Purpose/requirements | Freshet survey and June compliance sampling | | Sampling after significant rain (June 16-18) and bi-weekly field readings from ore pad standing pools | | Field readings from ore pad standing pools and sampling direct flow out of ore pad (new ULU-8A) | | | | | | Ore pad field readings and final check/sampling of all seeps prior to camp closure | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Date** | **June 9-13** | | **June 19-20** | | **July 1-3** | | **July 7-8** | | **July 16** | | **July 27-29** | | |
| **Station** | **Pad/area** | **Seep status** | **Sampled** | **Seep status** | **Sampled** | **Seep status** | **Sampled** | **Seep status** | **Sampled** | **Seep status** | **Sampled** | **Seep status** | **Sampled** | **Comments if recommendations not met** |
| Seep-01 | Ore pad | No flow | Yes | No flow | No | No flow | Field data | No flow | Field data | No flow | No | No flow | Field data | Field data frequency less than recommended for ore pad |
| Seep-02 | Waste rock-portal pad | Flowing | Yes | Not checked/recorded | | - | - | Flowing | Yes | - | - | No flow | Field data | Likely flowing, should have been checked/sampled |
| Seep-03 | Camp pad (drill core area) | Dry | - | No flow | Field data | Dry | - | No flow | Field data | No flow | Field data | Dry | - | |
| Seep-04 | Waste rock-portal pad | Dry | - | Not checked/recorded | | - | - | - | - | | | Dry | - | Should have been checked after rain |
| Seep-05 | Ore pad | No flow | Yes | No flow | Field data | No flow | Field data | No flow | Field data | No flow | Field data | No flow | Field data | |
| Seep-06 | East Lk inflow from ore pad | Flowing | Yes | Flowing | No | - | - | - | - | - | - | Dry | - | Flow present after rain, should have been sampled |
| Seep-07 | Camp pad | Inaccessible flow | | Inaccessible flow | | Inaccessible flow | | - | - | - | - | No flow | - | |
| Seep-08 | Camp pad | Flowing | Yes | No flow | - | No flow | Field data | - | - | - | - | No flow | Field data | |
| Seep-09 | Waste rock-portal pad | Dry | - | Dry | - | Dry | - | Inaccessible flow | | - | - | Dry | - | |
| Seep-10 | Waste rock-portal pad | Dry | - | Dry | - | Dry | - | Dry | - | - | - | Dry | - | |
| Seep-11 | Waste rock-portal pad | Flowing | Yes | Flowing | Field data | No flow | Field data | No flow | Field data | - | - | No flow | Field data | Flow present after rain, should have been sampled |
| Seep-12 | Lk G43 inflow from ore pad | Flowing | Yes | Flowing | Yes | Flowing | Field data | - | - | - | - | Dry | - | |
| Seep-13 | East Lk inflow from waste rock-portal pad | Flowing | Yes | Not checked/recorded | | - | - | - | - | - | - | Dry | - | Likely flowing, should have been checked/sampled |
| Seep-14 | East Lk inflow from waste rock-portal pad | Flowing | Yes | Not checked/recorded | | - | - | - | - | - | - | Dry | - | Likely flowing, should have been checked/sampled |
| Seep-15 | East Lk inflow from waste rock-portal pad | Flowing | Yes | Not checked/recorded | | - | - | - | - | - | - | Dry | - | Likely flowing, should have been checked/sampled |
| Seep-16 | Portal pond inflow (snowmelt) | Dry | - | - | - | - | - | - | - | - | - | - | - | |
| Seep-17 | Camp pad | Flowing | Yes | Flowing | Yes | No flow | Field data | - | - | - | - | Flowing | Yes | |
| Seep-18 | Obsolete (replaced by Seep-20) | - | - | - | - | - | - | - | - | - | - | - | - | |
| Seep-19 | Obsolete (Camp 3) | - | - | - | - | - | - | - | - | - | - | - | - | |
| Seep-20 | Camp pad | Flowing | Yes | Flowing | Yes | Flowing | Field data | - | - | - | - | Flowing | Yes | |
| Seep-21 | Camp pad | Dry | - | No flow | Field data | No flow | Field data | - | - | - | - | No flow | Field data | |
| Seep-22 | Ore pad | No flow | Yes | No flow | Field data | No flow | Field data | Dry | - | Dry | - | Dry | - | |
| Seep-23 | Ore pad | No flow | Yes | Not checked/recorded | | No flow | Field data | No flow | Field data | No flow | Field data | No flow | Field data | Should have been checked after rain |
| Seep-24 | Portal area | Flowing | Yes | Not checked/recorded | | - | - | - | - | - | - | Dry | - | Should have been checked after rain |
| Seep-25 | Waste rock-portal pad | Flowing | Yes | Dry | - | Dry | - | Dry | - | - | - | Dry | - | |
| Seep-26 | Waste rock-portal pad | Flowing | Yes | Dry | - | - | - | - | - | - | - | Not checked/recorded | | |
| ULU-7 | Waste rock-portal pad | Dry | - | Not checked/recorded | | Dry | - | - | - | - | - | Not checked/recorded | | Was likely checked as other nearby seeps were checked |
| ULU-8 | Ore pad | No flow | Yes | No flow | No | Flowing | Yes | Not recorded | | Not recorded | | No flow | Field data | Field data frequency less than recommended for ore pad |
| ULU-8A | Ore pad | - | - | - | - | Flowing | Yes | Flowing | Yes | Flowing | Yes | No flow | Field data | |
| ULU-15 | Camp pad-Landfill | Flowing | Yes | No flow | - | Dry | - | Dry | - | Dry | - | Dry | - | |
| Ref-03 | - | Flowing | Yes | Not checked/recorded | | Flowing | Yes | - | - | - | - | Dry | - | |
| Ref-06 | - | Flowing | Yes | Not checked/recorded | | Flowing | Yes | - | - | - | - | Dry | - | |

Source: SRK Consulting\NA CAPR002649 Ulu Reclamation SOW 2023 - Internal\Task100_ML-ARD\150_Lab liaison and QC\ Ulu seep tracking.xlsx

**Notes:** Highlighting indicates: Green = field data collection above the recommendations, pink = not checked or no record of check, red = flow present after rain so should have been sampled, yellow = field data collection less frequent than recommended for the ore pad.

## 3.4 Analytical Methods

### 3.4.1 Rinse Tests

Where necessary prior to sieving, gravel samples were spread out on trays indoors and dried at room temperature. Rinse testing was conducted on the -2 mm fraction of each sample. The method is documented in SRK (2022d) and uses a 1:1 ratio (by weight) of sample to de-ionized water. pH and conductivity were measured in the samples, and in blank tests containing only de-ionized water.

### 3.4.2 Seepage Analysis

The following chemical parameters were measured in the field at seepage sampling locations:

- pH and electrical conductivity (EC),
- Oxidation reduction potential (ORP) or dissolved oxygen (depending on which meter was available/functioning at site)

Samples were submitted to Bureau Veritas Labs (BV) in Yellowknife and then forwarded to BV in Calgary for analysis of the following parameters:

- Lab pH and EC
- Total suspended solids (TSS), total dissolved solids (TDS), hardness, acidity
- Anions (alkalinity, sulphate, chloride, nitrate, nitrite, ammonia, bromide, fluoride)
- Total and dissolved metals

## 3.5 Seepage Data QA/QC and Compilation

SRK checked sample receipt confirmation reports issued by the lab for correct sample login and analytical requirements. SRK compiled the seepage lab results with field data provided by Blue Star, for QC assessment (Section 4). Seepage results were subsequently compiled with the seepage results from previous years of monitoring (SRK 2023) for data interpretation.

## 3.6 Data Interpretation Methods

### 3.6.1 General

Where results were below the detection limit (DLs), the DL value was used in charts and calculations.

### 3.6.2 pH, ARD and Acidic Water in the Tundra

For the purpose of classification, direct drainage from an infrastructure pad (contact water) that has pH of 5 or below is considered to be acidic (ARD). Drainage with pH 5 to 6.5 is considered mildly acidic. pH 6.5 to 8 is considered circum-neutral, and pH above 8 is considered alkaline.

A localized area within an infrastructure pad that has pH less than 5 (identified through rinse pH testing) is not considered ARD unless it produces drainage with pH less than 5, i.e., surface or sub-surface flow out of the pad.

Water within the tundra may have acidic pH that is not necessarily ARD as the tundra is expected to be naturally acidic due to the presence of organic acids, as indicated by rinse pHs of pH 4.3 to 5.8 from background tundra soil samples measured in 2022 (SRK 2023). Acidic waters caused by organic acids typically have much lower conductivity than acidic waters resulting from oxidation of sulphide minerals.

Seepage from the infrastructure pads is expected to interact with the tundra which may lower the pH of the seepage if the source drainage had circum-neutral pH but low alkalinity.

Within the seepage monitoring program attempts have been made to establish whether water sampled in the tundra represents:

- Flow (or recent flow) from the infrastructure pads, that may have minor interaction with the tundra but is indicative of the direct influence the pads are having on drainage chemistry, and the processes (geochemical reactions) occurring in the pads.
- Standing water (with no visible flow) that likely originated from the infrastructure pads (through sub-surface drainage) but may have been modified through extended interaction with the tundra, or evaporation. The chemistry of standing water could become more “severe” (e.g., lower pH) or concentrated, through extended tundra interaction and/or evaporation in which case it is no longer indicative of drainage chemistry from the pads; however, it would still represent the conditions present downgradient of the pads in water that may have the potential to migrate further downstream.

Where there is a lack of direct flow out of the pads, the difference between these scenarios is important for data interpretation and understanding whether ARD from the infrastructure pads is present. Water that is considered likely to have drained from an infrastructure pad (through sub-surface flow) that has pH of 5 or below may be considered ARD based on interpretation of other results such as field conductivity, concentrations of sulphate and metals, and context from the up-stream/up-gradient rock. This is discussed with the results in Section 5.

### 3.6.3 Metal Leaching Interpretation Methods

The 2020 to 2023 seepage data were used to interpret metal leaching characteristics and controls. Metal leaching interpretation included:

- Assessment of major ions and their proportions to indicate dominant processes controlling water chemistry;
- Assessment of the molar ratio of calcium and magnesium (representing calcite and dolomite dissolution) to sulphate (representing sulphide oxidation) with pH to provide an indication of how effectively carbonate minerals are neutralizing the acid generated by sulphide oxidation;
- Charting of key parameters against pH to assess pH control;

- Assessment of current parameters of concern through comparison of the seepage data (dissolved concentrations) to Canadian Council for Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life freshwater (CCME PAL-FW; CCME 2021). For sulphate, the BC guideline for PAL-FW (MOE 2013) was used as no CCME sulphate guideline exists; and
- Charting of key parameters against time to examine trends from 2020 through 2023.

# 4 Quality Control Results

SRK used the five field method blanks and five duplicate sample pairs along with the broader lab and field data for QC evaluation of the overall seepage dataset. The six trip blanks were used to evaluate potential external contamination (outside of the sampling procedures).

A summary of the QC checks performed are summarized in Table 4-1, along with SRKs acceptance criteria, and the results of the QC analysis. The QC failures are discussed below (see letter reference to the failures in the table below).

A **–** Three field blanks (DI water sampled and filtered in the field) had levels of dissolved barium and strontium (5 to 10 times DLs) that are often seen with the filtration cups used at Ulu. Dissolved copper and nickel were measured at 5 to 12 times DLs and dissolved zinc was measured at 24 times DL. Although these elements are expected to be in the background at Ulu and could potentially be introduced during sampling, it is unclear if this was the case as these elements were also present in the trip blanks (see next note).

B **–** Three trip blanks (which were not opened at site) had levels of dissolved copper (4-6 times DL), dissolved nickel (7-10 times DL), dissolved zinc (6 times DL), total copper (4 times DL), total nickel (6 to 21 times DL), and total nickel (7 times DL) that failed the QC criteria (SRK and BV's). The reruns confirmed some of these and not others. Further investigations by BV led them to indicate the trip blanks may have been contaminated in the lab during analysis but that other samples were not affected.

C **–** One duplicate pair failed having heterogeneity in dissolved copper, iron, lead, zinc. Also see next note.

D **–** Six samples failed for having dissolved metal results higher than total metal results for a few parameters. One was part of a duplicate pair (noted in C). Heterogeneity is not entirely unexpected in flowing water. For three of the samples, zinc was the only parameter that failed. Some of the samples were collected using a syringe and were challenging to collect.

Overall, the dataset from the samples was considered acceptable. The levels of contamination in the trip blanks and field blanks were below the concentrations observed in the samples.

**Table 4-1. Seepage QA/QC Results**

| QC Test | SRK QC Criteria | Results and Comments | Comment Reference |
|---|---|---|---|
| | | **Physical Test[1]** | |
| Field Blank (n=5) | <5X DL | All passed. | |
| Trip Blank (n=6) | <2X DL | Trip Blank (7/19/2023) pH higher than typical. Rerun confirmed. | |
| Field vs. Lab pH Samples (n=39) | Within 1 pH unit difference. | All passed. | |
| Field vs. Lab Conductivity (n=39) | For samples >10X DL, should be within +/-30% RPD. | ULU-8A (7/16/2023) failed (62% RPD, field EC higher than lab EC. Lab EC consistent with TDS therefore not rechecked). | |
| Field Duplicate (n=5) | For samples >10X DL, should be within +/-30% RPD. For pH should be +/-0.2 difference pH units. | All passed. | |
| | | **Anions and Nutrients[2]** | |
| Field Blank (n=5) | <5X DL | All passed. | |
| Trip Blank (n=6) | <2X DL | All passed. | |
| Field Duplicate (n=3) | For samples >10X DL, should be within +/-30% RPD. | 1 duplicate pair failed: SEEP-05 & SEEP-105 failed for Br-not rechecked, not a parameter of concern. | |
| Ion Balance (n=39) | For EC>100 uS/cm, % difference should be within +/-10%. | All passed. | |
| | | **Trace Elements with ICP-MS Finish** | |
| Field Blank (n=5) | <5X DL | SEEP-00C (6/20/2023) failed for: D-Ba, D-Ni, D-Sr, D-Zn, T-P. Reruns confirmed. SEEP-00D (7/8/2023) failed for: D-Ba, T-P. Reruns confirmed. SEEP-00E (7/22/2023) failed for: D-Ba, D-Cu, D-Ni, D-Sr, T-Ba. Reruns confirmed. | A |
| Trip Blank (n=6) | <2X DL | TRIP BLANK (6/13/2023) failed for: D-Mn, D-Sr, D-U. Rerun results were lower. Lab suspected vial contamination for the Trip Blank vial and that samples in the batch were not affected. Lab checked instrument QC samples and all were within QC lab criteria. TRIP BLANK (7/5/2023) failed for: D-Cr, D-Cu, D-Fe, D-Ni, D-Zn, T-Cu, T-Ni, T-Zn. Rerun confirmed and the 2nd bottle was reran which had lower results. Lab validated <DL results for D-Zn, T-Cu, T-Ni, T-Zn. Lab suspected contamination due to "splashing during preparation or loading of the samples" TRIP BLANK (6/22/2023) failed for: D-Ni, D-Cu, T-Ni. Reruns confirmed. TRIP BLANK (7/19/2023) failed for: T-Ni. Rerun confirmed. | B |
| Field Duplicate (n=5) | For samples >10X DL, should be within +/-30% RPD. For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | 1 duplicate pair failed: REF-06 & REF-106 (7/3/2023) failed for D-Cu, D-Fe, D-Pb, D-Zn. Reruns confirmed. | C |
| Total vs. Dissolved Metals (n=44) | For samples >10X DL, Total metals>Dissolved metals, (Dissolved metals-Total metals)/(average(total metals, dissolved metals) is within +/-30% RPD. For ICP metal scan, it is acceptable for 10% of parameters to be outside of this criterion. | SEEP-12 (6/9/2023) failed for: Zn. SEEP-12 (9/19/2023) failed for: As, Sr, Na. SEEP-17 (6/19/2023) failed for: Zn. ULU-8A (7/1/2023) failed for: Pb. SEEP-00C (7/3/2023) failed for Ni, Zn. REF-106 (7/3/2023) failed for: Cu, Pb, Zn. SEEP-05 SW-125 (7/22/2023) failed for: Zn. Reruns confirmed. | D |

Source: C:\Users\kketchum\SRK Consulting\NA CAPR002649 Ulu Reclamation SOW 2023 - Internal\Task100_ML-ARD\150_Lab liaison and QC\Ulu_Compiled_QAQC_Seepage_CAPR002649_rtc_rev00.xlsx

**Notes**

1 – parameters include Conductivity, pH, Acidity (pH 4.5), Acidity (pH 8.3), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity.

2 – parameters include: total alkalinity and species, Br, F, Cl, $SO_4$, total ammonia, $NO_2$, $NO_3$

# 5 Results

## 5.1 2023 Rinse pH Monitoring

The 2023 test pit logs with photographs are provided in Appendix A. The rinse test results are provided in Table 5-1. The deionized water used in the tests had pH of 6.0 to 6.8 and conductivity of 1.1 to 3.6 µS/cm. For comparison, rinse tests on background tundra soil samples had pH of 4.3 to 5.8 and conductivity of 27 to 79 µS/cm (SRK 2023). Rinse pH versus rinse conductivity are plotted in Figure 5.1 to Figure 5.3 for samples from both the 2020/2021 program and the 2023 program. The 2023 rinse pH data are shown by location in Figure 5.4 colour-coded by pH range. Results are summarized below by area.

**Table 5-1. 2023 Rinse Test Results**

| Area | Test Pit | Sample | Sample depth (cm) | Colour of <2mm sieved rock fraction | Rinse pH | Rinse Conductivity (µS/cm) |
|---|---|---|---|---|---|---|
| Camp pad | TP23-23 | 23A | 30 | orange | 3.4 | 450 |
| Camp pad | TP23-23 | 23B | 45 | grey | 6.9 | 110 |
| Camp pad | TP23-24 | 24A | <60 | brown | 3.7 | 280 |
| Camp pad | TP23-24 | 24B | 100 | grey | 5.7 | 310 |
| Camp pad | TP23-25 | 25A | 100 | orange | 3.1 | 630 |
| Camp pad | TP23-25 | 25B | 50 | grey | 7.9 | 130 |
| Camp pad | TP23-25 | 25C | 200 | grey | 7.8 | 370 |
| Camp pad | TP23-26 | 26 | 100 | grey | 8.2 | 150 |
| Camp pad | TP23-27 | 27 | 100 | grey | 8.5 | 110 |
| Camp pad | TP23-28 | 28 | 60 | grey | 7.7 | 74 |
| Camp pad | TP23-29 | 29 | <108 | grey-brown | 3.5 | 910 |
| Ore pad | TP23-01 | 01 | 88 | dark grey | 7.9 | 220 |
| Ore pad | TP23-02 | 02A | 130 | orange | 3.6 | 490 |
| Ore pad | TP23-02 | 02B | 115 | grey | 7.4 | 120 |
| Ore pad | TP23-03 | 03 | 135 | grey | 7.9 | 220 |
| Ore pad | TP23-04 | 04 | 90 | dark grey | 8.4 | 110 |
| Ore pad | TP23-05 | 05 | 85 | grey | 7.6 | 270 |
| Ore pad | TP23-06 | 06A | 75 | orange | 3.2 | 800 |
| Ore pad | TP23-06 | 06B | 120 | grey | 5.9 | 390 |
| Ore pad | TP23-07 | 07 | 60 | dark grey | 7.9 | 130 |
| Ore pad | TP23-08 | 08 | 60 | grey | 8.2 | 200 |
| Ore pad | TP23-09 | 09 | 180 | orange | 3.9 | 670 |
| Ore pad | TP23-10 | 10 | 120 | grey | 8.0 | 150 |
| Ore pad | TP23-11 | 11 | 70 | grey | 7.9 | 140 |
| Ore pad | TP23-30 | 30 | 20 | orange | 2.9 | 940 |
| Waste rock pad | TP23-13 | 13A | 50 | orange | 3.6 | 480 |
| Waste rock pad | TP23-13 | 13B | 70 | grey | 7.1 | 180 |
| Waste rock pad | TP23-15 | 15 | 50 | brown-grey | 7.3 | 260 |
| Waste rock pad | TP23-16 | 16A | 50 | grey | 7.9 | 240 |

| Area | Test Pit | Sample | Sample depth (cm) | Colour of <2mm sieved rock fraction | Rinse pH | Rinse Conductivity (µS/cm) |
|---|---|---|---|---|---|---|
| Waste rock pad | TP23-16 | 16B | 45 | orange | 3.9 | 650 |
| Waste rock pad | TP23-17 | 17A | 10 | orange | 4.3 | 420 |
| Waste rock pad | TP23-17 | 17B | 50 | grey | 8.0 | 78 |
| Portal area (relocated ore) | TP23-12 | 12 | 15 | grey-brown | 4.3 | 1120 |
| Portal area (relocated ore) | TP23-18 | 18 | 20 | brown-grey | 4.3 | 1880 |
| Portal area (berm) | TP23-19 | 19 | 20 | orange | 3.2 | 590 |
| Portal area (SW of pond) | TP23-20 | 20 | 50 | orange | 3.6 | 280 |
| Portal area (SW of pond) | TP23-21 | 21 | 50 | orange | 3.3 | 420 |

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

### 5.1.1 Ore Pad

For reference, ore pad rinse pH results from test pits in 2020 were predominantly above pH 8.0, with only the north edge of the ore pad identified as having pH below 7 at depth (i.e., pH 5.6 from a test pit close to the north edge of the pad; SRK 2021). Near-surface samples from the edges of the pad were however acidic (i.e., pH 4.0 from brown oxidized residual rock left on the tundra after part of the north edge of the ore pad was removed (Figure 1.1); and pH 3.3 to 3.5 from orange strongly oxidized rock along the southern edge of the pad; SRK 2022b). The 2023 results were as follows:

- Test pit samples from the eastern half of the ore pad had rinse pH of 7.9 to 8.4, similar to 2020 results.
- In the western half of the ore pad results were more variable:
  - Three of the six test pits contained only rock that was grey and had rinse pH of 7.6 to 7.9
  - TP23-02 in the north edge of the ore pad had grey rock down to 115 cm depth (with rinse pH 7.4), and this was underlain by a greater than 75 cm thickness of brown-orange strongly oxidized rock (with rinse pH 3.6). The strongly oxidized rock extended for 3 m in from the edge of the pad.
  - TP23-06 had a 55 cm thickness of strongly oxidized orange rock (with rinse pH 3.2), overlying a 48 cm thickness of grey rock (with rinse pH 5.9), and
  - TP23-09 near the southern edge of the ore pad contained a 2 m thickness of strongly oxidized brown-orange rock with rinse pH 3.9.
  - The residual rock on the tundra adjacent to the north edge of the ore pad had rinse pH 2.9.

Rinse conductivity was 110 to 270 µS/cm in circum-neutral pH samples and 490 to 940 µS/cm in 2023 samples with pH below 4 (Figure 5.1). This is likely due to the presence of soluble secondary sulphate minerals and is consistent with the brown-orange colour of the low pH samples, resulting from precipitation of oxidized iron on the surfaces of the weathered rock. Both sulphate and iron are expected to be released through oxidation of the pyrrhotite and pyrite present in the waste rock.

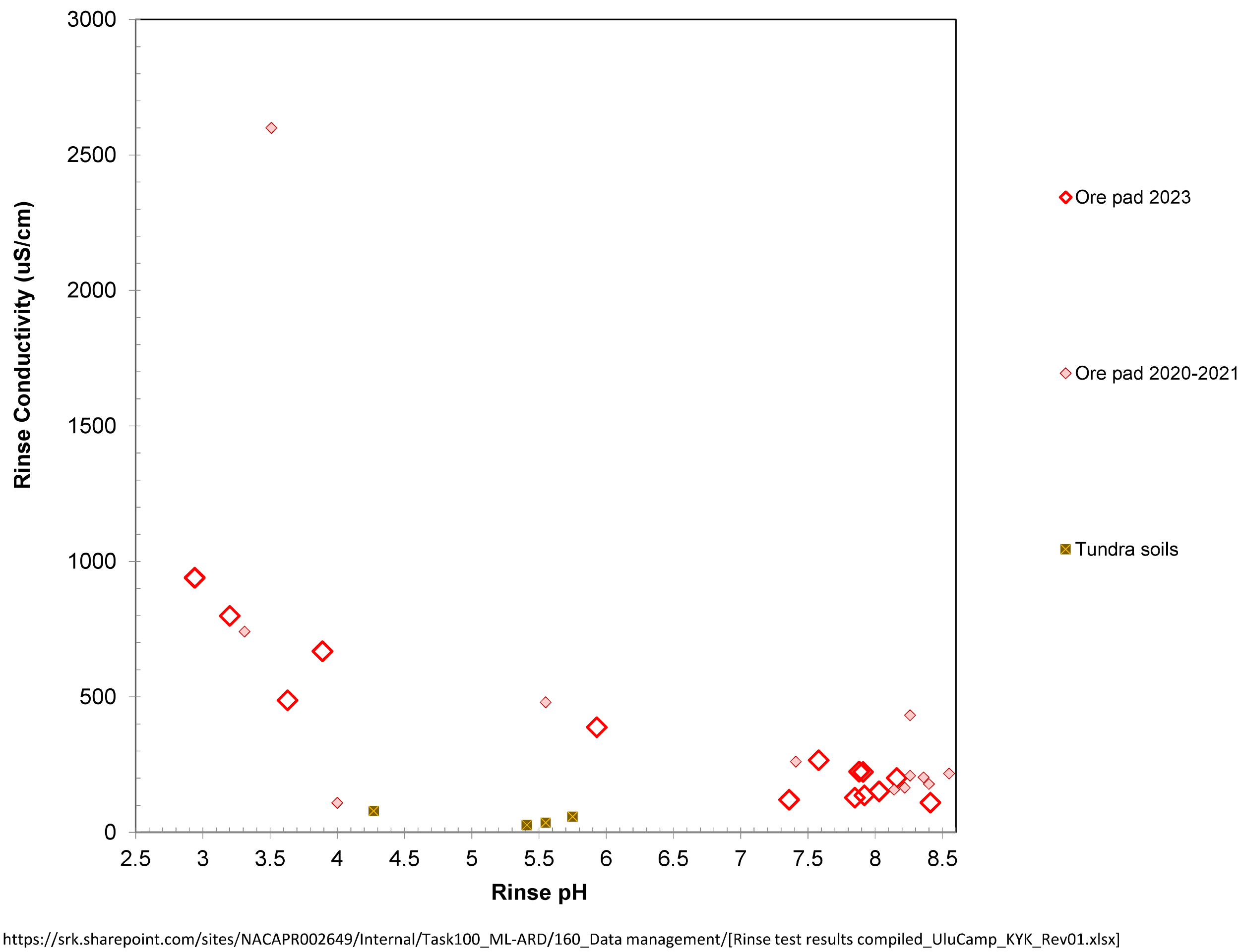



**Figure 5.1. Rinse pH vs rinse conductivity for ore pad samples**

### 5.1.2 Waste Rock-Portal Area

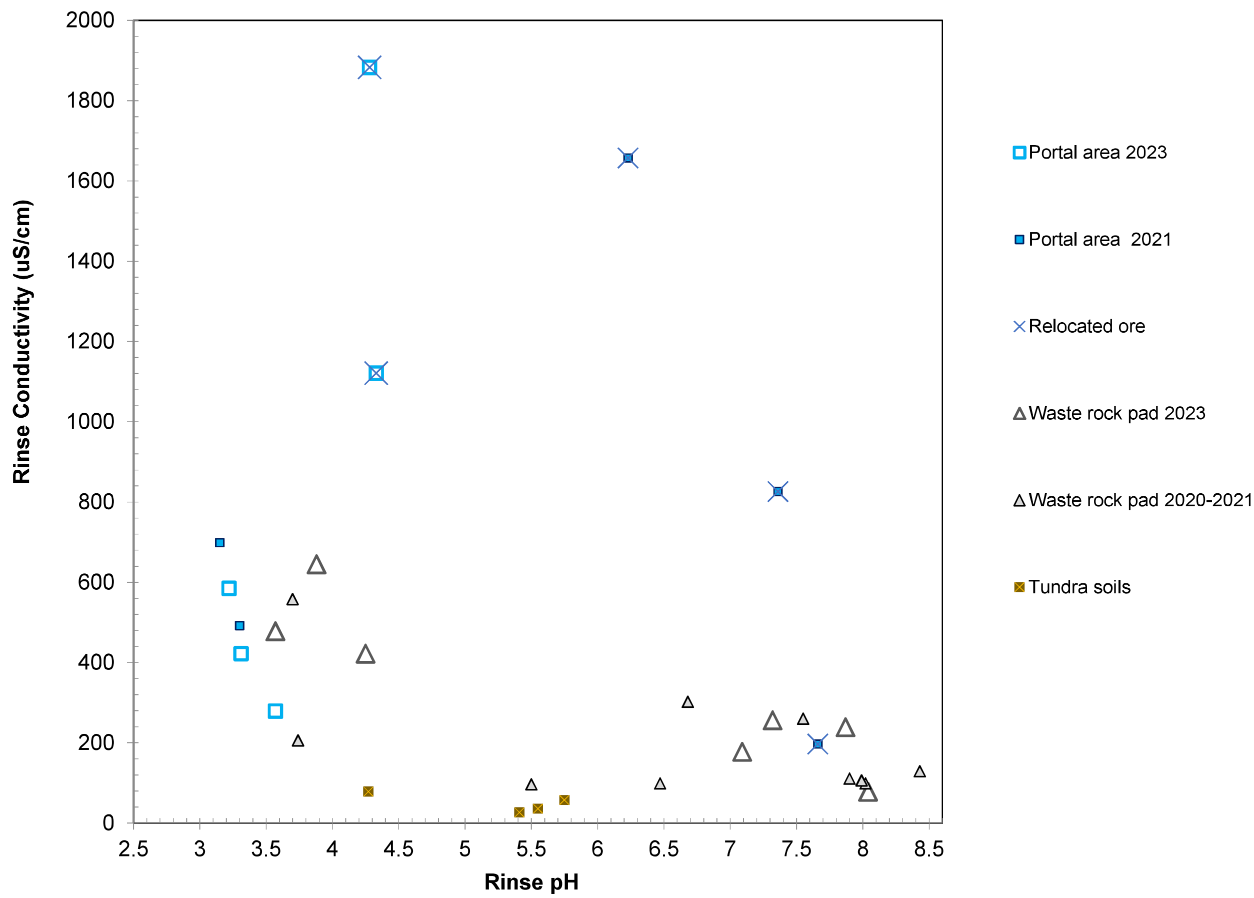
The waste rock pad previously had variable rinse pH ranging from pH 3.7 to 8.4 in 2020 and 2021 test pits; however acidic pH was only identified in one test pit just west of the waste rock stockpile (with strongly oxidized orange rock present from surface to 1.5 m).

In the five 2023 test pits in the waste rock pad, one contained only glacial deposits and was not sampled (TP23-14), one contained brown-grey rock with rinse pH 7.3 (TP23-15) and the others contained some acid generating rock as follows:

- TP23-13 and TP23-17 both contained a 15 cm to 20 cm thickness of strongly oxidized orange rock (rinse pH 3.6 to 4.3), underlain by grey rock with rinse pH of 7.1 or 8.0. These test pits both reached tundra soil at 75 to 80 cm deep.
- TP23-16 contained strongly oxidized orange rock (rinse pH 3.9) present from surface to 1.4 m on one side of the test pit, and grey rock (with rinse pH of 7.9) present from surface to 1.4 m on the other side of the test pit. There was tundra soil below this depth.

Around the portal, 2023 results for waste rock were similar to those from 2021, with rinse pH of 3.2 to 3.6.

Remnant ore that was moved in 2018 from a stockpile on the ore pad (Figure 1.1), and now sits above and to the east of the portal pond (plotted as "relocated ore" on Figure 5.2), appears to have decreased in rinse pH from pH 6.2-7.7 (n=3) in 2021, to pH 4.3 (n=2) in 2023. This rock had notably higher rinse conductivity than the waste rock in the pads, likely due to higher sulphide contents and hence more abundant soluble weathering products are expected to be generated through weathering. This material may have potential for leaching of higher levels of zinc, copper, and nickel compared to the waste rock, therefore development of acidic conditions in the ore is notable.



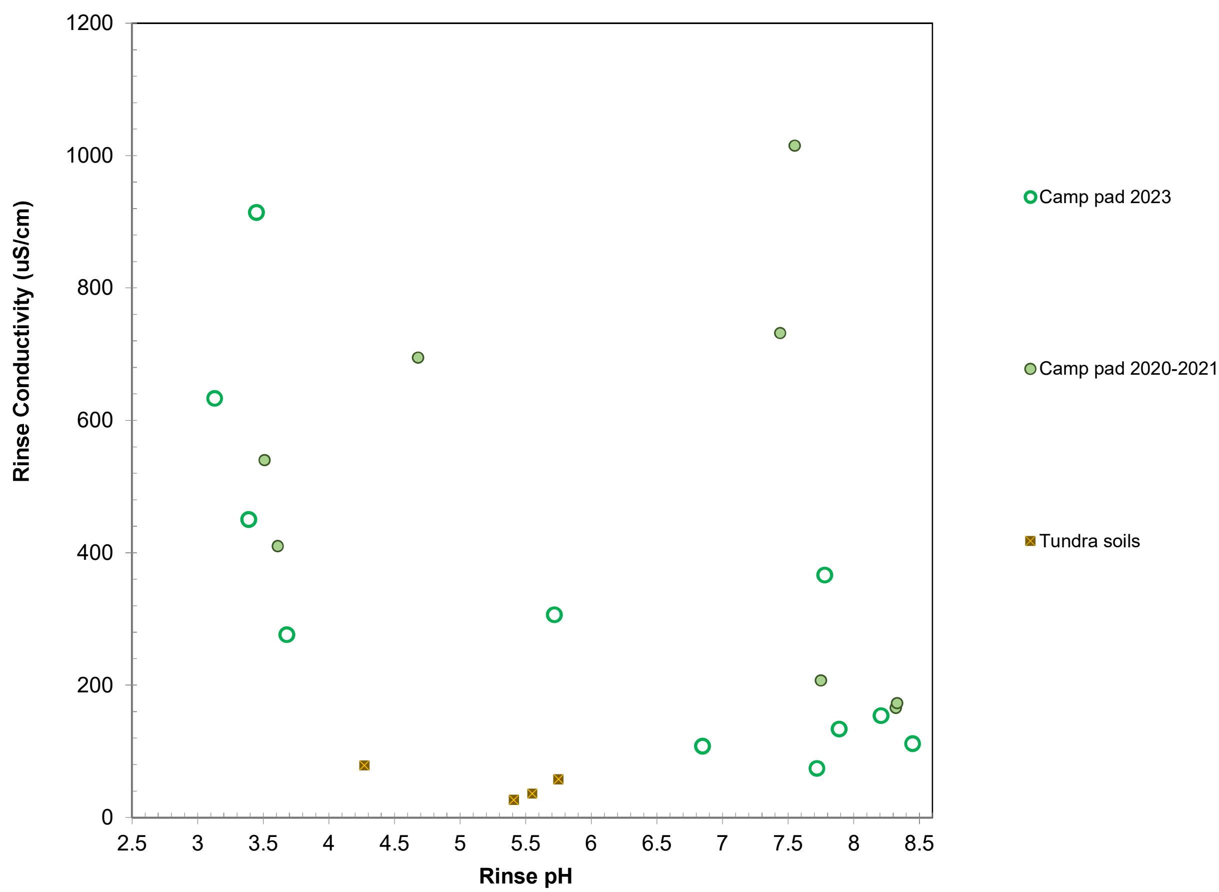

https://srk.sharepoint.com/sites/NACAPR002649/Internal/Task100_ML-ARD/160_Data management/[Rinse test results compiled_UluCamp_KYK_Rev01.xlsx]

**Figure 5.2. Rinse pH vs rinse conductivity for waste rock-portal area samples**

### 5.1.3 Camp Pad

Camp pad rinse pH results from test pits in 2020/2021 were above 7.3 except at the drill core storage area (one test pit with rinse pH 3.5, with underlying rock with rinse pH 4.7) and at the northwest edge of the camp pad by the tents (rinse pH 3.6 from an intermittent orange layer, with surrounding grey rock with rinse pH 8.3). A near surface sample from the edge of the drill core storage area also had rinse pH 2.9 in 2021. The 2023 results were as follows:

- Three test pits along the northeast edge of the camp pad contained only grey rock with rinse pHs of 7.7 to 8.5. One test pit at the far south end of this edge of the camp pad contained just over a meter thickness of brown oxidized rock (rinse pH 3.5) overlying tundra soil.
- TP23-24 in the drill core storage area contained 60 cm thickness of brown rock (rinse pH 3.7) overlying a meter of grey rock (rinse pH 5.7).
- TP23-25 at the edge of the drill core storage area contained about a 2 m thickness of orange strongly oxidized rock (rinse pH 3.1), extending for 2 to 3 m into the pad. Further towards the interior of the pad, and also underlying the orange rock (at 2 m depth), was grey rock with rinse pH of 7.8-7.9. Below 2 m the rock was frozen. The thickness of rock in the pad here above the tundra ground level was 3.6 m.
- TP23-23 at the northwest edge of the camp pad (by the tents) contained 35-70 cm of rock overlying over a meter of sand. The rock was predominantly grey (rinse pH 6.9) with an intermittent 20 cm orange oxidized layer (rinse pH 3.4).




https://srk.sharepoint.com/sites/NACAPR002649/Internal/Task100_ML-ARD/160_Data management/[Rinse test results compiled_UluCamp_KYK_Rev01.xlsx]

**Figure 5.3. Rinse pH vs rinse conductivity for camp pad test pit samples**